Negative evidence in language acquisition*

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Abstract

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Whether children require "negative evidence" (i.e., information about which strings of words are not grammatical sentences) to eliminate their ungrammatical utterances is a central question in language acquisition because, lacking negative evidence, a child would require internal mechanisms to unlearn grammatical errors. Several recent studies argue that parents provide noisy feedback, that is, certain discourse patterns that differ in frequency depending on the grammaticality of children's utterances. However, no one has explicitly discussed how children could use noisy feedback, and I show that noisy feedback is unlikely to be necessary for language learning because (a) if noisy feedback exists it is too weak: a child would have to repeat a given sentence verbatim at least 85 times to decide with reasonable certainty that it is ungrammatical; (b) no kind of noisy feedback is provided to all children at all ages for all types of errors; and (c) noisy feedback may be an artifact of defining parental reply categories relative to the child's utterance. For example, because nearly all parental speech is grammatical, exact repetitions (verbatim repetitions of child utterances) necessarily follow more of children's grammatical utterances than their ungrammatical utterances. There is no evidence that noisy feedback is required for language learning, or even that noisy feedback exists. Thus

internal mechanisms are necessary to account for the unlearning of ungrammatical utterances.

Introduction

A major challenge for theories of language acquisition is to explain how children recover from grammatical errors, such as (1) and (2):

(1) *I maked it with water. (Sarah 4;5; Brown, 1973)
(2) *And fill the little sugars up in the bowl. (Mark 4;7; Pinker, 1989)

Do children eliminate their grammatical errors solely on the basis of internal mechanisms, or do they require external feedback from their parents?

Brown and Hanlon (1970) carried out two analyses in the first systematic examination of whether parents provide feedback contingent on children's grammatical errors. In the first, they examined whether parents comprehend their children better if their children's utterances are grammatical. Each child question was classified as grammatical or ungrammatical; each parental reply was coded to indicate whether the parent understood or failed to understand the child's utterance. Replies indicating the lack of comprehension followed about as many grammatical child questions (42%) as ungrammatical ones (47%); similarly, replies indicating comprehension were equally likely following grammatical and ungrammatical speech (45% in both cases). Brown and Hanlon concluded that "In general, the results provide no support for the notion that there is a communication pressure favoring mature constructions" (p. 45).

In their second analysis, Brown and Hanlon coded whether parental replies indicated approval (e.g., *That's right* or *Yes*) or disapproval (e.g., *That's wrong* or *No*). Again, there was no relation between parental reply types and child grammaticality. Finding not "even a shred of evidence that approval and disapproval are contingent on syntactic correctness" (p. 47), Brown and Hanlon concluded that:

> While there are several bases for approval and disapproval, they are almost always semantic or phonological. Explicit approval or disapproval of either syntax or morphology is extremely rare in our records and so seems not to be the force propelling the child from immature to mature forms. (p. 48)

Based largely on their conclusions, much subsequent research in language acquisition has tried to solve the puzzle of how children acquire language solely from *positive evidence* (i.e., hearing sentences that belong to a language) and without *negative evidence* (i.e., information about which sentences do not belong to that language) (e.g., Baker, 1979; Baker & McCarthy, 1981; Berwick, 1985;

Bowerman, 1983, 1987, 1988; Braine, 1971; Chomsky & Lasnik, 1977; Fodor & Crain, 1987; Grimshaw, 1981; Gropen, Pinker, Hollander, & Goldberg, 1991; Lasnik, 1981, 1989; Marcus et al., 1992; Matthews & Demopoulous, 1989; Mazurkewich & White, 1984; Pinker 1984, 1989; Roeper, 1981; Wexler & Culicover, 1980; Wexler & Hamburger, 1973; Wexler & Manzini, 1987.)

The "no negative evidence problem" – that is, how children could learn language without negative evidence – is often seen as necessarily tied to nativist explanations that posit the existence of internal and innate mechanisms. In fact, Braine (1971), the first to discuss the implications of the "no negative evidence" problem, used the problem to argue *against* Chomsky's (1965) nativist explanation of language acquisition. Arguing that Chomsky's hypothesis-testing proposal would require negative evidence, Braine presented anecdotal evidence suggesting that negative evidence was insufficiently frequent and perhaps ignored, hence refuting Chomsky's proposal.

Without negative evidence, any model of language acquisition, nativist or not, must account for how the child can learn language from positive evidence alone. Suppose a child must learn that a certain sentence, B, is ungrammatical. The child might learn this in two ways. First, something external to the child (i.e., explicit negative evidence) could tell the child that B is ungrammatical. If the parent does not provide an explicit denial of sentence B, the only alternative is that the parent says a sentence (or a set of sentences), A, and that the child has a mechanism which eliminates B when given A. That mechanism, innate or learned, must be internal to the child, regardless of whether it is, for example, a general pragmatic mechanism or a linguistically specific mechanism. The existence or non-existence of negative evidence allows us to determine whether internal mechanisms are needed. If negative evidence does not exist, the task of language acquisition researchers must be to discover which internal mechanisms do allow children to eliminate their errors.[1]

Recently, in what I will call discourse studies, some researchers have disputed the claim that there is no negative evidence (Bohannon & Stanowicz, 1988; Demetras, Post, & Snow, 1986; Hirsh-Pasek, Treiman, & Schneiderman, 1984; Morgan & Travis, 1989). These studies, reporting evidence from the distribution of certain patterns of discourse between parents and children, argue that parents

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[1] "Indirect negative evidence" (e.g., Chomsky 1981) – information about which sentences have not appeared in the input – is sometimes offered as a third type of evidence available to the child. The use of indirect negative evidence would require an inference such as "If X appears in the input, assume that Y is not in the language, unless you hear Y in the input." Indirect negative evidence thus depends on a reanalysis of positive evidence based on mechanisms internal to the child, rather than input external to the child; hence for the purposes of this paper I collapse it with positive evidence. See Pinker (1989, pp. 14–15) for further discussion.

Table 1.   *Definitions of types of parental replies used in discourse studies*

Explicit approval	Parent says yes or uh-huh or the like
Non sequiturs	Parent fails to understand child
Repetitions (only Hirsh-Pasek et al.)	Parent repeats child utterance, perhaps with changes
Imitations/exact reps.	Parent repeats child utterance, verbatim
Expansion	Parent repeats child utterance, but makes grammatical changes or adds new material
Recasts	Parent repeats child utterances, but with minor grammatical changes
Topic extensions	Continued topic but not a repetition or expansion
Move-ons/no responses	Parent moves conversation along
Clarification questions	Parent asks a question that requests child to repeat part of utterance
Confirmation questions	Parent asks a yes/no question

do provide implicit feedback to their children based on whether children speak grammatically.[2]

Each study used somewhat different reply categories; the Appendix reprints exact definitions. Table 1 provides rough definitions of each type of parental reply. Some discourse patterns, such as expansions (interchanges between a child and a parent in which a parent repeats the child's utterance with small changes), are claimed to be elicited more often by ungrammatical speech than by grammatical speech. Other discourse patterns such as exact repetitions (interchanges in which a parent exactly repeats a child utterance) are claimed to be elicited more often by grammatical speech than by ungrammatical speech.

In all cases, the differences in parental replies to grammatical versus ungrammatical sentences were statistical rather than categorical (i.e., all-or-none). I call this type of feedback *noisy feedback*, since parents provided each type of

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[2]All of the studies that I will discuss contrast parental replies to grammatical sentences with parental replies to ungrammatical sentences. However, one study, Moerk (1991), presented examples only of how parents reply to ungrammatical sentences and failed to present examples of how parents reply to *grammatical* utterances. For example, in the following exchange, Moerk called the reply *What did I do?* a "correction" (Eve: *What did you doed?* Mother: *What did I do?*), but he neglected to note that the identical parental reply, two samples earlier, is not a "correction" (Eve: *Hurt my eye*. Mother: *Your eye?* Eve: *Yeah*. Mother: *What did I do?*) (Eve, 2;1). Moerk provided no objective definition of "corrections" and no explanation of how a child could recognize or use them. Applying this method, one could argue that the word *red* provides negative evidence: simply cull transcript examples in which the parent said *red* following a child's ungrammatical utterances and ignore the occasions in which the parent said *red* after the child's grammatical utterances. Without the crucial contrast between replies to grammatical and ungrammatical sentences, such studies are irrelevant to the question of whether parents provide negative evidence.

reply after both grammatical and ungrammatical sentences, albeit in different proportions.

In a recent discourse study, Bohannon and Stanowicz (1988) argue that discourse-based noisy feedback "may be considered superior to simple denials and as qualified to assume the role of 'negative evidence'" (p. 688), and concluded that "To the extent that current theories of language acquisition also ignore adults' tendency to provide feedback (i.e., negative and specific evidence), these theories will fail to accurately account for language acquisition" (p. 688).

These conclusions, if correct, would undermine much of the research based on the assumption that parents do not provide negative evidence. However, because the methodology and results of the discourse studies vary and often conflict with one another, and because there has been little discussion of how children could use noisy feedback to eliminate grammatical errors, the role and existence of noisy feedback remain controversial. This controversy is evident both empirically, in the conflicting results and conclusions of Bohannon and Stanowicz (1988) and Morgan and Travis (1989), and theoretically, in a recent debate between Gordon (1990) and Bohannon, MacWhinney, and Snow (1990).

The goal of this paper is to define and apply clear criteria for clarifying the role and existence of noisy feedback. These criteria will lead to the following conclusions:

- Noisy feedback is too weak to be a plausible way of eliminating errors. Even under statistically optimal conditions, a child would have to repeat a given sentence verbatim more than 85 times to eliminate it from his or her grammar.

- Noisy feedback is inconsistent across parents, declines or disappears with age, and is probably not provided for all types of errors and is thus unavailable for much of language acquisition. Furthermore, some apparent patterns of noisy feedback may be averaging artifacts that do not correspond to types of feedback given to any individual child.

- Because parental reply categories are defined only with respect to the child's utterance, "correlations" between the two may be artifacts resulting from the definition of parental reply categories and of constant noncontingent properties of parental and child speech. For example, several studies show that verbatim repetitions follow more grammatical than ungrammatical sentences. But because parents virtually never speak ungrammatically, verbatim repetitions necessarily negatively correlate with children's ungrammatical utterances.

Any one of these three conclusions, the weakness, the inconsistency, or the inherently artifactual nature of noisy feedback, would by itself severely undermine, if not falsify, the position that parents provide feedback to their children and thus that such feedback is required for language acquisition. Of course, even if parents provided feedback, it might turn out empirically that children do not use it. For example, Zwicky (1970), in discussing his daughter's inflectional

overregularizations (e.g., *goed*), points out that "six months of frequent corrections by her parents had no noticeable effect". Braine (1971) even more clearly illustrates that feedback may be ineffective:

> For experimental purposes, I have occasionally made an extensive effort to change the syntax of my two children through correction. One case was use by my two-and-a-half-year-old daughter of *other one* as a noun modifier. Over a period of a few weeks I repeatedly but fruitlessly tried to persuade her to substitute *other* + N for *other one* + N. With different nouns on different occasions, the interchanges went somewhat as follows: "Want other one spoon, Daddy" – "You mean, you want THE OTHER SPOON" – "Yes, I want other one spoon, please, Daddy" – "Can you say 'the other spoon'?" – "Other . . . one . . . spoon" – "Say . . . 'other' " – "Other" – "Spoon" – "Spoon" – "Other . . . spoon" – "Other . . . spoon. Now give me other one spoon?" Further tuition is ruled out by her protest, vigorously supported by my wife. Examples indicating a similar difficulty in using negative information will probably be available to any reader who has tried to correct the grammar of a two- or three-year-old child. (pp. 160–161)

Even when children understand that they are being corrected, they sometimes make incorrect generalizations, as McNeill (1966, p. 69) shows:

> Child: Nobody don't like me.
> Mother: No, say "nobody likes me."
> Child: Nobody don't like me.
> [Eight repetitions of this dialogue follow.]
> Mother: No, now listen carefully, say "NOBODY LIKES ME."
> Child: Oh! Nobody don't likes me.

These examples suggest that it is the child's underlying linguistic system, rather than negative evidence, which forces children to change their grammars. Until the existence of reliably parental feedback is firmly established, however, it is premature to consider whether children actually use it.

Types of parental feedback and their role in language learnability

Positive evidence is simply the input, that is, the sentences children hear. In contrast, *negative evidence* is a parental behavior that provides information about when sentences are not in the language. Negative evidence does not tell a child which sentences are grammatical; rather, it indicates that the child has uttered an ungrammatical sentence. Moreover, negative evidence does not tell a child *why* a particular sentence is ungrammatical.

A child who does not speak can receive no negative evidence, aside from explicit metalinguistic statements (e.g., *don't say X*). Negative evidence must respond to a child's utterance; it can only arise if parents are in some way *sensitive* (though not necessarily consciously) to whether their children speak grammatically.

The parental behavior that provides negative evidence I will call the *reply type*. The reply type may take many forms: the parent might say *no*, provide a

repetition, shrug, or even spank the child. An individual occurrence of a given reply type (e.g., a single utterance of the word *no*) is a *reply instance*.

To distinguish three kinds of negative evidence that are often collapsed, I use the terms *complete feedback*, *partial feedback* and *noisy feedback*. *Complete feedback* is any corrective signal provided for all and only those sentences that are ungrammatical (cf. Gold's (1967) term *informant presentation* in the formal mathematical literature on learnability). *Partial feedback* is any corrective signal provided following some ungrammatical sentences, but never provided following correct sentences. *Noisy feedback* is a corrective signal provided after some errors and after some correct sentences, but in different proportions. A single reply instance of noisy feedback, unlike instances of complete feedback and partial feedback, does not guarantee that a sentence is ungrammatical.

Verbal parental feedback, such as repetitions or expansions, inherently provides the child with positive evidence, as well as potentially providing negative evidence. Several studies have reported that expansion may spur learning (though Morgan, Bonamo, & Travis, 1991, conclude the opposite). Crucially, however, even if children learn from expansions, they might do so without using negative evidence. In principle, a child could learn whether some sentence is grammatical (a) only from positive evidence, which tells the child that the parental utterance is a possible way of saying what she wanted to say; (b) only from negative evidence, which tells the child that her utterance is not acceptable; or (c) both, which would tell the child both that her sentence was unacceptable and provide an acceptable alternative; each of these possibilities is plausible *a priori*. Consider this hypothetical dialogue:

(3) Child: I eated the food.
    Parent: I ate the food.

This parental reply clearly provides the child with a piece of positive evidence: *I ate the food* is a grammatical sentence. Positive evidence alone does not tell the child whether *eated* and *ate* are stylistic variants or synonyms or whether *eated* is unacceptable, but might do so in combination with internal mechanisms. The parental reply could serve as negative evidence only if the child recognizes it as an exemplar of a recast and has mechanisms that use such information.

Complete feedback

A child who received complete feedback might eventually converge on the correct language by eliminating all possible but ungrammatical sentences from her language (Gold, 1967; Pinker 1979).

If complete feedback existed it would probably be easy to detect, since there would, by definition, be a perfect correlation between the reply type and the

grammaticality of the child's utterance. Nobody, though, has ever provided any evidence that children receive complete feedback; every reply type studied in the discourse studies is not provided for all ungrammatical sentences, and is provided for some grammatical sentences. Nobody claims, for instance, that parents expand children's utterances every time that a child errs but never when the child speaks grammatically. Thus children almost certainly do not receive complete feedback.

Partial feedback

Partial feedback, by definition, is not provided every time a child makes an error. There has been no explicit discussion of how children could use such feedback, although Gordon (1990) has suggested that "it may, in fact, be possible to show that learning can occur with inconsistent feedback . . . using statistical rather than absolute criteria to determine grammaticality" (p. 219). It is not clear whether children have mechanisms for using partial feedback, nor what those mechanisms might be.

In any case, partial feedback does not seem to exist. No reply type studied in the discourse studies is provided only for ungrammatical sentences but not for grammatical sentences, or vice versa. The evidence from the discourse studies suggests that all patterns of discourse provide, at best, noisy feedback: every reply type is provided following both grammatical and ungrammatical speech.

Noisy feedback

Several studies claim to have documented patterns of noisy feedback, but there has been no explicit discussion of how children might use it. I will examine a concrete example, after defining four terms. The proportion of reply instances (e.g. expansions) elicited by grammatical speech will be denoted by $\text{pr}\{\text{gr}\}$. The proportion of reply instances elicited by ungrammatical speech is, then, $\text{pr}\{\text{ungr}\}$. The number of times the child tests a given sentence is n; the observed proportion of reply instances is $p(obs)$. I will assume that the feedback is provided probabilistically and independently.

Suppose $\text{pr}\{\text{ungr}\} = .20$ and $\text{pr}\{\text{gr}\} = .12$ (These proportions are drawn from the distribution of noisy feedback reported by Hirsh-Pasek et al.) Suppose the child says a sentence once (i.e., $n = 1$). Depending on whether the parent provides a reply instance, $p(obs)$ will be either 0 or 1. Suppose $p(obs)$ is 1; given the small sample size, $p(obs)$ could easily come from either distribution. The

chance that $p(obs)$ comes from pr{ungr} is .625 (since 20 out of every 32 reply instances would follow ungrammatical sentences). The chance that it comes from pr{gr} is .375 ($=1-.625$). Thus if the child decides that the sentence is ungrammatical, there is a .375 chance that the child is wrong. Or if $p(obs)$ is 0, there is a .52 (88/168) chance that the sentence is grammatical, and a .48 chance that the sentence is ungrammatical. In either case, the child has some information but not enough.

The child's chances improve if the child increases the sample size, n, by repeating the sentence. Suppose after 100 repetitions of the sentence, $p(obs) =$ .17. Then it is relatively likely that the sentence is from pr{ungr} but still reasonably likely that $p(obs)$ comes from pr{gr}. If a child repeats the test sentence 1000 times, with $p(obs) = .20$, the child could decide with near certainty. In general, the more times the child repeats the same sentence, the more information the child gathers, and the easier it is for the child to determine the grammaticality of that sentence, with some degree of certainty; I will assume that the degree of certainty equals the rate of error.

Because the end point of language acquisition is the adult state, I assume that the acceptable rate of error, ε, should reflect the rate at which adults make grammatical errors (or perhaps be lower, since adults often know when they have made errors). If ε is too high, the child will fail to converge on the adult state of rarely making errors. The overall rate of adult past tense overregularization errors (e.g. *maked* or *maded*) is around .00004 (Marcus et al., 1992), while the overall rate of adult speech errors is about .001 (Stemberger, 1989). To be generous by an order of magnitude, suppose ε is .01.[3]

In Figure 1, the left curve represents the sampling distribution of the proportion of parental reply instances out of child utterances provided following grammatical sentences, while the right curve represents the sampling distribution of the proportion of parental reply instances out of child utterances provided following ungrammatical sentences. The shapes of the two curves depend on the proportions of feedback to grammatical and ungrammatical sentences and the number of times, n, that the child repeats the test sentence; here pr{gr} = .12, pr{ungr} = .20, $n = 10$.

In order to decide whether a sentence is grammatical, assuming $\varepsilon = .01$, a child must determine whether $p(obs)$ is within the 99% confidence interval of the grammatical distribution, within the 99% confidence interval of the ungrammatical distribution, or within the overlap between the two confidence intervals, which I call *the region of ambiguity*, shown as the cross-hatched region in Figure 1. This

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[3]Actually, two error rates are involved here: the chance of incorrectly accepting a sentence as grammatical and the chance of incorrectly accepting a sentence as ungrammatical. Since most speakers agree both on which sentences are grammatical and on which sentences are ungrammatical, both rates should be very low. Lacking evidence to the contrary, I assume that these two error rates are equal.
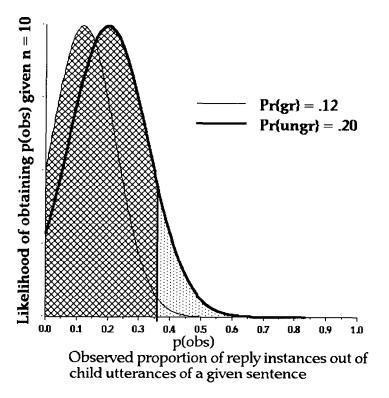
Figure 1. Proportion of child utterances of a given sentence which are followed by a reply instance, given n = 10. The vertical line, at p(obs) = .36, represents the upper bound of the 99% confidence interval of pr{gr}. The cross-hatched region of ambiguity represents the range of possible proportions of feedback which fall within the 99% confidence intervals of the distributions of parental responses both to grammatical and ungrammatical sentences. The dotted region to the right represents the area of confidence interval of pr{ungr} that is not within the confidence interval of pr{gr}.

region indicates possible values of $p(obs)$ under which a child cannot make a decision within the specified risk of error.[4]

The only way the child can reduce the region of ambiguity is to repeat her test sentence again and again, n times. Figure 2 represents the smallest value of n in which the region of ambiguity is eliminated (for $\varepsilon = .01$). Before being able to make a decision, the child would need to repeat the same construction 446 times.

Of course, the minimum number of repetitions necessary to decide whether a sentence is grammatical depends on the proportions of feedback; these values

[4]Note that for positive evidence there is virtually no region of ambiguity. If the parent says a sentence, the child can be nearly certain that the sentence is grammatical. According to Newport, Gleitman, and Gleitman (1977), 99.44% of parental speech to children is grammatical. Similarly, if the parent provided complete feedback, there would also be no region of ambiguity. Upon hearing a reply instance, the child could immediately decide that a given sentence was ungrammatical.
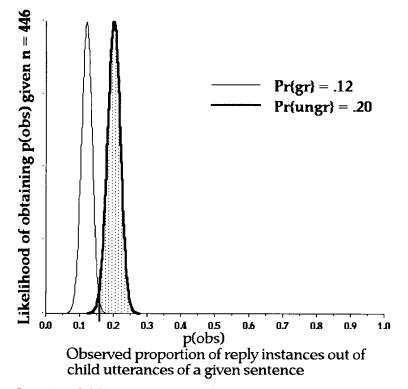
Likelihood of obtaining p(obs) given n = 446

Pr{gr} = .12

Pr{ungr} = .20

p(obs)

Observed proportion of reply instances out of
child utterances of a given sentence

Figure 2. *Proportion of child utterances of a given sentence which are followed by a reply instance, given* n = 446. *The vertical line, at* p(obs) = .16, *represents both the lower bound of the 99% confidence interval of* pr{ungr} *and the upper bound of the 99% confidence interval of* pr{gr}. *Thus, the region of ambiguity is zero. The left region indicates the confidence interval of* pr{gr}. *The right, dotted region, represents the confidence interval of* pr{ungr}.

vary across the discourse studies. Table 2 shows estimates of *n* for the clearest and easiest reply types the child could use. Weaker differences between parental replies to grammatical and ungrammatical sentences would require the child to repeat a test sentence even more often.

The lowest estimate of *n*, derived from data reported by Bohannon and Stanowicz (1988), is 85; the highest estimate of *n* is 679. If a child does not repeat a given sentence *n* times, noisy feedback cannot account for how the child eliminates the error.

However, aside from formulas and routines, most of children's speech is not repetitive. Children repeat few sentences even ten times, let alone 85. For example, Pinker (1989) searched 86,332 child utterances taken from transcripts of spontaneous speech for errors in which a child misused the argument structure of a dative (e.g., *Don't say me that*). None of these errors was repeated anywhere near 85 times: one child (Eve) made 11 errors with the verb *write*, no other error

Table 2.   *Minimum number of times* (n) *a child would need to repeat a given sentence verbatim to decide whether it was grammatical, with chance of error, ε, less than .01, calculated for the strongest reply types reported in the discourse studies (n may be determined by finding the minimum number of repetitions of a single sentence such that the 99% confidence intervals of the two distributions (pr{gr}, pr{ungr}) do not overlap)*

Study	Reply type	pr{ungr}	pr{gr}	n
Hirsh-Pasek et al.	Repetitions 2-year-olds	20	12	446
	3–5-year-olds	no differences		n/a
Penner	Expansions: group 1	18.3	4.6	104
	Expansions: group 2	11.3	6.3	679
Bohannon and Stanowicz	Total of all reply types	35	14	85
Morgan and Travis	Expansions (A, E, and S)	11.3	2.7	169

Note: The data from Demetras et al. are excluded because most patterns of reply varied across parents and no inferential statistics (or sample sizes) were provided. Without such information we cannot infer the reliability of the data. The data for Morgan and Travis are an average across the patterns of parental expansions to Adam, Eve, and Sarah, from Table 4, Morgan and Travis (1989, p. 545), because there is substantial variation between the pattern of expansions to the different children. Eve would only require 63 verbatim repetitions, but Sarah would require 300.

was repeated more than three times, and thus noisy feedback is almost certainly too weak to account for how children eliminate their errors.

Children might follow strategies other than the one I have outlined, but none of these can reduce *n* without increasing the error rate. For instance, children might be thoroughly productive and assume that every sentence is grammatical unless the sentence receives frequent and repeated correction. Following this strategy, children would overgenerate implausibly often, repeating ungrammatical sentences far more often than they are actually observed to do (Marcus et al., 1992). Children also cannot be completely conservative and assume that all sentences are ungrammatical, since they productively create sentences they have never heard (e.g., Pinker, 1989). In any case, if children utilize noisy feedback before repeating a sentence enough times, their risk of errors must go up, because there is only a limited amount of information in each reply instance, and the only way to get more information is to repeat their sentences again and again in an effort to increase the reliability of the information contained in parental replies.

Combining noisy feedback from different sentences

I have assumed that children determine grammaticality on a sentence-by-sentence basis. Could children instead determine the grammaticality of entire classes of sentences on the basis of negative evidence? For instance, a child trying to test whether *The boy eat apples* is grammatical might combine feedback

provided to that sentence with feedback provided to "equivalent" sentences such as *The girl eat apples*, in order to overcome the inherent weakness of noisy feedback.

Combining feedback provided to some set of equivalent sentences requires a child to determine which sentences are "equivalent"; determining equivalency, however, can only be done properly after the child knows which factors affect a sentence's grammaticality, defeating the very purpose of using noisy feedback. Sometimes two sentences similar in structure, differing by no more than a word, are both equally acceptable in a language; for example, *A boy ate some apples* and *A girl ate some apples* are both grammatical, and *Some a boy apples ate* and *Some a girl apples ate* are both ungrammatical. Often, however, two apparently quite similar sentences are not equally acceptable in the target language. For example, *A boy ate some apples* is grammatical but *A boy ate much apples* is ungrammatical. A child who combined the feedback provided for these two sentences would err, as would a child who combined feedback for *Fill the water in the bowl* with *Pour the water in the bowl*, or *John slapped Bill* with *John hitted Bill*. The rules governing which sentences are and are not equivalent, with respect to feedback, are the very rules of the grammar the child is trying to learn. If feedback is to be the means by which children form equivalence classes then children's use of feedback cannot rely on the pre-existence of those equivalence classes. There is no doubt that children do form equivalence classes, but negative evidence does not explain how children form them.[5]

Learning the probabilities of noisy feedback

The model presented above assumes that the child has perfect knowledge of ($pr\{gr\}$ and $pr\{ungr\}$). If the child's knowledge of the reply probabilities is poor, errors of falsely accepting ungrammatical sentences or else errors of falsely rejecting grammatical sentences becomes more likely. For instance, if $pr\{gr\}$ = .12 and $pr\{ungr\}$ = .2, but the child incorrectly hypothesizes that $pr\{gr\}$ = .2 and $pr\{ungr\}$ = .4, and the child utters a grammatical sentence multiple times and receives $p(obs)$ = .2, the child will conclude falsely that the sentence is grammatical.

Given individual differences between parents (to be discussed below), it is unlikely that the probabilities of feedback are specified innately. How, then, could the child learn the reply probabilities? The child cannot simply record how many of her ungrammatical versus grammatical sentences elicit instances of some reply. Children could safely assume that their parents speak grammatically, but by

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[5]The child learning from positive evidence alone may seem to face the same dilemma – how to form the equivalence classes without knowing them. The answer proposed by Chomsky and others is that the child has innate knowledge which constrains the inductions by which the child may form equivalence classes.

hypothesis they do not know which sentences are ungrammatical. A child might construct minimal pairs by comparing the parent's sentence with a sentence that is likely to be ungrammatical. But this begs the question: how would the child know which sentences are likely to be ungrammatical? In sum, it is unclear how children could learn the probabilities of feedback.

Some researchers seem to want to eliminate language-specific learning mechanisms in favor of parental feedback on the grounds that models that depend on parental feedback might be simpler, but consider what new mechanisms they must propose. The child must recognize the (subtle) feedback reply types and discriminate the useful reply types from the noise, and then make use of them. Furthermore, the child must learn (at least approximations of) the probabilities of feedback, induced in some unspecified manner. Though a child might solve all these problems, it is hardly clear that models of language acquisition that depend on feedback present simpler models than those based on internal, linguistic-specific constraints.

Summary

I distinguished three types of negative evidence: complete, partial, and noisy feedback. There is no evidence that either complete feedback (negative evidence provided following all ungrammatical sentences and no grammatical sentences) or partial feedback (negative evidence provided for some ungrammatical sentences but no grammatical sentences) exists. Noisy feedback, the only attested type of feedback, is negative evidence provided for some grammatical sentences as well as some ungrammatical sentences. Under conditions of noisy feedback (unlike complete feedback and partial feedback), a single reply instance cannot guarantee that a given sentence is ungrammatical. Under certain reasonable assumptions about feedback probabilities and acceptable error levels, a child would have to repeat the sentence in question, *verbatim*, at least 85 times before deciding whether it is grammatical. Furthermore, to use noisy feedback, the child must solve the difficult bootstrapping problem of determining the probabilities of reply instances for both grammatical and ungrammatical sentences. Theories of language acquisition that require noisy feedback are thus plausible only to the extent that it is plausible that children notice noisy feedback, have mechanisms to make use of it, and repeat sentences at least 85 times each.

Generality and availability of noisy feedback

Noisy feedback is interesting only if it can eliminate the need for specific internal mechanisms, but these mechanisms are only eliminable if noisy feedback is

necessary for language learning. If noisy feedback were merely helpful for language learning, but not necessary, internal mechanisms would still be needed to account for language acquisition. In this section I will develop and apply criteria, based in part on those discussed by Grimshaw and Pinker (1989), Pinker (1989), and Morgan and Travis (1989), for determining whether there is evidence that any type of feedback is a necessary component of language acquisition.

Criteria

Does every child receive noisy feedback?

Since every child learns language, a particular type of parental feedback can be a precondition for learning language only if it is provided to every child. Many types of feedback may be *sufficient* for language acquisition, but if any child manages to learn language lacking that particular type of feedback, then that particular type of parental feedback cannot be necessary for language acquisition. (Note that every child receives positive evidence.)

Because between-subject differences are crucial, appropriate statistical analyses of patterns of noisy feedback should examine patterns of feedback within individual parent–child dyads. Combining data from several children may create two types of averaging artifacts. First, aggregating data from multiple children may hide differences between the patterns of feedback provided to those children. Suppose one parent provided reliable noisy feedback, but another parent did not provide reliable feedback. Combining the data from these two parent–child dyads, one might falsely conclude that the pattern of feedback is available to both children. To avoid such problems, a more fine-grained analysis is necessary.

Second, when studies average raw data[6] from several dyads, patterns of noisy feedback can emerge *that no child actually received*. For example, if 80% of Johnny's utterances are grammatical, and Johnny's mother repeats a random 75% of his utterances, but 60% of Billy's utterances are grammatical and his mother only repeats half of Billy's sentences, at random, then combining the same amount of data for both children will lead to the (false) conclusion that 64% of grammatical utterances elicited repetitions, compared to only 58% of ungrammatical utterances; see Table 3.

Do parents provide noisy feedback until errors stop?

If certain aspects of language acquisition depend on parental feedback, parents must provide feedback until children have finished acquiring those aspects of

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[6]Averaging percentages rather than raw data would prevent the emergence of entirely spurious reply contingencies but could still conceal important individual differences.

Table 3. *How patterns of feedback could be an artifact of averaging data from several children*

	Grammatical	Ungrammatical
Johnny	60/80 = .75	15/20 = .75
Billy	30/60 = .5	20/40 = .5
Average	90/140 = .64	35/60 = .58

Note: Number of utterances repeated out of 100.

language. Moreover, if feedback declines or disappears with age, combining data might suggest falsely that noisy feedback is available, even if no child actually receives such feedback. Suppose that a parent consistently repeats every utterance of his or her child at age 2 but by the time the child is 3 the parent no longer repeats many of the child's utterances. If at age 2 the child produces 80% ungrammatical utterances, but by age 3 the child only produces 60% ungrammatical sentences, then, as shown in Table 4, one might conclude falsely that the parent repeats a higher proportion of ungrammatical sentences than grammatical sentences, *even though no parent ever replies differentially to grammatical and ungrammatical sentences*. The misleading conclusion results from (a) the parent's repeating fewer of the older child's sentences and (b) the older child's greater proportion of grammatical sentences. Averaging data across different children of different ages may cause similar artifacts.

Do parents provide noisy feedback for all kinds of linguistic errors?

Language has several components or levels of representation, including phonological, syntactic, and semantic representations. There is empirical evidence that parents reply to different types of errors in different ways. For example, Brown and Hanlon (1970, p. 48) concluded that the "bases for approval and disapproval . . . are almost always semantic or phonological". To show that negative feedback is necessary for the elimination of errors of some kind, phonological, morphological, syntactic, or semantic, one must provide evidence that adequate feedback corresponding to that specific kind of error exists.

Table 4. *How patterns of feedback could be an artifact of averaging over age*

	Grammatical	Ungrammatical
2-year-old	20/20 = 1	80/80 = 1
3-year-old	0/40 = 0	0/60 = .0
Average	20/60 = .33	80/140 = .53

Note: Number of utterances repeated out of 100.

Do parents provide noisy feedback for different types of grammatical constructions?

Parents might provide feedback for some syntactic constructions, but still fail to provide feedback for other syntactic constructions. A child who received parental feedback for, say, agreement errors (e.g., *He eat the candy*), but not for improper locative verb alternations (e.g., *Fill the little sugars up in the bowl*), could not learn which locative alternations are permissible on the basis of parental feedback. Parental feedback must be available for all grammatical constructions for which it is posited to correct.

Summary

To determine whether a particular type of noisy feedback could be necessary for unlearning errors, there are four criteria: (1) the reply type must be available to all children; (2) the reply type must be available throughout acquisition; (3) the reply type must be available for errors in each component of language; (4) the reply type must be available after all types of errors within a given component. Any pattern of noisy feedback that is necessary for language acquisition would meet all of these criteria. Positive feedback meets all of them: all children, at all ages, receive positive evidence for all types of representation and nearly all types of constructions. Complete feedback, if it existed, would also meet these criteria.

Application of criteria

Does every child receive noisy feedback?

Many patterns of feedback were inconsistent across dyads within the studies that reported them, as indicated by asterisks in Table 5. Futhermore, many of the remaining effects failed to replicate in other studies.[7] The rightmost column indicates that only one pattern of feedback was provided to all children studied: recasts. Bohannon and Stanowicz found that, on average, parents provided more recasts after ungrammatical than grammatical sentences. However, though they indicate that parents and non-parents replied differently, it is unclear whether every child received more recasts after ungrammatical sentences; even recasts may not be consistent across the children they studied.

The studies that allow examination of individual differences show that different parents provide different, even conflicting, patterns of feedback. Demetras et al.

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[7]An anonymous reviewer suggested that differences in social or economic status might account for some of the variation in feedback.

Table 5.   *Availability of particular types of feedback across all children studied*

	Found by	Not found by	Did all children receive the same type of feedback?
Explicit approval	–	BH, HPTS, P	No
Non sequiturs	–	BH	No
Repetitions	HPTS	DPS*	No
Imitations (or exact repetitions)	DPS, BS	P, MT*	No
Expansion	P, BS	DPS*, MT	No
Recasts	BS		Yes
Topic extensions/move-ons	DPS	P,* MT*	No
Clarification questions	DPS, BS	MT	No
Confirmation questions	–	P, MT	No

Notes: Morgan and Travis distinguished partial and exact imitations. Exact imitations were consistent across parents; partial imitations were not.

Penner found that confirmation questions were more common after ungrammatical sentences; these effects, however, were not statistically significant.

*Indicates that the effect found was inconsistent across children within that study.

BH, Brown and Hanlon; HPTS, Hirsh-Pasek et al.; DPS, Demetras et al.; P, Penner; BS, Bohannon and Stanowicz; MT, Morgan and Travis.

found that some children receive certain reply types, such as expanded repetitions, more after ill-formed sentences than well-formed sentences.[8] However, other children receive the same reply types more often after *well*-formed sentences. Penner noted that "although parents repeated correct child utterances slightly more frequently than incorrect child utterances, the pattern was not consistent for all parents". Morgan and Travis, studying three subjects, Adam, Eve, and Sarah (from Brown, 1973), found that, for each set of parents, the contingencies between parental replies and the grammaticality of children's utterances were different. For example, while Adam's parents asked more clarification questions after his *well*-formed wh- questions, Eve and Sarah's parents were more likely to ask clarification questions after their children's *ill*-formed wh- questions. If the reply types are contingent on grammaticality for some children, but contingent on ungrammaticality for other children, would some children eliminate *goed* in favor of *went*, while other children eliminate *went* in favor of *goed*?

Finally, Hirsh-Pasek et al., Penner, and Bohannon and Stanowicz all combined data from many children in their analyses,[9] leading to potential statistical artifacts. Data from children who received no feedback, when averaged with data from

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[8]Demetras et al. presented no inferential statistics, and many patterns of feedback are different for different parent–child dyads. Thus contingencies within individual dyads may be due to chance or sampling error.

[9]Penner provided information about the reliability of patterns of feedback across parents, but the other two studies do not.

children who did receive feedback, might incorrectly suggest that feedback is available to all children. Moreover, as shown above in Table 4, it is even possible that some alleged patterns of feedback were not provided to any children.

In fact, there may be no type of feedback that is provided universally. Gordon (1990) argued that in the Piedmont Carolinas, and possibly in other cultures, parents rarely speak directly to their children. The existence of cultures in which parents do not provide any feedback would prove that children can learn from positive evidence alone and that no form of feedback can be a necessary precondition to learning language.

Bohannon et al. (1990, p. 224) criticize Gordon's example as being "an anecdote . . . [that] hardly constitutes believable counterevidence". In fact, Gordon's example is based on a well-documented ethnographic study from Heath (1983), from which I quote:

> Trackton adults do not see babies or young children as suitable partners for regular conversation . . . [U]nless they wish to issue a warning, give a command, provide a recommendation, or engage the child in a teasing exchange, adults rarely address speech specifically to very young children. (p. 86)

Many other cultures with markedly different patterns of parent–child interaction exist. Ochs and Schieffelin (1984) discuss two such cultures. (See also Eisenberg, 1982; Pye, 1986.) In Kaluli, extensive adult modeling is reported, along with a lack of expansions – apparently without any evident consequences for either rate or success of acquisition:

> In addition to instructing their children by telling them what to say in often extensive interactional sequences, Kaluli mothers pay attention to the form of their children's utterances. Kaluli correct the phonological, morphological, or lexical form of an utterance, or its pragmatic or semantic meaning. (p. 293)

> Rather than offering possible interpretations or guessing at the meaning of what a child is saying, caregivers make extensive use of clarification requests such as "huh?" and "what?" in an attempt to elicit clearer expression from the child . . . However, caregivers do not elaborate or expand utterances initiated by the child. (p. 294)

In the case of Samoan, parental feedback is minimal – again, with no apparent consequences for acquisition:

> [C]aregiver speech is largely talk directed *at* the infant and typically caregivers do not engage in "conversations" *with* infants over several exchanges . . . When a small child begins to speak, he or she learns to make his or her needs known to the higher ranking caregiver. The child learns not to necessarily expect a direct response. (p. 296)

> Procedures for clarification are sensitive to the relative rank of conversational participants in the following manner . . . If a low status person's speech is unclear, the burden of clarifications tends to be placed more on the speaker. [This] situation applies to most situations in which young children produce ambiguous or unclear utterances. Both adult and child caregivers tend not to try to determine the message content of such utterances by, for example, repeating or expanding such an utterance with a query intonation . . . A caregiver may choose to initiate clarification by asking

"What?" or "Huh?" but it is up to the child to make his or her speech intelligible to the addressee. (p. 298)

Even if Bohannon et al. concede such examples, they still argue that

> The absence of a particular form of feedback in a particular community does not belie its utility for those children who do receive it, nor does it mean that no form of feedback is necessary for language learning to proceed normally. (1990, p. 224)

Although it is true that some form of feedback may be sufficient for those who receive it, any type of feedback that is not available universally cannot be a necessary type of feedback. (This does not eliminate the possibility that some other form might be necessary.)

Could different children use different reply types to learn language? In that case, each child would need to determine which types of feedback his or her parents provide. One might argue that children attend to all possible reply types, and that the reply types that their parents do not use in a manner contingent on grammaticality have no net effect on the child's grammar. But if, for example, some parents use repetitions to indicate grammaticality whereas other parents use repetitions to indicate ungrammaticality, then each child would have to determine whether his or her parents' repetitions correlate positively, negatively, or not all with grammaticality.

Determining the status of possible reply types raises three problems. First, the child can only calculate a given reply type's status if the child knows which sentences are grammatical. But this is precisely the knowledge the child is trying to acquire. Second, the bootstrapping problem – determining the probabilities for a particular reply instance without knowing which sentences are ungrammatical – is worse if the child does not know which reply types are and are not contingent on grammaticality. As the child tests more reply types for possible sources of feedback, the child's chance of falsely concluding that some reply type is contingent on grammaticality increases (just as running many t tests increases the chance of a type I error). Finally, learning which reply types are useful may require the child to have an unrealistically large memory and unrealistically powerful processing capacities, because the child would have to record whether each possible reply instance occurred for every sentence or at least for enough sentences to discover reliably the reply instance probabilities of a given type of feedback for a grammatical versus an ungrammatical sentence.

In sum, the only plausible way that some pattern of noisy feedback could be necessary for language acquisition is if every parent provides the same reply type to *every* child, and the child is predisposed to expect that reply type to be contingent on grammaticality. But the empirical evidence, both within the discourse studies and across cultures, strongly suggests that no single pattern of feedback is available to all children, and hence noisy feedback is unlikely to be necessary for language acquisition.

Do parents provide noisy feedback until errors stop?

Although several studies appear to show that noisy feedback is available to 2-year-olds, they also show that noisy feedback diminishes rapidly or even disappears altogether. Hirsh-Pasek et al. found that noisy feedback *disappears* with age: ". . . . sensitivity to well-formedness is only apparent among [parents of] 2-year-olds. The same pattern of results failed to emerge at other ages" (p. 86). Penner studied two groups of children, and the older group (mean age = 3;0) received weaker feedback on all measures that the younger group (mean age = 2;0). Morgan and Travis found that parental feedback provided to Eve declined significantly from the start of data collection (1;10) to the end of data collection (2;3). Neither Adam nor Sarah showed significant parental reply contingencies after age 4. In sum, there is no evidence that children over 4 receive any noisy feedback.[10]

Yet children continue to learn language after feedback has disappeared. Many types of linguistic errors persist throughout the preschool years. Sarah said *I maked it with water* at age 4;5 (Brown, 1973). She makes these inflectional errors at a greater rate at age 5 than at age 2;6 (Marcus et al., 1992). These errors continue into at least first grade and perhaps as late as 9 or 10. Similarly, locative errors, such as Mark's *And fill the little sugars up in the bowl* (from Pinker, 1989) occur until at least age 7 (Bowerman, 1988). Thus noisy feedback, given its decline over time, is extremely unlikely to account for the unlearning of many of these errors.

Do parents provide noisy feedback for all kinds of linguistic errors?

Hirsh-Pasek et al., Demetras et al., and Penner collapsed errors of many linguistic components (e.g., syntax, phonology, and semantics), making it impossible to distinguish whether parents provide feedback for all types of errors or only for some types of errors. Hirsh-Pasek et al. and Demetras et al. both collapsed errors of phonology (e.g., *evelator* instead of *elevator*) with syntactic errors in which words were misplaced or left out entirely. Penner combined morphological errors (e.g., *I ringed the bell*) with syntactic errors (e.g., *I rang bell*), and perhaps phonological errors as well.[11] Bohannon and Stanowicz distinguished phonological errors from syntactic errors but collapsed morphological and syntactic errors. These studies thus shed little light on whether noisy feedback is provided for different types of errors (c.f. Valian, in press).

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[10]Furthermore, Bohannon and Stanowicz averaged data from different children of different ages and thus some alleged patterns of feedback might be the result of averaging artifacts.

[11]It is unclear from Penner's text how phonological errors were treated, but Bohannon and Stanowicz (1988) write that "Penner (1987) lumped pragmatic, semantic, syntactic, and phonological errors into a single category of ill-formed children's speech" (pp. 684–685).

The very limited data available suggest that it is unlikely that parents provide adequate feedback for many types of errors. Bohannon and Stanowicz found that parents are much more likely to correct semantic errors than syntactic errors (88.6% vs. 35.9%). Morgan and Travis, the only researchers to separate particular types of grammatical errors, found that none of the children they studied received *any* statistically valid reply types contingent on the grammaticality of specific types of linguistic errors, after age 4. In sum, there is little evidence that parents provide feedback for anything other than the truth value and phonology of their children's utterances, consistent with the conclusions of Brown and Hanlon (1970).

Do parents provide noisy feedback for different types of grammatical constructions?

Only Morgan and Travis (1989) present data that allow construction-wise comparisons. These data suggest that different types of linguistic errors may receive opposite types of feedback. For example, since overall Adam's parents asked more clarification questions following ill-formed utterances (e.g., past tense errors) than well-formed utterances, Adam might infer that clarification questions indicate grammatical errors. But Adam's parents asked more clarification questions after well-formed wh- questions (questions containing *who*, *what*, *where*, *when*, *which* or *why*). If Adam eliminated those sentences to which his parents replied with clarification questions, he could reduce his past tense errors only to the detriment of his use of wh- questions, or vice versa. To use the parental feedback in clarification questions, Adam would need to learn different response contingencies for different grammatical forms; it is far from clear how Adam could figure this out. Finally, suppose Adam asked a wh- question with a past tense form (e.g., *Who runned?*) and his mother replied with a clarification question. How would Adam determine whether his mother was correcting his wh-question syntax or correcting his past tense formation?

Summary

There is no evidence that *any* type of parental feedback is available widely enough to obviate the need for specific linguistic mechanisms. Only one type of noisy feedback (recasts, examined in only one study) was available to all the children studied. No other pattern is provided consistently. No study showed patterns of complete, partial, or even noisy feedback available for children over age 4 despite the fact that children continue to make errors after this age. Every study except Morgan and Travis (1989) collapses morphological and syntactic errors; several studies even collapse phonological errors with syntactic errors.

Furthermore, because of dubious practices of averaging data from different children and from children of different ages, some patterns of feedback may conceal individual differences showing that certain patterns of feedback were not available to some children and hence not necessary for language acquisition. Worse, some alleged types of noisy feedback may be completely artifactual and never provided to any individual child. The existing evidence for noisy feedback thus fails to withstand the weight of careful empirical scrutiny and provides no evidence that noisy feedback is necessary for language acquisition.

Definitional artifacts

Many discourse studies classified parental replies in a manner confounded with the grammaticality of children's utterances, hence rendering the correlations between parental replies and children's grammaticality possibly artifactual. The coding criteria for parental replies cause two serious problems. First, many types of parental replies cannot be classified until one looks at the preceding child utterance, and these replies are sometimes coded differently depending on the grammaticality of a child's utterance (Morgan & Travis, 1989; Valian, in press).

For example, some parental utterances might be coded as repetitions following a grammatical child utterance, but as expansions following an ungrammatical child utterance. The child says the identical utterance in (5) and (6), but the utterance is deemed an expansion or recast in the former, and as a repetition in the latter:

(5) *Expansion or recast*
   C: The ball falled down.
   P: The ball fell down.

(6) *Repetition*
   C: The ball fell down.
   P: The ball fell down.

Second, because parents nearly always speak grammatically (99.44% of their utterances according to Newport, Gleitman, & Gleitman, 1977), certain parental reply categories, such as repetitions, are biased to occur more often after grammatical child utterances, while other types of parental coding categories, such as expansions, are biased to occur more often after ungrammatical child utterances. Thus some of the contingencies reported in the discourse studies reflect the consequences of coding categories virtually defined in terms of the grammaticality of the child's utterances, rather than being the result of actual parental sensitivity to the grammaticality of the child's utterances (Valian, in press, makes a similar point).

Consider the following analogy. Suppose that I claim that I can control the

color of the sky by my choice of which shirt to wear on a given morning. Every morning, an impartial observer records whether I wear a green shirt or a blue shirt, and records sky color *relative* to my shirt color.

After gathering data, we find an interaction between sky color and shirt color: if I wear a blue shirt then the sky may be the same color, but if I wear a green shirt then the sky is never the same color as my shirt. One might then conclude that the sky responds to, or is sensitive to, my choice in shirt color. But this conclusion is false: the sky is not sensitive to whether I wear a blue shirt or a green shirt.

The problem lies in the coding criteria for the sky's "replies". We code sky color only with respect to shirt color. A blue sky is coded as "same color" if I wear blue, but the same blue sky is coded as "different color" when I wear green. The sky is not sensitive to my shirt's color; the coding categories are. If we instead simply record the absolute color of the sky, there would be no artifactual contingency and we would not be misled: the sky is never green no matter what shirt I wear, and the sky is equally likely to blue no matter what shirt I wear.

Exact repetitions

Repetitions, like sky color, are classified relationally. There is no sentence that is a repetition independent of a child's utterance. And just as the "contingency" between relative sky color and shirt color is confounded with the fact that the sky is never green, the "contingency" between exact repetitions and child grammaticality (i.e., exact repetitions follow more grammatical than ungrammatical sentences) is also confounded. The contingency between repetitions and well-formed child speech is inevitable given that parents speak grammatically. When children speak ungrammatically, there is virtually no chance that their parents will repeat their utterances verbatim. Conversely, when children speak grammatically, their parents may repeat their utterance exactly. Demetras et al.'s exact repetitions, Penner's repetitions, and Bohannon and Stanowicz's exact repetitions are all tainted in this way.[12] (See also Valian, in press.)

Similar problems beset the other parental reply categories that showed some (albeit limited) contingency with grammaticality of children's speech. Recasts, expansions and clarification questions also can only be coded in relation to children's utterances and hence are inherently confounded with children's grammaticality. For instance, the parental reply *The ball fell down* is coded as a recast if the child speaks ungrammatically (e.g., *The ball falled down*) but as a repetition rather than a recast if the child speaks grammatically (e.g., *The ball fell down*).

[12]Hirsh-Pasek et al.'s category of repetitions differs from exact repetitions because they include parental responses which contain small changes.

Thus a contingency between recasts and ungrammatical child speech does not demonstrate that parents are sensitive to their children's grammar. Whenever some aspect of a child's sentence is relevant to the definition of the adult's reply, and that aspect is correlated with grammaticality, any correlation between the grammaticality of the child's utterance and the type of adult reply will be confounded.

Possible objections

Even if the observed patterns of feedback are the result of spurious correlations, the child could still make use of the parental replies. However, parental replies such as recasts and expansions appear not to reflect any parental sensitivity to grammaticality. Parents who are insensitive to children's grammaticality cannot give children *negative* evidence (except through explicit metalinguistic statements of the form *Don't say X*); they can only give children *positive* evidence. Recasts and expansions may serve as ideal positive evidence, but they do not tell children what is not in the language.

   Another possibility is that whenever a parent says something differently from the child, the child should assume he or she has made an error. A child following such a strategy would surely err: most parental utterances are different from their children's utterance even when the child speaks grammatically. For instance, a child might say *I want a cookie* and the mother might naturally reply *No, you've already had three cookies*. Discourse is driven by conversation, not implicit language lessons. Parents may choose a different word or construction to emphasize something different, or even change the topic entirely. Children who changed their grammars every time the parent said something different would radically damage their languages.

Summary

Coding parental replies relative to the child's previous utterance, as has been done often in the discourse studies reviewed here, leads to the possibility that the resulting correlations do not reflect true parental sensitivity but instead reflect only constant, non-contingent frequencies of certain kinds of child and parental behavior.

   The only evidence for noisy feedback comes from reply categories that are definitionally flawed. There are some reply types that are not defined relationally, such as explicit correction, and failures of comprehension (Brown & Hanlon, 1970). But everybody agrees that these reply types are not contingent on grammaticality.

Discussion

There are three serious problems with the position that parents provide negative evidence to help their children learn language. First, if such feedback does exist, it is too noisy to be used in practice. Second, it is not available to all children, not available at all the relevant ages, and probably not available for many types of errors. Third, reply categories have often been defined relative to the child's preceding utterance, and thus observed correlations between parental replies and children's utterances may simply be artifacts of the coding scheme. Any one of these problems is enough to significantly undermine the position that parents provide negative evidence to their children is significantly undermined.

Positive evidence, in contrast, suffers from none of these problems; nor would complete feedback if it existed. If a parent says something once, the child can assume that it is grammatical; the child need not wait for 85 repetitions. Positive evidence is available to every child regardless of age for all types of representation. Further, every parental utterance is positive evidence regardless of the child utterance. If complete feedback (i.e., negative evidence in the sense used by learnability theorists) existed, it would also meet every test I have applied. If parents provided some reply type following all and only ungrammatical sentences, then a single utterance would be a guaranteed test for ungrammaticality, not the 85 times necessary for noisy feedback. Complete feedback would be available by definition to all children at all ages for all types of errors and could be coded independently of children's utterances. But complete feedback apparently does not exist – nobody has ever claimed that parents correct all and only grammatical errors.

The fact that there is independent evidence for internal mechanisms provides a further argument against negative evidence. Consider errors such as Sarah's *I maked it with water*. As children acquire the English past tense system, they sometimes apply the regular past rule (add *-ed*) to irregular stems (e.g., *go*, *make*, or *sing*), thus producing erroneous past tense forms such as *goed* or *maked* (see Marcus et al., 1992). If negative evidence is not available, children must stop producing these forms through some internal (possibly linguistically specific) mechanism. Marcus et al. (1992) argue that children follow a principle of inflectional blocking that prevents the application of a regular rule (add *-ed* to form the past tense) whenever a child can retrieve an irregular past tense form for some stem. For example, if a child attempting to mark the past tense of *make* retrieves *made*, the regular rule is blocked. If the child fails to retrieve an irregular past tense form, the rule applies, and the child creates an incorrect form, such as *maked*. As children's retrieval of the correct past tense forms improves through positive evidence, overregularization errors disappear.

Internal mechanisms, without the aid of negative evidence, could also eliminate errors such as Mark's *I filled the sugars up into the bowl*, or a similar error, *I*

filled the water into the bowl. In these "locative" errors, children use verbs in inappropriate syntactic constructions. The child has used the "content" argument (*the water*) rather than the container "argument" (*the bowl*) as the object of the verb *fill*.[13] In contrast, it is perfectly acceptable to use *pour* with its "content" arguments as the object of the verb, as in *I poured the water into the glass*. Negative evidence might drive locative errors out of a child's grammar, but without negative evidence children would need to eliminate errors through internal mechanisms. Gropen et al. (1991) argued that locative errors result when a universal linking rule, *object affectedness*, is combined with an improper semantic representation of the verb *fill*. The *object affectedness* rule states that the direct object of a verb corresponds to an object that is specified as affected in some particular way in the semantic representation of a verb. Gropen et al. argued that in the adult grammar, the semantic representation of the verb *fill* does not specify how the content is affected (a glass can be filled by pouring but also by dipping or bailing), hence the content argument cannot appear as the object. In contrast, the semantics of *pour* does specify that its content argument is affected in a specific way, namely it must move downward in a stream, and hence it *may* appear as the direct object of the verb. According to this theory, children always follow the universal linking rule, but if they have an improper semantic representation for a verb such as *fill*, which does specify the manner of motion of the content argument (e.g., being poured), then they would allow *water* to be the object. Gropen et al. predicted that children who thought that *fill*'s semantics specified that its content argument was affected (e.g., by selecting pictures of pouring as exemplifying *fill*) would be the same children who made syntactic errors such as saying *Fill the water into the sink*. On their account, children could learn the correct semantics using only positive evidence (e.g., hearing *fill* used without pouring as when a cup is dipped in a punch bowl) and crucially, once the semantics is learned from positive evidence, the linking rule fixes the syntax automatically, allowing children to unlearn their errors without negative evidence.

If negative evidence really were generally available, it is unlikely that the empirical evidence would support the existence of these mechanisms, because they would be solutions to non-problems. But there is evidence for internal mechanisms. For example, Marcus et al. (1992) showed that children are more likely to overregularize verbs to which they have less exposure. As exposure to correct past tense forms increases, overregularization errors decrease, hence supporting the inflectional blocking hypothesis. Gropen et al. (1991) found that semantic errors do indeed correlate with syntactic errors; children that make semantic errors with *fill* are the same ones that use the wrong syntactic frames for *fill*, hence supporting the existence of the object affectedness linking rule. These

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[13]The precise details of the syntax and semantics and their relationship are outside of the scope of this paper.

examples suggest that internal linguistic mechanisms are real and that there is no need for negative evidence.

Finally, it is important to reject the notion that nativist explanations of language acquisition depend on the lack of negative evidence. Even if perfect negative evidence were available, innate constraints on the generalizations which children make would be necessary because many plausible errors simply never occur. For instance, children never go through a period where they erroneously form yes–no questions by moving the first *is* to the front of the sentence. Although one can turn *The man is hungry* into *Is the man hungry?*, children never, by a false analogy, turn *The man who is hungry is ordering dinner* into *Is the man who hungry is ordering dinner?* (e.g., Chomsky, 1965, 1980; Crain & Nakayama, 1987). More generally, at every stage of language acquisition – inferring the meaning of a new word or morpheme, creating a morphological or syntactic rule, or determining the subcategorization frame of a new verb – the child can make an infinity of logically possible generalizations, regardless of whether negative evidence exists. The child simply cannot cycle through all logical possibilities and check to see what his parents say about each one.

Children do learn languages; but they appear to do so without requiring negative evidence: complete feedback and partial feedback do not exist. Noisy feedback, the signal that has been claimed to exist, may largely be an averaging artifact and is at best available in a fraction of the circumstances in which it would be needed. Many of the observed patterns of noisy feedback are likely to be averaging artifacts and definitional artifacts, but even if there were no artifacts, the child would need to say a sentence such as *Fill the little sugars up in the bowl* more than 85 times to be sufficiently confident that it was an ungrammatical sentence. There is no existing evidence that noisy feedback can account for the unlearning of grammatical errors, and given the inherent weakness of noisy feedback it is also extremely unlikely that any yet-to-be-discovered interactional patterns would be adequate to account for language acquisition. These considerations suggest that the problem of accounting for children's avoidance and recovery from errors in language acquisition is likely to be explained by the nature of their internal learning mechanisms. The specific mechanisms I have discussed, such as inflectional blocking and linking rules, are not the only ones that have been proposed and may not be empirically correct. But any explanation of language acquisition that depends on parental feedback seems unlikely to succeed, and quantitative examinations of interaction patterns in parent–child conversation are unlikely to shed much light on this important issue.

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Appendix: Definitions of parental reply categories

Hirsh-Pasek, Treiman, and Schneiderman (1984)

Strict repetitions: [were coded if the parent repeated] the child's exact wording with the possible exceptions that (*a*) ill-formed aspects were rendered in their correct grammatical form as in *People lives in Florida → People live in Florida.* (*b*) *I* and *you* were appropriately interchanged.

Loose repetitions: [were coded if] (*d*) content words were replaced with proforms or vice versa . . . (*e*) modifiers were added or deleted . . . (*f*) a phrase of the child's utterance was repeated without the rest of the utterance . . . or (*g*) the child's utterance was embedded with a longer utterance.

Demetras, Post, and Snow (1986)

Approval/correction: These utterances are explicit responses to the child's preceding utterance that either approve or give negative feedback to the child. Words such as *yes, no, that's right*, signal explicit feedback.

Repetitions: Four types of repetitions [were] coded: exact, contracted, expanded, and extended. The use of deictic forms (e.g., substitution of *you* for *me, come* for *go*) are accepted as repetitions.

Exact repetitions: [were coded if the parental reply was] Exact repetition of what the child said.

Contracted: [were coded if the parental reply was a] Shortening of the child's utterance in any way.

Expanded repetitions: [represented a] Correction of child's utterance with appropriate syntax or morphology. Child: *daddy house*/Mother: *Daddy's house*.

Clarification questions: These responses refer directly to the child's preceding utterance. Questions that start a new topic are not included. Also any questions requesting knowledge from the child are not included. The different types of questions are as follows:

Wh- [questions]: . . . must start with a wh- word and clarify, otherwise scored as a Move-On.

Occasional questions: Questions that have a wh- word embedded in them: *You went where?*

Repetition questions: These are repetitions (as described above) that have a rising intonation contour at the end of the sentence.

Move-ons (MO): In these utterances the mother uses the same topic or starts a new topic, but does not 'negotiate' with the child for meaning. We infer that the mother understands what the child said, accepts it, and moves on with the conversation.

Penner (1987)

Topic extensions: . . . continued the current topic of the interaction, but did not qualify for the placement in another category, such as repetitions or expansions. The topic was defined by the nonverbal as well as the verbal context of the interaction.

Verbal agreement/approval: Included confirmations, agreements, or praise using words like "Yes", "That's right", "Good" and "OK".

Expansions: Parents repeated all or part of the utterance and made additions and other grammatical or semantic changes to words and morphemes in the utterance. Parental responses that qualified as expansions were judged to function to expand upon the previous child's utterance (e.g., C: "Ball fall" A: "The ball fell down").

Repetitions: The parent repeated all or part of the child's utterance without adding to the utterance.

No response: The child's utterance was followed by a pause of at least 2 sec. that did not contain a verbal or nonverbal parental response or another child's utterance.

Confirming questions: included expansions and repetitions that were accompanied by question intonation. Therefore, this category contained a subset of the responses that were also defined as either expansions or repetitions.

Bohannon and Stanowicz (1988)

Exact Repetitions: Consisted of verbatim reproductions of the child's entire preceding utterance.

Contracted Repetitions: Consisted of the reproduction of a reduced set of elements from the child's preceding utterance.

Expanded repetitions were coded if the adult reproduced major elements of the child's utterance and added new information.

Recasts [were coded] if the adult preserved the child's meaning but replaced elements of the child's utterance (e.g., C: "That be monkey"; A: "That is a monkey").

Clarification questions were . . . questions that related to the children's previous utterance without requesting any new information and counted other adult repetitions with rising terminal intonation as exact, contracted, recasted, and expanded.

Morgan and Travis (1989)

No Response: . . . if one or more child utterances immediately followed the utterance containing the error and if no utterance in the subsequent adult conversational turn was explicitly related (via complete or partial imitation) to the error-containing utterance.

Expansions: If any utterance in the adult conversational turn following the error . . . expanded the child utterance (e.g., C: *Where other stick*? P: *Where is the stick?*).

Imitations: If the adult exactly repeated the erroneous utterance (reversals in pronouns and deictic terms notwithstanding).

Clarification questions: If any adult utterance had the force of requesting the child to repeat all or part of the erroneous utterance.

Confirmation questions: If the adult reply to the erroneous utterance was a yes–no question pertaining to the linguistic content of the error-containing utterance.

Move-on: If none of the other categories were applicable.