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Longer-term effects of corrective input: an experimental approach*

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ABSTRACT

There is growing evidence that corrective input for grammatical errors is widely available to children (Farrar, 1992; Morgan, Bonamo & Travis, 1995). However, controversy still exists concerning the extent to which children can identify and exploit available negative input. In particular, very little is yet known about the longer-term effects of negative input. Performing a time series analysis on observational data, Morgan *et al.* (1995) conclude that corrective recasts are not related to future improvements in grammaticality. It is argued here, though, that the data sets analysed in this study are inherently ill-suited to the demands of time series analyses. The present study adopts an experimental approach in order to compare the effects of negative evidence versus positive input on the acquisition of irregular past tense verb forms. Twenty-six children (mean age 3;10) participated in a within-subjects design over a period of five weeks. It was found that improvements in the grammaticality of child speech were considerably greater in cases where negative evidence had been provided. Moreover, children's intuitions concerning the status of irregular and overregularized forms more closely approximated adult intuitions when corrective input was available.

INTRODUCTION

Until very recently, it was a standard assumption in theories of language acquisition that the child receives no information on the grammaticality of

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their speech (e.g. Brown & Hanlon, 1970; Pinker, 1989). Now, however, there is a consensus that the input is replete with potentially corrective information (see, for example, Farrar, 1992; Morgan, Bonamo & Travis, 1995). Most accounts emphasize the abundance of so-called recasts in adult speech, whereby the adult repeats part or all of a preceding child utterance, whilst introducing certain modifications:

(1) Child: That policeman FALLED all the way down to the tiger.
Adult: He FELL down.

Unless stated otherwise, all examples are taken from the dairy study reported in Saxton (1995). Adult responses of this kind have been reported in the negative input literature for all children on whom individual data are available, and for a wide variety of grammatical structures (Hirsh-Pasek, Treiman & Schneiderman, 1984; Demetras, Post & Snow, 1986; Penner, 1987; Bohannon & Stanowicz, 1988; Moerk, 1991; Farrar, 1992; Furrow, Baillie, McLaren & Moore, 1993; Morgan, Bonamo & Travis, 1995). Therefore, the availability of corrective information (at least for those children who have been studied) is beyond dispute. At the same time, however, it is clear that the deep controversy surrounding the negative input issue has not abated (cf. Bohannon, Padgett, Nelson & Mark, 1996; Morgan, 1996). Instead, the debate has shifted away from questions concerning the availability of corrective information to the issue of utilization. That is, do children actually identify and exploit whatever corrective information may be available in the input?

In addressing this question, one can examine both the child's immediate and longer-term responses to negative input. With respect to immediate effects, both observational and experimental data have been reported which demonstrate that negative input can occasion a shift in the child's speech from ungrammatical to grammatical (see Farrar, 1992; Morgan *et al.*, 1995; Saxton, 1997). The child's immediate responses provide the most direct indication that children can respond appropriately to corrective input. It is also possible that the child's immediate responses are predictive of its longer-term effects on the child's developing grammar. The longer-term effects do, of course, provide the ultimate locus of interest for researchers, since the aim is to gauge the contribution of negative input in the final attainment of a mature grammatical system. Evidence for longer-term effects would also allay suspicions that the child's immediate responses represent no more than an ephemeral phenomenon, with no permanent influence on the development of grammar.

As yet, empirical evidence on this important issue is extremely scarce, with Morgan *et al.* (1995) providing the only published article. Morgan *et al.* conducted a time series analysis on Brown's (1973) naturalistic conversational

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data for Adam, Eve, and Sarah, in an innovative application of econometric theory to problems of child language acquisition. A time series study involves the regression of one or more explanatory variables on a series of observations. In order to conform to the demands of econometric methods, a number of conditions must be met. For example, the explanatory variables should be independent, in order to avoid multicollinearity. A further foundational assumption underlying econometric techniques is that the observations in a time series are made at strictly regular intervals.

Morgan *et al.* focus on the relationship between the time series for two variables: the grammaticality of child speech (measured as percentage of occasions when a given structure is used correctly), and frequency of minimal recasts. In particular, they invoke the concept of a leading indicator, in order to examine whether information concerning the incidence of recasts can increase the power of predictions about the future grammaticality of child speech. The adopted procedure involves regressing a time series on itself (an autoregression), using lagged values from the time series as predictors. Thus, the incidence of maternal recasts at time T_X was used to predict child grammaticality at lags of 2, 4, 6, 8, 10, and 12 weeks (see Morgan *et al.*, 1995 and Gottman & Ringland, 1981, for a more complete description).

Terms in the regression model of the leading indicator are referred to as cross-regressive (a departure from standard econometric procedures). Given that cross-regressive terms are employed, Morgan *et al.* suggest that 'if recasts serve as corrections, we would expect significant cross-regressive terms to be positively weighted: higher levels of recasts at early points in time should be associated with higher levels of grammaticality at later points in time' (p. 188). In the event, it emerged that significant cross regressive terms were predominantly negative for both articles and WH-question auxiliaries. On this basis, Morgan *et al.* conclude that 'recasts are negative leading indicators of grammaticality' (p. 190). Before accepting this conclusion, though, a number of factors should be considered which make their findings somewhat problematic in interpretation.

First, Bohannon *et al.* (1996) are not convinced that the regression procedures adopted in this study are adequate to the task projected for them. In arriving at this conclusion, Bohannon *et al.* generated four data sets from models in which the effects of recasts were known at the outset. The so-called Boltzman equation was used to model learning in the child, on the grounds that it accommodates easily the pattern of learning reported by Morgan *et al.*: poor performance initially, then rapid progress, followed by a phase of asymptotic performance (Bohannon *et al.*, 1996). It was found that Morgan *et al.*'s regression procedures did not discriminate between any of these data sets. In particular, a low negative partial correlation emerged both when recasts had an inhibitory effect on learning and also when recasts were critical for learning. In response, Morgan (1996) notes that Bohannon *et al.*'s

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simulations do not appear to be based on appropriate data sets, owing to apparent conflicts with his own data. Moreover, Morgan (1996) suggests that the Boltzman equation used in Bohannon *et al.*'s simulation is inappropriate since this equation assumes that input which strengthens a given response simultaneously weakens an alternative response, 'thereby begging the question of what aspects of input might or might not be corrective.' This latter remark is difficult to interpret since one would predict that any form of negative input would underscore the rejection of an ungrammatical form in favour of a grammatical alternative. More seriously, it is pointed out that Bohannon *et al.* fail to specify any of the parameters used in the Boltzman equation, rendering impossible the acts of interpretation or replication of their findings. Tantalizingly, therefore, Bohannon *et al.* offer an intriguing application of simulation methodology, but do not provide the wherewithal to assess the significance of their findings.

A further point of note is that some significant cross regressive terms were positively weighted. Moreover, a consistent pattern emerged, whereby the negative terms associated with relatively short lags give way to positive terms over longer periods. Typical of this pattern are the findings for Sarah, with respect to articles, where significant negative terms are reported for lags of 2, 6, and 8 weeks. However, when a lag of 10 weeks is considered, the cross regressive term is strongly positive. In interpreting these findings, Morgan *et al.* effectively ignore the observed positive terms, and stress instead the predominance of negative terms, a practice which is difficult to justify. If one takes into account the observed positive terms, it would seem that recasts are functioning as both a negative and a positive leading indicator simultaneously. Thus, high levels of recasts at T_X are associated with a forthcoming dip in grammaticality in the short-term, followed by an increase in grammaticality in the longer-term. It is, of course, the ultimate level of grammaticality attained by the child which is of interest, so it is interesting to note the consistent pattern whereby negative cross regressive terms tend to give way to positively weighted values. Ostensibly, therefore, Morgan *et al.*'s findings would seem to indicate that recasts are associated with increasing grammaticality over relatively long periods of time. In contrast with Morgan *et al.*, therefore, one might conclude that recasts do function in the longer-term in a manner consistent with their projected role as a source of negative evidence.

In fact, though, the mixture of positive and negative cross regressive terms presents a pattern of findings which is rarely, if ever, observed in more conventional time series analyses within econometric theory. As a result, one must examine the appropriacy of these methods for the particular data sets analysed by Morgan *et al.* Undoubtedly, the small sample sizes represent a major limitation, as Morgan *et al.* acknowledge, since they necessitate a liberal interpretation of what counts as a significant regression term

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($p < 0{\cdot}20$). Hence, the probability of encountering Type 1 errors is greatly increased. A further problem is that time series analyses conventionally incorporate a minimum of 30 data points in the series (see, for example, Bowen & Starr, 1982). Yet for one of the children, (Eve), fewer than 20 individual samples are available. From the description provided by Morgan *et al.*, it is not clear that any effort has been made to compensate for this deficiency. In consequence, Morgan *et al.*'s (legitimate) fears concerning Type 1 errors are exacerbated considerably, since data analyses for only two children will be available for corroborating any findings.

An additional point of concern is Morgan *et al.*'s assumption that the data for the three children were collected at regular two-weekly intervals. In fact, the pattern of data collection was markedly irregular, and hence the time series obtained, both for frequency of recasts and level of grammaticality, violate the standard assumption that measurements be made at equally spaced intervals. Moreover, many of the samples comprise two, sometimes three, separate recordings made on different dates. While the within-simple interval is often no more than one or two days, there are numerous occasions when it rivals or even exceeds between-sample intervals. Thus, for Adam, sample 41, the within-sample interval is 18 days, while the gap between samples 41 and 42 is 17 days. To compound matters, the between-sample intervals vary greatly for all three children, with very few adhering to the 14-day interval assumed by Morgan *et al.* (12 out of 55 samples for Adam; none out of 20 for Eve; and 4 out of 139 for Sarah). Of course, Brown's (1973) data on Adam, Eve, and Sarah were not gathered with the intention of conducting a time series analysis, so it is perhaps not surprising to discover that they are quite inappropriate for that purpose. As it stands, therefore, the prospect of applying econometric techniques in the study of child language acquisition remains an intriguing possibility, awaiting data sets which conform more rigorously to the demands of time series analysis.

Fortunately, time series analysis does not represent the only method available for gauging the longer-term effects of parental input. The present study proposes to examine longer-term effects via the experimental approach described in Saxton (1997). The initial aim was to teach children two irregular nonsense verbs, with the aim of exposing them to the irregular past tense form in either a corrective or a non-corrective context. The use of nonsense verbs ensures that no previous experience can impinge on the child's use of the verbs in the experimental context. It also affords the experimenter complete control over the way in which the target verbs are presented to children. The categories of input examined in the present study are negative evidence and positive input, as defined within the Contrast theory of negative input (Saxton, 1997). Thus, NEGATIVE EVIDENCE is defined as an adult response, directly contingent on a child grammatical error, which embodies the grammatical alternative to that error.

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(2) *Negative evidence for linguistic form* (*X*)
Child: ……[ungrammatical version of linguistic form (X)]……
Adult: ……[grammatical version of (X)]……

(a) Child: And you get lots of MOUSES on a farm.
Adult Yes, you sometimes get a lot of MICE.
(b) Child: And how dare HIM!
Adult: How dare HE.

Positive input is distinguished from negative evidence, not with respect to the linguistic information supplied to the child, but with respect to the discourse context within which that information is supplied. Thus, POSITIVE INPUT is defined as the production by the adult of grammatical forms in all cases which do not qualify as negative evidence, that is, in all non-error-contingent contexts. The examples in (3) below are constructed for expository purposes.

(3) *Positive input for linguistic form* (*X*)
Child/Adult: [any utterance, excluding ungrammatical versions of the linguistic form (X)]
Adult: ……[grammatical version of (X)]……

(a) Child: I've never seen so many mice.
Adult Yes, you sometimes get a lot of MICE.
(b) Child: He's taken the last chocolate.
Adult: How dare HE.

On these definitions, negative evidence and positive input present the child with precisely the same linguistic structures. Arguably, however, the two forms of input differ fundamentally with respect to the information they yield about the adult grammar. According to the DIRECT CONTRAST HYPOTHESIS, negative evidence can inform the child not only that a given adult form is grammatical, but also, critically, that their own form is ungrammatical (Saxton, 1997). Positive input, on the other hand, can do no more than confirm that linguistic forms produced by the adult are grammatical.

The corrective impact of negative evidence lies in the fact that child and adult forms are directly juxtaposed with one another. In effect, the adult rejects the form chosen by the child and selects an alternative form. Moreover, the adult selects a different form in a context which could hardly be more conspicuous, since child and adult are jointly focused on the same topic of conversation. The child is thus afforded an ideal opportunity to observe the contrast in usage between child and adult forms. Thus, although *mouses* and *mice* fulfil identical functions linguistically, the child is exposed to the adult's preference for *mice* over *mouses*. Observe that this preference can never be demonstrated via positive input, since child and adult forms are not

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directly contrasted with one another. Instead, positive input serves only to confirm the existence (or grammaticality) of the adult form.

Previous research on negative input has focused on adult recasts as a potential source of corrective input. Recasts modify the original child utterance in some way, while preserving essential elements of the child's meaning (e.g. Bohannon *et al*., 1996). The definition of negative evidence, on the other hand, does not recognize the relevance of reproducing the child's meaning. Instead, it is the contrast in child and adult forms alone which is held to be of importance. More generally, there is a focus on just those aspects of an adult response which might bear a corrective potential for child errors. The category of recast, meanwhile, encompasses a far wider range of responses. Firstly, recasts can follow both grammatical and ungrammatical child utterances. And secondly, the kinds of change which may be wrought to the original child utterance are not confined to corrections of child errors. Any kind of addition, deletion or permutation of the original child utterance would yield a recast. There is, then, an inevitable confound between corrective recasts (negative evidence) and all other kinds of recast. According to the Contrast theory, these two sub-categories of recast constitute fundamentally different kinds of response. In addition, numerous conceptual difficulties arise when one tries to explain how the child might exploit recasts as a source of corrective input. For example, it is not clear how the child could identify the category of recast in the input, or easily accommodate the fact that recasts follow both grammatical and ungrammatical child utterances (see Saxton, 1997, for a detailed review).

The aim of the present study was to compare the cumulative effects of positive input versus negative evidence on child grammaticality over a period of five weeks. The procedure involved an experimental intervention, in which strict control can be exerted over the frequencies and kinds of input supplied to the child. To our knowledge, the present study represents the first experimental investigation of the longer-term effects of corrective input. However, the work of Keith Nelson and his colleagues provides a close parallel, since they have charted the effects of recasts on child grammar in a number of intervention studies (e.g. Baker & Nelson, 1984; Nelson, Denninger, Bonvillian, Kaplan & Baker, 1984; Camarata, Nelson & Camarata, 1994; Nelson, Camarata, Welsh, Butkovsky & Camarata, 1996). For example, Nelson *et al*. (1996) report that recasts are more effective in improving child grammar than a procedure in which imitations of target structures were elicited from children. The imitative procedure effectively supplied the children with positive input, albeit in a rather unnatural conversational context (e.g. '*The boy is running. Say the boy is running*'). As one might expect from the preceding discussion, though, the recast condition in Nelson *et al*. (1996) was rather different from the Negative Evidence condition implemented in the presented study. Although some of the recasts

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in Nelson's interventions would clearly qualify as negative evidence, many of them were not even contingent on child errors. It is impossible, therefore, to disentangle any differential effects which corrective versus non-corrective recasts may have had (see Saxton, 1997, for a discussion of Nelson's rare event cognitive comparison theory in relation to the Contrast theory). A further departure from Nelson *et al.*'s (1996) procedure is the use, in the present study, of novel verb forms (see also Saxton, 1997). By teaching children nonce forms, one can eliminate the possibility that previous exposure to positive and negative input will affect the children's behaviour in the experimental situation. A final innovation, described below, is the implementation of a grammatically judgement task, in order to provide some insight on the status of target forms in the child's grammar.

In the present study, each child was taught two nonsense verbs. For one of the verbs, exposure to the correct irregular form was via positive input only, while for the other verb a mixture of positive input and negative evidence was supplied. The two conditions were distinguished, then, by the fact that only in the Negative Evidence condition were children supplied with corrective input of any kind. It was predicted that learning would be facilitated in the Negative Evidence condition, as measured by the prevalence of grammatical forms in the children's own speech. It was also predicted that the rate of learning would be faster in the Negative Evidence condition, on the grounds that negative evidence supplies the child with a richer source of information about the adult grammar than positive input. As mentioned, negative evidence not only affirms the grammaticality of adult forms, but also highlights the ungrammaticality of erroneous child forms. Positive input, on the other hand, cannot inform the child about what is ungrammatical in her speech. In consequence, erroneous forms may never be entirely eradicated from the child's speech, if they were to rely on positive input only. This latter observation constitutes a central tenet in many theories of language acquisition, in particular those which emphasize the poverty of the child's initial input resources (see, for example, Morgan *et al.*, 1995).

The present study follows other studies in choosing the prevalence of grammatical forms in the child's own speech as an index of effectiveness (Farrar, 1992; Morgan *et al.*, 1995; Saxton, 1997). It is reasoned that grammatical forms should become more frequent in the child's speech if putative forms of corrective input are genuinely contributing to language learning. Of course, gradual increases in the grammaticality of child speech are perhaps the most common indicator used in child language research that acquisition is actually taking place. However, one must be mindful that the sheer frequency of linguistic forms does not, in and of itself, tell one very much about the status of those forms in the child's developing grammar. Thus, an increase in the frequency of grammatical forms in child speech may indicate little more than the child's sensitivity to the overwhelming pre-

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dominance of such forms in the input. In principle, even if the occurrence of ungrammatical forms in child speech were reduced to zero, it is not necessarily the case that such forms would be regarded by the child as ungrammatical. It would be extremely useful, therefore, to supplement measures of grammaticality with methods that tap into the child's intuitions concerning the status of key linguistic forms. In consequence, a further aim of this study was to investigate children's own sense of what is grammatical and what is not grammatical. It was predicted that exposure to corrective input, over a period of five weeks, would allow children to develop intuitions very similar to those of an adult. Thus, it was predicted that, in the Negative Evidence condition, children would accept the irregular past tense form as grammatical, whilst rejecting the overregularized form. In the Positive Input condition, by contrast, it was predicted that children would tend to accept both irregular and overregularized past tense forms as acceptable.

METHOD

Subjects

Twenty-six children participated in the study, fourteen girls and twelve boys, ranging in age from 3;8 to 4;6 (mean 3;10). The children attended two different nursery schools in London, and were drawn from a wide range of socioeconomic backgrounds. The main criterion for inclusion was that children be monolingual native speakers of English. Although several participants came from non-indigenous backgrounds, they were included on the grounds that they were both fluent speakers of English and also that their parents spoke only in English to them at home.

Procedure

Two nonsense verbs, taken from Saxton (1997), were taught to subjects in the base and *-ing* forms only, in three separate sessions over three days. The aim was to avoid the past tense forms in the training sessions, and introduce them to participants only in the testing phase. The testing phase began only when the experimenter was confident that the child had grasped both the meaning and pronunciation of the two verbs. Children's knowledge was tested by asking them to identify the novel verb forms, as depicted in simple line drawings, prior to eliciting the verb forms with simple questions about the pictures (e.g. *What's the grasshopper doing?*). The two test verbs, designated as irregular by the experimenter, were modelled on genuine verb alternations: *pell/pold* (cf. *sell/sold*) and *streep/strept* (cf. *creep/crept*). The meaning of *pell* was designated as a repeated clapping motion in which the target (typically a body part) is trapped between the palms. *Streep*, on the other hand, was used to denote a twisting motion applied (again to a body

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part) with a cross-ended stick. A within-subjects design was adopted whereby, for one of the verbs, exposure to the past tense form was via positive input only, while for the other verb, children were supplied with negative evidence for the correct past tense form. For half of the subjects, *pell* appeared in the Positive Input condition, while *streep* appeared in the Negative Evidence condition. This order was reversed for the remaining subjects, in order to control for the possible effects of individual verbs on child responsiveness.

Children were tested individually in a quiet area on ten separate occasions over a five week period, with testing sessions occurring every 3 or 4 days. Four stimuli figured in each test session (two for the Positive Input verb and two for the Negative Evidence verb). The order of stimuli was rotated through sessions and counterbalanced across subjects. Overall, subjects were exposed to the irregular past tense forms on 20 occasions in each input condition. The irregular past tense forms were introduced to the children via a number of simple story scenarios, using glove puppets. For example, four puppets might be propped up in a circle and the child would be told that they were all friends, chatting together. A spider puppet, manipulated by the experimenter, would then creep up on one of the characters and perform one of the verb actions, before running away. A past tense context is thus set up for the use of the verb, since the characters can then ask about what happened. Thus, in the Positive Input condition, the experimenter commented on the action, by saying, for example: *Did you see? The spider pold the grasshopper!* Thus, the correct form is supplied, but not contingent on a child error. The experimenter would then record the child's subsequent response, in order to gauge their willingness to use the past tense form themselves. It was sometimes necessary (in both conditions), to encourage the child further to produce their own past tense form, by saying, for example: *Is that right? Can you tell me what happened?*

In the Negative Evidence condition, the experimenter first elicits a past tense form from the child by asking *What happened?* In the first testing session, the child is almost bound to produce an error in response to this question, since they have never been exposed to the correct irregular form. Typical responses for *streep* might be *He streeped/streep the tortoise*. Having elicited a past tense form, the experimenter supplied negative evidence via the following kind of response: *That's right, he strept the tortoise*. The child's immediate response would then be monitored, with instances of correct usage of the past tense form being noted. In fact, one can only guarantee being able to supply negative evidence for the first stimulus. On subsequent occasions, the child may recall the correct past tense form and supply it as the initial response to the prompt (*What happened?*). In such cases, there is no error to correct, but it was decided to supply the irregular past tense form anyway, even though it would not count as an instance of negative evidence.

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The rationale for this decision, and the implications for interpreting the results, are examined in the Discussion section (below).

Grammaticality judgement task

In the week following the final testing session, twelve of the original subjects (six boys, six girls) were available for participation in the grammaticality judgement task, which was conducted over two sessions, separated by three days. Inspired by the work of Crain (e.g. Crain, 1991), children were asked to perform the verb actions on a teddy (e.g. *Can you pell his nose?*). These actions were then remarked on by a 'bystander' dragon puppet (e.g. *You pold/pelled his nose*). The child's task was to feed the dragon a boiled sweet if the dragon 'says it right,' or alternatively, to stuff a rag in its mouth, if she 'says it wrong.' If children are motivated to respond solely on the basis of meaning, then they should feed the dragon a sweet on every occasion, since the meaning of all the test sentences is entirely transparent. Any differential in responding to sentences containing *pelled* versus *pold* can therefore be attributed to children's sensitivity to the linguistic FORM of the utterances.

Following a training session, children were exposed to a total of 20 test sentences across the two sessions, interspersed with 20 distractor sentences involving real verbs (*feeled/felt*; *bited/bit*). Each of the four test verb forms (*pold/pelled*; *strept/streeped*) occurred on a total of five occasions each in sentences of the same type: *You* (*verb action-past*) *his* (*body part*). The same five body parts figured in the five sentences for each of the four verb forms. The order of sentences was randomized, with the only constraint being that sentences containing the same verb were not allowed to occur consecutively. In this way, one can better guard against the possibility that the child's judgements would be tainted by comparison with a form which has just occurred in the input. Child responses were scored in terms of their accuracy with respect to the adult grammar.

RESULTS

Responses where the child used the correct irregular past tense form modelled by the experimenter were designated as Use Correct (UC) responses. Child errors were coded as Persist-with-Error (PE), while no further usages of the target forms were coded as Move Ons (MO). Typical child errors included overregularized forms (*streeped* and *pelled*), in addition to base forms in the past context (*streep*; *pell*). It is apparent from Table 1 (below) that Move Ons occurred only rarely, a fact which may be attributed to the practice of explicitly encouraging children to use the target forms, following provision of either negative evidence or positive input.

Overall, there was a striking difference in the incidence of UC responses in the two input conditions. Across all children and all ten testing sessions, 172 UC responses were recorded in the Positive Input condition as against 357

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in the Negative Evidence condition (maximum possible 520). Conflating data for all children, a comparison of responses within individual sessions confirmed that this difference is highly significant ($t = 6{\cdot}63$, d.f. $= 9$; $p < 0{\cdot}0005$). The graph in Figure 1, below, reveals that levels of UC

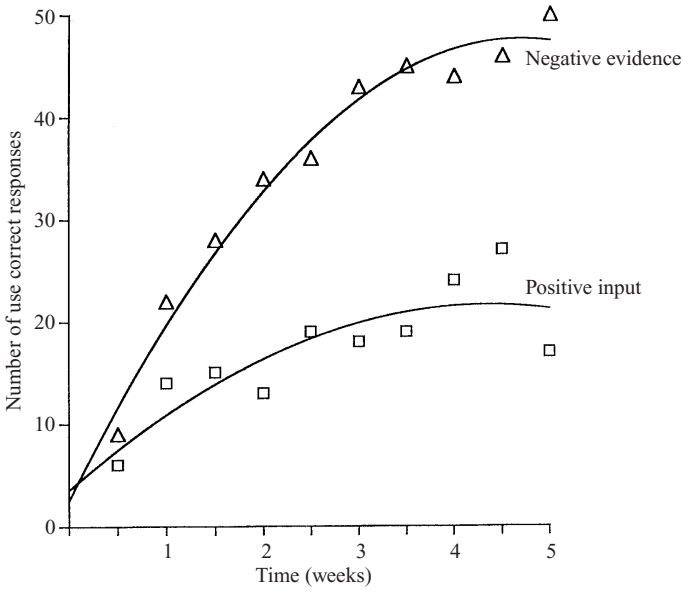


Fig. 1. Use Correct responses for all children over time.

responses, a measure of the grammaticality of child speech, increases at a much faster rate in the Negative Evidence, as against the Positive Input, condition. By the final session, performance in the Negative Evidence condition is approaching ceiling (the maximum number of possible correct responses per session being 52). By contrast, performance in the Positive Input condition levelled out by about the fifth session, with UC responses being supplied on around 40% of possible occasions.

Since each child was exposed to positive input only for one of the verbs and negative evidence for the other verb, a within-subjects comparison is possible. When the data for each subject are conflated across the ten testing sessions, it emerged that Use Correct responses are more prevalent in the Positive Input condition for only 3 of the 26 subjects (see Table 1). Furthermore, for these three subjects, the difference between the two input conditions was minimal (differing by one or two UC responses only). Overall, UC responses were far more prevalent in the Negative Evidence condition ($t = 6{\cdot}15$, d.f. $= 25$; $p < 0{\cdot}0005$). It is also possible to examine

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TABLE 1. *Child responses to negative evidence and positive input for each child across all ten testing sessions*

	Positive Input			Negative Evidence		
Subject	UC	PE	MO	UC	PE	MO
1	0	20	0	10	10	0
2	13	0	7	15	3	2
3	16	3	1	15	5	0
4	14	3	3	20	0	0
5	13	7	0	20	0	0
6	11	9	0	17	3	0
7	12	8	0	14	5	1
8	14	5	1	16	4	0
9	11	6	3	17	3	0
10	3	17	0	19	0	1
11	16	2	2	19	1	0
12	2	14	4	19	1	0
13	12	6	2	12	8	0
14	0	20	0	16	4	0
15	1	19	0	13	7	0
16	4	16	0	3	17	0
17	4	16	0	2	18	0
18	2	18	0	14	6	0
19	6	14	0	16	4	0
20	2	18	0	18	2	0
21	1	19	0	16	4	0
22	3	17	0	10	10	0
23	2	18	0	10	10	0
24	4	16	0	14	6	0
25	6	14	0	10	10	0
26	0	20	0	2	18	0
Total	172	325	23	357	159	4

KEY: UC, Use Correct; PE, Persist-with-Error; MO, Move On.

whether the difference between positive input and negative evidence becomes more marked over time, by performing a test of linear contrasts. Scores for each session were weighted to reflect their position in the testing sequence, with the effect that scores in the later sessions contribute progressively more to the overall total for each child than scores in the earlier sessions. A simple comparison of the overall scores revealed that, for individual children, UC responses become increasingly more prevalent over time in the Negative Evidence condition when compared with the Positive Input condition ($t = 3{\cdot}71$, d.f. $= 25$; $p < 0{\cdot}0005$). Thus, children are much more likely to show improvements over time in the grammatical accuracy of their speech when they are exposed to negative evidence.

Of related interest is the number of times children produced the correct form as their initial response in the Negative Evidence condition. In cases

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where children start out by producing the correct form, it is impossible for the experimenter to supply negative evidence, for the simple reason that negative evidence occurs contingent on child errors. As a result, children are likely to receive different levels of negative evidence across the five-week testing period. One might term these initial correct responses pre-emptive, since the provision of negative evidence is blocked. In the event, pre-emptive responses of this kind were observed mainly towards the end of the testing period (as one might predict), with frequencies for individual children ranging between 3 and 13 (maximum possible 19). Hence, all children received a mixture of positive input and negative evidence in the Negative Evidence condition, but positive input only in the Positive Input condition. Potential problems for interpretation of the findings are considered in the discussion section below.

Turning to the findings for the grammaticality judgement task, clear differences emerged in the intuitions held by children, according to whether or not they had been exposed to negative evidence (see Table 2). Children's

TABLE 2. *Children's correct intuitions concerning the grammaticality of grammatical and ungrammatical past tense forms* (*maximum possible* 5)

	Ungrammatical forms		Grammatical forms	
Subject	Positive Input	Negative Input	Positive Input	Negative Input
1	3	5	0	5
2	3	3	1	5
3	2	5	1	4
4	4	5	1	5
5	2	3	4	5
6	0	0	2	4
7	0	3	3	5
8	1	2	3	5
9	2	3	3	4
10	2	1	4	4
11	2	1	4	5
12	4	3	4	5
Total	25	34	30	56

performance on grammatical forms is near ceiling in the Negative Evidence condition. Notably, children are far less confident about the grammaticality of the irregular form when it has been heard as positive input only (56 correct responses for Negative Evidence, compared with 30 for Positive Input) ($t = 4{\cdot}91$, d.f. $= 11$; $p < 0{\cdot}0005$). The advantage enjoyed by negative evidence is maintained when one considers intuitions concerning the ungrammatical

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forms also (34 correct responses as against 25 for Positive Input). The difference between the two conditions is less pronounced in this case, but is nevertheless statistically significant ($t = 1{\cdot}83$, d.f. $= 11$; $p < 0{\cdot}05$). Overall, therefore, it would seem that negative evidence leads to markedly greater improvements in the accuracy of child speech than positive input. Moreover, these effect are witnessed not merely in the child's immediate speech output, but represent cumulative increases in accuracy over a five-week period. In addition, this experiment furnishes data on children's understanding of past tense forms when learnt under different input conditions. Evidently, negative evidence, but not positive input, allows the child to develop intuitions which more closely resemble those of an adult. Critically, this means that negative evidence teaches the child not only that the irregular form is grammatical, but also that the overregularized form is ungrammatical.

DISCUSSION

The findings from this study are important for demonstrating that child sensitivity to corrective information in the input is more than a fleeting phenomenon. Thus, the effects of negative evidence are clearly sustained throughout the five-week testing period. Indeed, the difference between the two input conditions becomes more marked over time. This conclusion is based in part on the observed changes in the grammaticality of child speech, since the provision of negative evidence led to higher levels of Use Correct responses than positive input alone. In addition, the grammaticality judgement task provided a critical insight on the child's intuitions concerning the status of different past tense forms. Evidently, children's responses more closely resembled those of an adult when negative evidence was available, since they were more likely both to accept the irregular form and reject the overregularized form.

In contrast, positive input alone left children much less certain about the grammatical status of the overregularized form. On the assumption that children have three response options in the grammaticality judgement task (accept, reject, or no response), then children were performing at little better than chance in this case. As predicted, therefore, positive input alone does not apprise children of the ungrammaticality of the overregularized form. This finding runs counter to the theoretical position advanced recently by Marcus and his colleagues (e.g. Marcus, Pinker, Ullman, Hollander, Rosen & Xu, 1992). Marcus *et al*. predict that exposure to an irregular past tense form automatically blocks the on-line suffixation process, which would otherwise lead to the production of a regularized form. The errors which subsequently occur are regarded as mere performance errors, which can be attributed to the failure of an immature memory retrieval system. On this view, therefore, the occurrence of overregularized forms does not denote the existence of an overgeneralized child grammar, in which both irregular and

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overregularized forms are systematic alternatives for one another. Instead, the child's grammar reflects the adult system in admitting only the irregular past tense form. The data presented here, however, would seem to suggest that children do not automatically reject the overregularized form. It is also interesting to note that children's faith in the grammaticality of the irregular form is considerably stronger when negative evidence has been supplied for the overregularized form.

The experimental method adopted here is clearly of value in exploring the effects of corrective input. The technique relies on the extent to which one can elicit grammatical errors from children. Provided that children can be persuaded to talk at all, there is little problem in eliciting past tense errors on the first occasion of use. Having never heard the past tense form of the novel verb before, the child is bound to produce an error, since she is not yet privy to the fact that the verb is irregular. This method works well for investigating the immediate effects of negative input, as reported in Saxton (1997). When one turns to examine longer-term effects, however, one can be far less certain of eliciting past tense errors on every occasion. Once children have been exposed to the correct irregular form, it is conceivable that subsequent initial responses will comprise the irregular form. In the Positive Input condition, there is no problem, since the provision of the irregular form is not dependent on the production of a child error. In the Negative Evidence condition, on the other hand, one must decide in advance how to respond if an error is not produced by the child.

One approach would be simply to repeat the procedure of setting up a past tense context, leading to the prompt question (*What happened?*), as often as may be required. However, the two input conditions would then be quite different and there is also a real danger that boredom with the testing situation would quickly set in. An alternative, pursued here, was to model the correct form for the child, regardless of their initial response in the Negative Evidence condition. If the child does not produce an error as her initial response, then one is effectively supplying the child with positive input. In the event, this mixture of positive and negative input was experienced by all children in the Negative Evidence condition. Since the input offered to the child is dictated by the nature of the child's initial use of the test verb, it is impossible to legislate in advance for the amount of negative input which will be received by individual children. It was nevertheless decided to proceed in this manner for three reasons. First, it ensured that children were exposed to the correct irregular form on an equal number of occasions overall for each verb. Second, ecological validity is enhanced, since the mixture of positive and negative input obviously mirrors real life more closely than a situation in which negative input is the sole source of information regarding a grammatical form. And thirdly, the more positive input which encroaches into the Negative Evidence condition, the fewer chances there are for negative

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evidence to exert an influence on the child. Hence, any differences which are observed between the two conditions will be all the more impressive. Furthermore, the predicted differences would remain attributable to the influence of negative evidence, since the two conditions are distinguished by the fact that negative evidence is supplied in the Negative Evidence, but never in the Positive Input, condition.

On the question of ecological validity, it may still be argued that the proportion of negative input supplied to children far exceeds the levels witnessed in naturalistic corpora. Although children produced differing numbers of errors, negative evidence was supplied on 100% of occasions when errors did occur. However, the absolute frequencies involved are very low when compared with extant naturalistic corpora (e.g. Farrar, 1992; Morgan *et al.*, 1995). Moreover, it is likely that the quantity of negative input is probably less significant than the quality of information it bears for the child. Provided that the child is exposed to such input at a point in development when it can be of benefit, it may be the case that relatively few instances of negative input would be required in order to facilitate acquisition. This issue remains open to further enquiry. In particular, it would be interesting to replicate more closely the proportions of positive and negative input naturally available to the child. It would also be interesting to determine the minimum level of negative evidence required to effect permanent changes in the child's grammar. In this respect, the present study has demonstrated that clear effects can be discerned after exposure to fewer than 20 instances of negative evidence. When set against the vast amount of conversation generated between parents and children, it is not implausible to suggest that negative input may well be supplied to children in sufficient quantities to influence the process of retreat from error.

Negative input has maintained a central position in theories of child language acquisition for more than thirty years. Or rather, a projected ABSENCE of negative input has been at the centre of interest (e.g. Gold, 1967; Wexler & Culicover, 1980; Pinker, 1988; Morgan, 1996). The reason for this interest is that the 'no negative evidence' assumption constitutes an instantiation of Chomsky's (1980) argument from the poverty of the stimulus (henceforth APS) (see, for example, Hyams, 1992). According to the APS, if one can demonstrate that linguistic, social or cultural experience have played no role in the acquisition of a given aspect of syntactic knowledge, then one can infer that this knowledge is innately determined. Thus, if a child is shown to acquire a given linguistic structure without the benefit of negative input, then one can assume that the child's knowledge about what is and is not grammatical with respect to that structure is innate. (As mentioned above, this conclusion is predicated, in part, on the assumption that positive input, although available, is too impoverished to yield this knowledge). When one considers that the 'no negative evidence' assumption can be applied, blanket-

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fashion, to the acquired (adult) grammar in its entirety, then the huge impact of this assumption on theorizing becomes apparent.

The simple logic of the APS is inescapable. At the same time, it is perhaps not always appreciated that the chances of being able to apply this method in practice are vanishingly small. In principle, one could demonstrate that negative input is not a NECESSARY component of language acquisition by finding a single child for whom negative input is unavailable (Pinker, 1989). In practice, however, few researchers would be confident that the sampling practices employed in child language studies are sufficiently robust to confirm the ABSENCE of some phenomenon. Given that critical input events may occur only rarely (Nelson, 1991), it is entirely plausible that the hour-long cross-sectional samples typical of many studies would fail to capture these events. As it happens, every empirical study on negative input has established that negative evidence (as defined here) IS available, not only for all children studied, but for every individual grammatical structure examined (as cited in the Introduction).

Even if one lays aside the issue of empirical feasibility, one can question the utility of the APS on theoretical grounds also. In brief, it is not clear that the 'no negative evidence' assumption provides any useful information about the child's genetic endowment. This point can be illustrated, for argument's sake, via linguistic principle (X). If one applies the APS, the acquisition of Principle (X) is said to be constrained jointly by the impoverished nature of available positive input and the complete absence of negative input. Hence, (X) must be innate. But how does one specify the nature of (X) in the first place? This task has traditionally been undertaken by linguists, who advance theoretical descriptions to account for Principle (X). However, for any given linguistic phenomenon, one can typically find a whole range of competing and evolving explanations. An example is provided by the many conflicting accounts of null subjects in linguistic theory (see, for example, Hyams, 1986; 1992; Huang, 1995). The problem is that EACH AND EVERY account of the null subject phenomenon can rely on the 'no negative evidence' assumption to support the notion that it corresponds to a genetically determined property of grammar. The 'no negative evidence' assumption could therefore never function as an evaluation metric for assessing the relative merits of one account over another. It emerges, then, that even if the 'no negative evidence' assumption were better supported empirically, its impact on the task of characterizing the innate component of language acquisition can be no more than minimal. At best, one might conclude that 'something is innate', but, if one accepts the existence and projected function of genes, this conclusion contributes nothing new to the nature-nurture debate (cf. Braine, 1994). Clearly, we require alternative sources of evidence if we are to determine the precise nature of the child's genetic endowment for language.

In the enthusiastic but ambitious quest to discover innate properties of

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language, it should not be forgotten that many challenges which are empirically more tractable can also enrich our understanding of child language acquisition. The study of negative input provides a case in point. In particular, there remains the problem of explaining how children expunge errors and attain a mature, adult-like system of grammar. This problem is often referred to as the 'no negative evidence' problem, but recent empirical findings all support the idea that negative input may, after all, be available, and furthermore, be exploited by the child. One might speak more generally, therefore, of the RETREAT PROBLEM facing the child (Saxton, 1997). Evidently, negative input would provide the simplest and most obvious solution to the retreat problem. For this reason, the issue should be pursued empirically far more vigorously than hitherto. In particular, while the present paper indicates that negative input can exert longer-term effects on child grammar, it remains unclear whether these effects are permanent.

The relative importance of negative input in solving the retreat problem also needs to be assessed carefully, in tandem with the many alternative solutions which have been proposed in the literature (e.g. indirect negative evidence, Chomsky, 1981; the Uniqueness principle, Wexler & Culicover, 1980; the subset principle, Berwick & Weinberg, 1984; the catapult mechanism, Randall, 1992; improvement in memory retrieval processes, Marcus *et al.*, 1992). It is quite possible that the child exploits several sources of converging input information, together with innate resources, in the retreat from error (Saxton, 1997). It is important, therefore, to assess the relative impact of each factor, and consider how they might interact with one another. On this approach, research is guided from the outset by the possibility that multiple sources of information and knowledge may be exploited by different children in different ways. This approach conflicts with one where alternative explanations are set one against another, in the search for a single, winner-takes-all account. At the very least, this latter approach tends to place excessive emphasis on the role played by a single factor. In consequence, it becomes more likely that the potential complexities of language acquisition will be overlooked. Accordingly, negative input should be viewed as one of several possible factors which might account for how children retreat from error (Saxton, 1997; see also Hirsh-Pasek & Golinkoff, 1996).

In conclusion, the findings reported here lend support to the theoretical distinction drawn between negative evidence and positive input within the Contrast theory. It will be recalled that the linguistic information available via each form of input is identical. The difference between the two lies in the structure of the discourse. It has been shown here that contingency of the adult form on the child's own error critically affects the quality of information supplied to the child. Thus, negative evidence confirms not only the grammaticality of the adult form, but also the ungrammaticality of the erroneous child form. Certainly, both these elements of knowledge are

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required if the child is to solve the retreat problem in language acquisition, and shed ungrammatical forms from the developing grammar. The present study contributes to a growing body of evidence that young children can identify and exploit the corrective potential of negative evidence. Furthermore, it would appear that the effects of negative evidence on the child are not merely transitory in nature, but may persist over an extended period of time.

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