Young children's acquisition of *wh*-questions: the role of structured input*

VIRGINIA VALIAN

Hunter College and CUNY Graduate Center

LYMAN CASEY

Northwestern University

ABSTRACT

Two-year-olds learn language quickly but how they exploit adult input remains obscure. Twenty-nine children aged 2;6 to 3;2, divided into three treatment groups, participated in an intervention experiment consisting of four sessions 1 week apart. Pre- and post-intervention sessions were identical for all children: children heard a *wh*-question and attempted to repeat it; a 'talking bear' answered. That same format was used for the two intervention sessions for children in a quasicontrol condition (Group QC). Children receiving modelling (Group M) heard a question twice before repeating it; those receiving implicit correction (Group IC) heard a question, attempted to repeat it, and heard it again. All groups improved in supplying and inverting an auxiliary for target questions with trained auxiliaries. Only experimental children generalized to auxiliaries on which they had not been trained. Very little input, if concentrated but varied, and presented so that the child attends to it and

attempts to parse it, is sufficient for the rapid extraction and generalization of syntactic regularities. Children can learn even more efficiently than has been thought.

INTRODUCTION

Perhaps the most commonly remarked-upon fact about first language acquisition is that children quickly and effortlessly learn the syntactic structure of their native tongue (Slobin, 1974, p. 40). The experiment to be described here suggests that we have nevertheless underestimated how quickly children are capable of learning language; normal language acquisition is slow compared to the rate at which children CAN learn individual syntactic structures.

Normal acquisition is 'slow', we propose, because the child is learning the entire language simultaneously, because the input is diffuse, and because the child's attention is seldom focused primarily on the syntactic form of the input. On our model, the child learns by attempting to provide a syntactic structure for the input. Environmental features which encourage the child to attempt repeated parses accelerate acquisition. Successful parsing should have two results: the grouping of elements into equivalence classes and the formation of rules over those classes.

Consider the case of *wh*-question formation – questions that begin with words like *where* and *when* – within one-clause sentences in English. These are questions like 'Where can Lucy play?' The child's learning task is to determine what items fall into the equivalence class we are here calling auxiliaries, and to understand that those auxiliaries obligatorily occur directly after the *wh*-word and before the subject in *wh*-questions.

Two-year-olds make errors in producing *wh*-questions and continue to make errors for some time (Klima & Bellugi, 1966; Labov & Labov, 1978; Bloom, Merkin & Wooten, 1982; Erreich, 1984; Klee, 1985; Stromswold, 1990). The most common errors are failure to include an auxiliary and placement of the auxiliary after, rather than before, the subject. Even four-year-olds will accept non-inverted *wh*-questions ('When Lucy can yell?') as acceptable in a grammaticality task (Stromswold, 1990). Analysis of one child's *wh*-questions found that the child inverted best with combinations of *wh*-words and auxiliaries that were frequent in the input (Rowland & Pine, 2000). The data suggest that the structure of *wh*-questions is slow to be acquired and is not mastered for some time after the child's initial production of formula-like *wh*-questions (e.g. 'What's that?').

The different facets of *wh*-questions suggest why their structure would be acquired slowly. *wh*-questions require the integration of several pieces of knowledge. The first piece of knowledge – that the *wh*-word appears at the front of the sentence – is one that English speakers appear to acquire very

early. Virtually no errors are reported of a *wh*-word being at the end of the sentence ('Can Lucy find the ball where?').

The second item of knowledge is that the sentence must be tensed and that tense must be placed on the main verb (V) or on an auxiliary (AUX) but not both (hence, the untensed 'Where Lucy play?' is ungrammatical, as is the doubly-tensed 'Where can Lucy plays?').

The third piece of knowledge is the equivalence class of elements which can invert with the subject. Following custom, we refer to those elements as AUXes, but they are actually a mixed group. They consist of tense (present or past) and agreement (person, number), modals (e.g. *can, will*), *have* (in either main verb or auxiliary form), and *be* (in either main verb or auxiliary form). All can appear simultaneously in a question ('Where might Lucy have been playing?'). If only tense and agreement are in AUX, the dummy form *do* is inserted to 'carry' the tense and agreement ('Where does Lucy play?'). If two or more AUXes are present, only tense and agreement plus the first auxiliary element are inverted.

In linguistic terms, what these elements have in common is that they are either generated in an inflection node (INFL) or move to that node from the verb phrase (VP). Children must learn that tense and modals are base-generated in INFL, whereas *have* and *be* are base-generated in the VP. They must further learn that only *have* and *be* can move to INFL. Finally, they must learn that the elements in INFL form an equivalence class: whatever is in INFL can be moved in front of the subject in questions (to COMP) – so-called subject-AUX inversion. Thus, what AUXes in English have in common is very abstract; only their position in INFL unites them. What distinguishes *wh*-questions from yes–no questions is that the movement from INFL to COMP is obligatory in the former but optional in the latter.

We suggest that the lengthy time period required to learn *wh*-question formation is due to integrating and consolidating these different pieces of knowledge. Input is obviously important in mastering questions, but how the child makes use of input remains something of a mystery across language acquisition as a whole. No specific features of parental speech have been shown to be reliably correlated with the speed of children's acquisition of syntax, including acquisition of auxiliaries and *wh*-questions.

There has been no reliable relation between any aspect of parental speech (measured as relative frequency) and the development of AUXes or any syntactic structure in children (Newport, Gleitman & Gleitman, 1977; Furrow, Nelson & Benedict, 1979; Barnes, Gutfreund, Satterly & Wells, 1983; Gleitman, Newport & Gleitman, 1984; Hoff-Ginsberg, 1986; Scarborough & Wyckoff, 1986; Richards, 1990; Richards & Robinson, 1993). Individual studies have reported effects but they are sporadic and not consistently replicated (for review and discussion, see Valian, 1999). In the normal course of events, auxiliaries appear to develop gradually (as suggested in the studies

above; Shatz, Hoff-Ginsberg & MacIver, 1989; Valian, 1991), with no obvious connection to the input.

Yet there are effects of absolute frequency of input, particularly on lexical acquisition (Barnes *et al.*, 1983; Gathercole, 1986; Huttenlocher, Haight, Bryk, Seltzer & Lyons, 1991; Hart & Risley, 1995; Naigles & Hoff-Ginsberg, 1998). For example, the frequency of a verb in parental input predicts, 10 weeks later, the frequency and diversity of use of that verb in the child's output (Naigles & Hoff-Ginsberg, 1998).

If absolute frequency is important, how does it work? We suggest that multiple exposures give the child multiple opportunities to ATTEND AND PARSE the input, allowing the child to 'collect data' about the form's function. If we assume that much input is 'lost' to the child because of lack of attention or divided attention, copious input can mitigate that lack.

Intervention studies can clarify the role of input by providing children with specially tailored input and examining the consequences for acquisition. Studies with nonsense suffixes show that both normal children and those with Specific Language Impairment (SLI) can be taught new morphemes (e.g. Connell & Stone, 1992). Similarly, children have been taught the irregular past tense for nonsense verbs, with corrective input more effective than simple exposure (Saxton, Kulcsar, Marshall & Rupra, 1998).

Intervention with syntax has had mixed results. Of studies which employed separate experimental and control groups, four have shown marked gains in learning after relatively small amounts of specialized input, all with children older than 3 years. Other studies have shown modest or no gain after intense exposure to new forms. In the most successful studies, the child has been asked to imitate a sentence type (an ordering rule – Malouf & Dodd, 1972; the passive – de Villiers, 1984), to act out a sentence (clauses with 'before' and 'after' – Ehri & Galanis, 1980; relative clauses – Roth, 1984), or to produce the type (Malouf & Dodd, 1972, where the child's production was followed by the experimenter's giving the correct form; Ehri & Galanis, 1980; de Villiers, 1984), sometimes in combination with each other.

More limited results were reported in a lengthy intervention aimed at accelerating two-year-olds' production of complex questions or complex verbs (Nelson, 1977). A later study with a small sample and lengthy training period targeted passives, relative clauses, and non-used auxiliaries. Here, too, there was acceleration, with recasts of the child's utterance slightly more effective than recasts of the adult's own utterance (Baker & Nelson, 1984). The results are suggestive but hard to evaluate because there was no control group, the experimental groups were not adequate controls for each other, and the reported differences were very small and not suitable for statistical analysis.

Unsuccessful intervention studies have failed to find any benefits from adult expansions of child utterances (Cazden, 1965; Feldman, 1971) or have demonstrated that high ambient frequency of a form is insufficient for

acquisition (Shatz *et al.*, 1989). Notably, Shatz *et al.* modelled the modal *could* 360 times over a 6-week period to 2-year-olds who were producing few if any modals. The children who heard *could* did not produce more modals or more auxiliaries in post-intervention sessions than did children who heard no *could*'s at all. Even the production of *could* itself was unaffected.

What distinguishes very successful from less successful interventions? First, very successful procedures had the child actively engage the structure in some way, whether *via* imitation, act-out, or elicited production. Such procedures encourage the child to work out possible connections between structure and meaning so that the sentence can be understood *via* its structure. Second, the interventions targeted a single structure. The input was restricted to one structure and the child 'practised' that same structure, allowing a focus of attention on form; when that happens, relatively few examples are necessary for accelerated learning.

The fact that specialized input can accelerate development does not imply that such input is necessary to acquire language in a timely way (Marcus, 1993). Children do not naturally receive concentrated structured input of the type that successful experiments have provided (Malouf & Dodd, 1972; Ehri & Galanis, 1980; de Villiers, 1984; Roth, 1984). But the same mechanisms may be at work in both the natural environment and the ideal intervention, with the differences between the two quantitative rather than qualitative. We consider four differences between the most successful interventions and the normal environment.

(a) Interventions encourage the child to parse EACH input. In the normal situation the child attempts to parse SOME of her input. A child who never attempted to assign a syntactic structure to her input would never learn the language. But in the natural situation the child can often ignore syntax that she understands only partially or not at all. That is why plentiful input in the normal situation is helpful to children: it increases the chances that the child will attempt a parse.

(b) Interventions provide varied examples within a structure rather than a single exemplar. The natural situation is even more variegated, including irrelevant as well as relevant utterances. Examples of irrelevant *wh*-questions are 'What about this?' and 'Who's sleeping in my bed?' The former lacks both verb and subject, so that there is no inversion to be seen. The latter has a subject as the *wh*-word, so that although the auxiliary has moved to INFL (and then COMP), that movement is not apparent on the surface; nor can there be inversion of the subject and the auxiliary if the subject is itself the *wh*-element. Further, auxiliaries are frequently contracted, as here, making them hard to perceive.

(c) In successful interventions the input is confined to a single structure and exposure is concentrated within a short time frame. In natural situations

the input is never confined to a single structure; rather, it is mixed with many other structures and spread out over time.

(d) Interventions direct the child's attention primarily to syntactic form; meaning takes a back seat. In the natural situation the emphasis is reversed: children primarily use language for a purpose, with syntax in the background. In addition, in the natural situation, the child's attention is constantly shifting and is frequently divided among multiple aspects of the input.

If ideal interventions are only quantitatively different from the normal environment, interventions can tell us something about how normal acquisition works. In the present experiment, we designed a novel intervention procedure for *wh*-questions with children ranging in age from 2;6 to 3;2. This is the first experiment to use (a) a systematic intervention, (b) with two-year-olds, (c) on a syntactic structure, (d) in a manner that allows statistical comparisons. Our aim was to link our analyses of natural input, which suggest a role for absolute frequency rather than parental self-repetition or expansion, with our analysis of the effective features of intervention studies, which suggests that the mechanism at work in language learning is attend-and-parse.

Three conditions, minimally different from each other, were used to investigate the role of frequency on the performance of children who knew something about *wh*-questions but had not mastered them. We included only children who could correctly imitate some – but not all – AUXes and correctly imitate some – but not all – inversions. Our focus was on how our interventions would affect a process that was underway but incomplete.

We hypothesized that children would particularly benefit from trying to parse two examples of the same sentence in quick succession. In the first parse the child would perform a variety of phonological, morphological, syntactic and semantic computations. The syntactic aspects of understanding and producing the question would lag behind the other aspects, because of the child's incomplete knowledge of the syntax of questions. In the second parse, there would be savings on some computations, such as lexical look-up, allowing more attention to still-to-be-mastered aspects of the syntax. Valian & Aubry (2002), in an elicited imitation task where the child had two opportunities to repeat a sentence, found that children more successfully imitated the target on the second hearing, suggesting both that elicited imitation demands active processing on the child's part and that the second parse allows more complete processing.

All three of our conditions required four sessions, approximately 1 week apart. The pre- and post-intervention sessions were identical for all children and measured ability to successfully imitate the experimenter's model. Pilot work had demonstrated that children of this age were unable to consistently

TABLE 1. *Procedures used in each treatment*

Quasicontrol [QC]	
Sessions 1 and 4: pre- and post-intervention	Sessions 2 and 3: intervention
Experimenter asks question	Experimenter asks question
Child attempts to repeat question	Child attempts to repeat question
Gabby Bear answers	Gabby Bear answers
Modelling [M]	
Sessions 1 and 4	Sessions 2 and 3
Experimenter asks question	Experimenter asks question
Child attempts to repeat question	Experimenter asks question again
Gabby Bear answers	Child attempts to repeat question
	Gabby Bear answers
Implicit correction [IC]	
Sessions 1 and 4	Sessions 2 and 3
Experimenter asks question	Experimenter asks question
Child attempts to repeat question	Child attempts to repeat question
Gabby Bear answers	Experimenter asks question again
	Gabby Bear answers

formulate *wh*-questions in response to prompts like 'Ask [a puppet] where Carol can play'. Further pilot work asked children to imitate a model. Most children were willing to attempt the imitations and made sufficient numbers of errors in doing so to justify use of this technique. After the child's imitation, a 'talking bear' named Gabby gave a prerecorded answer. The children were interested in the bear and wanted to hear 'him' reply.

The pre- and post-intervention sessions tested four AUXes – *do*, *can*, *will*, and *be*. An important feature of the design was to use only two auxiliaries – *can* and *be* – in the two intervention sessions. That allowed us to test generalization to items on which the child had not been trained in addition to evaluating improvement on the auxiliaries that were used during intervention.

The first condition was a quasicontrol that used the same procedure for all four sessions: the child heard a correctly modelled target question, attempted to repeat it, and then heard Gabby answer. We expected some learning to result, but less than in the experimental conditions.

The two experimental treatments were identical to the quasicontrol for the pre- and post-intervention sessions but differed during the two intervention sessions. Each experimental treatment was a laboratory facsimile of a naturally occurring form of parental input (see Table 1). MODELLING is similar to parental self-repetition; IMPLICIT CORRECTION is similar to the parental custom of repeating the child's statement with variations. Middle-class American parents produce frequent examples of both types of input (Cross, 1977; Newport *et al.*, 1977; Snow, 1977; Furrow *et al.*, 1979; Hoff-Ginsberg, 1986; Scarborough & Wyckoff, 1986).

During the two intervention sessions in the modelling condition, the child heard the model twice before attempting a single repetition; then the bear answered. The difference between quasicontrol and modelling was in the number of times children heard the target; attempted production was equal. During intervention in the implicit correction condition, children heard the target, attempted to repeat it, and heard the target again without attempting another repetition; then the bear answered. Children heard the target a second time whether their imitation of the first target was flawed or not. Within our framework, which emphasizes the benefits of frequency for an attend-and-parse mechanism, the two experimental groups should both be superior to the quasicontrol group but neither experimental group should be superior to the other.

METHOD

Participants and settings

Participants were monolingual standard English speaking children aged 2;6 to 3;2, recruited from local pre-schools, day care centres, parent–child classes, and personal contacts. Twenty-nine children formed the final sample. They ranged in Mean Length of Utterance (MLU, calculated using procedures specified in Brown, 1973) from 1·70 to 5·51.

Only children who included an auxiliary in 15–85 % of their imitations of the questions in Session 1 were included in the study. Very low production could indicate total lack of knowledge of auxiliaries; the focus here was on producing an auxiliary when required and producing it in the right position. Very high production was correlated with inversion; high producers were deemed to have mastered question formation. The selection procedure selected for children who made errors typical of spontaneous speech and who could be classified as lacking good understanding of the syntax of question-formation.

An additional 46 children were seen at least once. Twenty-five were un-interested in the game, produced too few attempted imitations, or lost interest during the 4 weeks of the experiment. Six performed too well on Session 1; 2 were lost due to equipment problems; 9 were lost due to scheduling problems; 2 had a African American English Vernacular dialect; 2 children from the modelling group were excluded because they did not wait to hear the experimenter's repetition of the question before attempting their own repetition.

Sessions took place at the child's preschool or home, with all sessions conducted at the same site and almost always in the same room. In some cases, a parent, grandparent, caretaker, additional observer, or teacher was present for the sessions. While they sometimes spoke during the spontaneous speech section of the study, they were encouraged to (and typically did) remain silent during the experimental portion of the study.

Procedure and experimental conditions

Children participated in 4 sessions, each approximately 1 week to 10 days apart. Sessions 1 and 4, before and after intervention, measured the children's question-asking ability. Sessions 2 and 3 were intervention sessions. All sessions were audiotaped; Sessions 1 and 4 were fully transcribed.

To stimulate spontaneous speech during the 15–30 min warmup period preceding the experiment proper in Session 1, we used Richard Scarry's *Best Word Book Ever*. On a few occasions, when the child was eager to show us another book or a favorite toy, we used the child's choice as a supplement to the Scarry book.

An integral feature of the procedure was a teddy bear (Gabby) with a tape recorder embedded in his back. The recorder was activated by a rheostatic control in the bear's chest. When Gabby was turned on, a prerecorded tape played, Gabby's mouth opened and shut in rough synchrony with the tape's words, and his eyes moved up and down. Gabby could thus 'answer' questions, and children enjoyed hearing Gabby 'talk'. Two functionally equivalent bears were used.

The experimenter introduced the children to the task by saying, 'Sometimes when we want to know something, but we don't know, we have to ask. Well, this is a game about asking. In this game, we'll ask Gabby about some pictures that I brought. And here's how we'll do it: first I'll ask Gabby about the picture, then you ask Gabby the same thing I asked. And then Gabby will answer us. Okay? Let's try'.

The experimenter held Gabby so that he was facing the child. The experimenter showed the child a line drawing taken from a colouring book, read an orientation sentence about the picture, and then asked a pertinent *wh*-question which the picture did not contain the answer to. For example, one drawing for a practice question showed a girl and a woman. The experimenter pointed to the picture and said, 'Here's Carol and her mother'. The experimenter paused briefly for the child to register the picture and then asked, 'What is her mommy's name? Let's ask Gabby. Gabby, what is her mommy's name?' The experimenter turned on the bear, who answered, 'Her mommy's name is Susan'. In subsequent practice questions the experimenter prompted the child to ask, by saying 'Your turn', or 'Now you ask', or 'You ask the same thing I asked'. Once the child understood the game, prompts were only occasionally necessary.

Since the children were hearing a sequence of unrelated experimental questions, the drawings helped to indicate the subject matter of the question. They depicted children and cartoon characters engaged in a variety of familiar, enjoyable activities. In no case did the drawing or the orientation sentence provide an answer to the following question. (The full set of stimuli for all sessions, including a short description of each drawing, the accompanying

orientation sentence, the experimental question, and the bear's answer is available from the first author.) There were 28 drawings for the preintervention session (4 for practice questions, 24 for experimental questions), and 16 for each of the remaining three sessions. Seven pictures were used twice.

As would be expected, some children initially attempted to answer the question rather than ask it. The experimenter would prompt the child to ask Gabby. Whether or not the child asked, the experimenter turned on the bear, who answered. For children who still did not understand, the experimenter clarified the game. Some children also occasionally attempted to ask their own questions of Gabby. The experimenter clarified the game as one in which the child asked what the experimenter asked.

As Table 1 shows, the procedures in Sessions 1 and 4 were identical for all children. Session 1 established the children's baseline ability to ask *wh*-questions with 4 different auxiliaries and 2 different *wh*-words. Session 4 established the child's final ability to ask questions. Treatment effect was measured by the difference in performance between Sessions 1 and 4. Sessions 2 and 3, the intervention sessions, differed depending on which treatment group a child was assigned to.

Quasicontrol. The quasicontrol group (QC) experienced the same procedure on Sessions 2 and 3 that it experienced on Sessions 1 and 4. Since some improvement for the experimental groups might have been expected simply as a function of familiarity with the task of repeating *wh*-questions, a quasicontrol procedure was used in preference to an ordinary control in which the child would have received no further exposure to elicited imitation or no exposure to imitation of questions.

Modelling. In Sessions 2 and 3, the modelling group (M) heard each question twice before repeating it. Modelling thereby provided a laboratory simulation of parental self-repetition. The experimenter introduced the change in procedure by reminding the child of the game of asking Gabby, and saying that they would play a little differently that day. 'Here's how we're gonna play. First I'm gonna ask Gabby two times, then you ask one time. And then Gabby will tell us the answer. Okay? So first I ask two times, then you ask one time.'

The experimenter then modelled the target twice, with the second repetition immediately following the first, with slightly different intonation. If a child began asking the question before the experimenter asked the question a second time, the experimenter would stop and remind the child that today the experimenter would ask two times before the child asked. If it seemed necessary to remind the child further, the experimenter might put up an index finger and whisper 'wait' after the first question.

At Session 4 the experimenter told the child that today the experimenter would just be asking one time, and then the child could ask. Children adjusted to that change in procedure with little difficulty.

Implicit correction. In Sessions 2 and 3, the implicit correction group (IC) heard each question, attempted to imitate it, and then heard the question again (regardless of whether or not the child correctly imitated the question). Implicit correction thereby provided a laboratory simulation of parental repetitions of children's utterances, repetitions which may or may not include an implicit correction of the child's formulation. The experimenter introduced the change in procedure by reminding the child of the game of asking Gabby, and saying that they would play a little differently that day. 'Here's how we're gonna play. First I'm gonna ask Gabby about the picture, then you ask, and then I'll ask again. And then Gabby will tell us the answer. Okay?' If the child appeared to need more information, the experimenter added, 'So first me, then you, then me.'

If the child attempted to repeat the experimenter's second question the experimenter typically said 'Wait. Now it's Gabby's turn'. After playing Gabby's answer the experimenter would remind the children how the game was played. If a further reminder was necessary, the experimenter held up an index finger and said 'wait'.

At Session 4 the experimenter told the child that today the experimenter would just be asking one time. Children adjusted to that change with little difficulty.

In summary, treatment conditions varied how often the child heard the question in the two intervention sessions – once for QC, twice for M and IC. The two experimental groups differed from each other in the placement of the experimenter's second question. In modelling, the second question appeared before the child attempted his or her imitation; in implicit correction, the second question appeared after the child attempted his or her imitation.

Stimuli

The *wh*-questions children imitated were different for each of the 4 sessions. In Session 1, children received 4 practice questions and 24 experimental questions. The practice sentences used *what* and main verb *be*, as in 'What colour is his hair?' Session 1 contained more experimental questions than subsequent sessions (16 each) because pilot work showed some children did not grasp the nature of the 'asking game' very quickly. We wanted to ensure that Session 1 would provide a solid data base.

Table 2 outlines the question types used in each session. Half the experimental questions began with *when* and half with *where*. For each *wh*-word, three questions used *do* as the auxiliary, three used *can*, three used *will*, and three used main Verb (V) *be*. Questions ranged in length from 4 to 7 words and were balanced for length across the four auxiliary types. Nominal and pronominal singular and plural subjects were used, thus altering the form of *be*

TABLE 2. *Outline of question types used in Sessions 1–4*

Session 1 – pre-intervention
  4 practice sentences to teach child the procedure
  24 sentences in quasirandom order
    12 *when*: 3 *do*, 3 *will*, 3 *can*, 3 main verb *be*
    12 *where*: 3 *do*, 3 *will*, 3 *can*, 3 main verb *be*

Sessions 2 and 3 – intervention
  16 previously unheard sentences in quasirandom order
    8 *when*: 4 *can*, 4 main verb *be*
    8 *where*: 4 *can*, 4 main verb *be*

Session 4 – post-intervention
  16 previously unheard sentences in quasirandom order
    8 *when*: 2 *do*, 2 *will*, 2 *can*, 2 main verb *be*
    8 *where*: 2 *do*, 2 *will*, 2 *can*, 2 main verb *be*

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and *do*, but not *can* and *will*. Given the children's limited vocabulary, the *wh*-words used, and other constraints, a certain inanity was unavoidable.

Examples of questions are: 'where is his bedroom?', 'where are Gabby's toys?', 'when is Tom's babysitter with him?', 'when are vacations?', 'where does the garbage go?', 'where do monkeys eat bananas?', 'when does the telephone ring?', 'when do neighbours visit?', 'where can a rabbit jump?', 'where can we read a story book?', 'when can Lucy yell?', 'when can we sing our ABC's?', 'where will she go today?', 'where will flowers grow?', 'when will Santa Claus come?', and 'when will they see their friends?'

In Sessions 2 and 3, the intervention sessions, 16 experimental questions were used. Half the questions began with *when* and half with *where*. Two auxiliaries were used, main V *be* and *can*, divided equally between the two types of *wh*-words. (Main V *be* inverts with the subject in questions in the same way that auxiliaries do. For that reason, we refer throughout to main V *be* as an auxiliary even though it is not strictly correct.) The form of *be* varies depending on the person and number of the subject and the form of *can* does not; similarly, the form of *do* varies and the form of *will* does not.

In Session 4, 16 experimental questions were used, half with *when* and half with *where*. As in Session 1, all four auxiliaries were used, divided equally between *when* and *where*.

An important feature of the design was the use of all four auxiliaries in Sessions 1 and 4, but only two auxiliaries in Sessions 2 and 3. That allowed us to assess whether improvement was limited to the trained auxiliaries or generalized to the untrained auxiliaries. In all sessions, the order of presentation was balanced so that each *wh*-word and auxiliary were presented an equal number of times in each half of the session.

Four different answer tapes were prerecorded (by VVV, who did not serve as an experimenter; although the voice was female, pilot testing showed that children preferred to treat Gabby as a 'he' rather than a 'she'). At the

beginning of each tape Gabby greeted the child, and at the end of each tape Gabby said goodbye. In the middle of each tape Gabby sang a short song (Session 1 – the ABC song; Session 2 – 'Twinkle twinkle little star'; Session 3 – 'Mary had a little lamb'; Session 4 – 'Eensy-weensy spider' and 'London Bridge', with 'Mary had a little lamb' at the end).

Transcription

The audiotapes for Sessions 1 and 4 were transcribed by one person (almost always the experimenter who had visited the child) and checked by a second person. Disagreements concerning transcription were resolved by a third listener or by discussion between the first two listeners. Transcribers were aware of the child's treatment group.

Criteria for scorability

For a child's response to be scorable, (a) a child had to make a response; (b) the response had to be intelligible at least in part; (c) there had to be sufficient overlap between the target and child's response – *via* the subject, object, or main verb of the target question – to establish that the child was attempting to model the target; (d) there had to be no indication that the child was asking a different question. If the child attempted the target twice, the first full attempt was scored. If the child began a repetition before the experimenter had finished but was stopped by the experimenter, the full repetition that the child produced once the experimenter had finished was scored. If the experimenter produced the wrong question the child's response was not scored.

Coding

Each scorable response was then coded for auxiliary usage and inversion. Two different auxiliary measures were used: target auxiliary use, and any auxiliary use.

TARGET AUXILIARY USE measured the percentage of times the child supplied the specific auxiliary used in the target question. Changes of tense or agreement were allowed, as were contractions (e.g. *was* or *are* for *is*, *could* for *can* or *'ll* for *will*). The numerator was the number of scorable questions including the target auxiliary; the denominator was the number of scorable questions.

ANY AUXILIARY USE measured the percentage of times the child included any auxiliary, even if it differed from the one in the target question. Only *bona fide* auxiliaries were permitted: the modals *can/could*, *will/would*, *shall/should*, *may/might*, or *be, do*, or *have*. Changes of tense or agreement were allowed, as were contractions. Semi-auxiliaries like *gonna* and *wanna* or other verbs were not allowed. By restricting substitutions to genuine auxiliaries, we ensured

TABLE 3. *Mean (and* S.D.*) age, MLU, percent auxiliary inclusion, and percent inversion at preintervention session*

	Age	MLU	Target AUX	Any AUX	Inversion
Quasicontrol $N=11$ (6 girls)	2;9 (0;2.15)	3·46 (0·93)	40 (19)	57 (27)	44 (22)
Modelling $N=9$ (6 girls)	2;9 (0;2.6)	3·26 (0·69)	37 (19)	55 (29)	43 (23)
Implicit correction $N=9$ (4 girls)	2;9 (0;1.27)	3·42 (1·03)	44 (20)	58 (24)	49 (18)
Overall	2;9 (0;2.6)	3·38 (0·87)	41 (19)	57 (22)	46 (21)

Note. Target AUX, inclusion of target auxiliary; Any AUX, inclusion of any auxiliary; Inversion, inversion of subject and any auxiliary. No group differences are significant.

that only members of the correct equivalence class were included. This measure was a superset, including both target auxiliary use and other auxiliaries. Children could fail to show improvement in supplying the exact auxiliary in the target but improve in supplying a member of the auxiliary category. The numerator was the number of scorable questions including any auxiliary; the denominator was the number of scorable questions.

Examples of inclusions for any auxiliary are substitutions of a form of *be* for *do* (e.g. 'Where's fish swim?' for 'Where do fish swim?'); incomplete specification of the auxiliary (e.g. 'When kuh they play?' for 'When can they play?'); use of a different modal. Unintelligible syllables in the correct auxiliary position were not allowed (e.g. 'where [syllable] cats climb?' was not an acceptable substitute for 'where can cats climb?').

INVERSION measured the percentage of times the child inverted the subject and the auxiliary. Inversion required the presence of both the subject and the auxiliary in their correct positions but did not require the same auxiliary as that used in the target. The numerator was the number of scorable questions where inversion was present; the denominator was the number of scorable questions. Very occasionally a child inverted a subject and a main verb; the child was credited with inversion in that case.

Most scoring was nonproblematic. Examples of difficult scoring decisions and criteria used to resolve them are available from the first author.

Assignment of children to treatment group

Children were assigned to treatment group based on how often they included any auxiliary (the second auxiliary measure described above) in their imitations in Session 1 in order to balance auxiliary inclusion across conditions. As shown in Table 3, the treatment groups were successfully equated on overall auxiliary inclusion. QC children averaged 57% (S.D. = 26) auxiliary use, M

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children 55% (S.D. = 29), and IC children 59% (S.D. = 29). An analysis of variance (ANOVA) showed no differences among the three groups.

Equating the children on any auxiliary usage resulted in their being equated on every other measure. We performed further ANOVAs to compare the children's performance on the auxiliaries on which they would be trained (*can/ be*), and on the ones on which they would not be trained (*will/do*). For all three dependent measures (target auxiliary use, any auxiliary use, and inversion) there were no differences. Finally, each group was the same age 2;9, and each group had a similar MLU: 3·46 for QC children, 3·26 for M children, and 3·41 for IC children.

Experimenter control measures and extraneous variables

To determine whether experimenters might have inadvertently asked more spontaneous questions of some treatment groups than others, we measured the experimenters' total yes/no questions, inverted yes/no questions, *wh*-questions, fragment questions, tag questions, and embedded questions. There were no significant differences by treatment group for any type of question, or for total questions. We also checked how many times experimenters produced an experimental question. Given children's fluctuating attention, it was sometimes necessary for the experimenter to ask a question twice. There were no significant differences in experimenter repetition.

Analyses

We analysed improvement in three areas. The first measure – target auxiliary – was improvement in how often children included the specific target auxiliary used in the experimenter's question. The second measure – any auxiliary – was improvement in how often children included any *bona fide* auxiliary in their attempted questions, even if it did not match the target. The third measure – inversion – was improvement in how often the children's attempt inverted the subject and the auxiliary. For each measure we computed an omnibus 3 × 2 × 2 analysis of variance (ANOVA) with treatment group (QC, M or IC) as the between-subjects variable and auxiliary type (trained vs. untrained) and session (before vs. after intervention) as within-subjects variables. Because an important theoretical question was whether the three treatment groups would perform similarly on trained and untrained auxiliaries, planned comparisons compared treatment groups for each auxiliary type separately.

RESULTS

We had predicted that hearing a sentence twice – as occurred in our two experimental groups – would be more beneficial for children than hearing it

TABLE 4. *Target auxiliary use before and after intervention in percent* (S.D.)

| | Auxiliary type | | | | | | | | |
| | Trained (*can/be*) | | | Untrained (*will/do*) | | | Combined | | |
Treatment	before	after	gain	before	after	gain	before	after	gain
Quasicontrol									
mean	56	66	10	25	22	−3	40	44	4
(S.D.)	(30)	(30)		(13)	(18)				
Modelling									
mean	50	73	23	24	26	2	37	50	13
(S.D.)	(27)	(24)		(23)	(28)				
Implicit correction									
mean	62	72	10	29	35	6	46	54	8
(S.D.)	(33)	(30)		(21)	(24)				
Overall									
mean	56	70	14	26	27	1	41	49	8
(S.D.)	(29)	(27)		(19)	(23)				

The main effect of session was significant (ignoring auxiliary type and treatment, children improved in supplying the target AUX), as was the main effect of auxiliary type (ignoring session and treatment, children produced more targets for trained auxiliaries). The interaction between auxiliary type and session was significant (children improved more on trained than untrained auxiliaries).

once, as occurred in our quasicontrol group. Our results confirmed that prediction: the modelling and implicit correction groups showed more generalization than the quasicontrol group (and did not differ from each other). Only the two experimental groups improved on sentences containing auxiliaries on which they had not been trained (*do/will*), increasing their inclusion of an auxiliary and, most important, increasing their rate of inversion. All three groups showed benefits for the specific auxiliaries on which they had been trained (*can/be*), increasing their imitation of those auxiliaries, increasing their inclusion of some auxiliary or other, and increasing inversion.

Increase in use of target auxiliary

All three treatment groups improved to the same extent in supplying the target auxiliary, but improvement was limited to the trained auxiliaries. As shown in Table 4, there was a main effect of auxiliary type. Trained auxiliary targets were easier to match (63%) than the untrained auxiliary targets (26%; $F(1, 26) = 61\cdot47$, $M.S.E. = 620\cdot85$, $p < 0\cdot0001$). The main effect of session showed that there was a reliable increase from pre- (41%) to post-intervention (49%) in use of the target auxiliary ($F(1, 26) = 10\cdot51$, $M.S.E. = 181\cdot58$, $p < 0\cdot005$). There was no main effect of treatment group and no interactions with treatment group; the three groups did not differ in how much they improved.

TABLE 5. *Any auxiliary use before and after intervention in percent* (S.D.)

| | Auxiliary type | | | | | | | | |
| Treatment | Trained (*can/be*) | | | Untrained (*will/do*) | | | Combined | | |
	before	after	gain	before	after	gain	before	after	gain
Quasicontrol									
mean	64	73	9	50	45	−5	57	59	2
(S.D.)	(28)	(29)		(23)	(26)				
Modelling									
mean	64	81	16	46	61	15	55	71	16
(S.D.)	(29)	(19)		(26)	(41)				
Implicit correction									
mean	69	81	12	49	75	26	59	78	19
(S.D.)	(35)	(23)		(21)	(28)				
Overall									
mean	66	78	12	48	59	11	57	69	12
(S.D.)	(30)	(24)		(23)	(33)				

The main effect of session was significant (ignoring auxiliary type and treatment, children improved in supplying any AUX), as was the main effect of auxiliary type (ignoring session and treatment, children produced more auxiliaries for trained auxiliaries). The interaction between treatment group and session was significant (experimental children improved more than did quasicontrol children).

Improvement was confined to the trained auxiliaries, as the interaction between auxiliary type and session suggested ($F(1, 26) = 6·16$, $M.S.E. = 193·84$, $p < 0·02$) and analyses for each auxiliary type confirmed. An ANOVA limited to *can/be* showed an average gain of 14 percentage points ($F(1, 26) = 20·84$, $M.S.E. = 146·93$, $p = 0·0001$) and no interaction between treatment group and session. An ANOVA limited to *will/do* showed no improvement for any treatment group – an average gain of only 1·3 percentage points – and no interaction involving treatment.

In summary, all children improved significantly in their ability to imitate the target auxiliary when the target was one of the two auxiliaries used during the two intervention sessions. When the target was an untrained auxiliary, there was no significant improvement in repetition. Note that *can* and *be* showed considerably higher rates of inclusion at the pre-intervention session than *did* and *will*; the possible relevance of this difference is considered in the discussion.

Any auxiliary

As shown in Table 5, three results for any auxiliary were similar to the results for the target auxiliary. There was a main effect for auxiliary type, with children using any auxiliary more when they heard trained (72%) than untrained auxiliaries (54%; $F(1, 26) = 26·9$, $M.S.E. = 334·37$, $p < 0·0001$). There was

also a main effect of session, with children including auxiliaries more often during the post- (69%) than pre-intervention (57%; $F(1, 26) = 22.26$, $M.S.E. = 190.76$, $p = 0.0001$). There was no main effect of treatment group.

With any auxiliary, however, there was a significant interaction between treatment group and session ($F(2, 26) = 4.38$, $M.S.E. = 190.76$, $p < 0.03$), indicating greater improvement by the experimental groups (gain = 16 percentage points for M children; 19 for IC) than the quasicontrol children (gain = 2). An ANOVA limited to the trained auxiliaries (can/be) showed an overall increase in the usage of any auxiliary from 66 to 78% ($F(1, 26) = 14.39$, $M.S.E. = 157.3$, $p < 0.001$), with no interaction between treatment group and session.

But the ANOVA for the untrained auxiliaries (will/do) showed both an overall main effect of session – an increase in use of any auxiliary from 48 to 59% ($F(1, 26) = 6.05$, $M.S.E. = 328.29$, $p < 0.03$) – and an interaction between treatment group and session ($F(2, 26) = 3.83$, $M.S.E. = 328.29$, $p < 0.04$). Improvement in including any auxiliary was limited to the two experimental groups: QC children showed a loss of 5 percentage points, M children showed a gain of 15 points, and IC children a gain of 26. The two experimental groups did not differ statistically from each other.

In summary, all children improved in supplying an auxiliary for the questions containing trained auxiliaries, which might be attributed to practice with already-known auxiliaries. Only the two experimental groups improved on questions with untrained auxiliaries. In virtue of hearing a question twice, the experimental groups extended what they knew about the requirement of including an auxiliary to a larger class than did the quasicontrol group.

Inversion

The results for improvement in inverting the subject and auxiliary also showed differences between the quasicontrol group and the two experimental groups. All three groups improved on inversion with questions containing the trained auxiliaries, but only the two experimental groups improved on questions with untrained auxiliaries.

As shown in Table 6, the children inverted more often when they heard questions with trained (58%) compared to untrained (45%) auxiliaries ($F(1, 26) = 16.74$, $M.S.E. = 295.6$, $p < 0.0005$). The children also inverted more after (58%) than before (45%) intervention, as shown by the main effect of session ($F(1, 26) = 18.29$, $M.S.E. = 275.27$, $p < 0.0005$).

The two experimental groups improved more than did the QC group, as shown by the significant interaction between treatment group and session ($F(2, 26) = 3.85$, $M.S.E. = 275.27$, $p < 0.05$), and the significant interaction between auxiliary type, treatment group, and session ($F(2, 26) = 3.52$, $M.S.E. = 192.58$, $p < 0.05$).

TABLE 6. *Inversion before and after intervention in percent (S.D.)*

| | Auxiliary type | | | | | | | | |
| | Trained (*can/be*) | | | Untrained (*will/do*) | | | Combined | | |
Treatment	before	after	gain	before	after	gain	before	after	gain
Quasicontrol									
mean	46	59	13	42	32	−10	44	46	2
(S.D.)	(24)	(26)		(26)	(21)				
Modelling									
mean	49	71	21	37	56	19	43	64	21
(S.D.)	(27)	(29)		(24)	(37)				
Implicit correction									
mean	56	70	14	42	64	22	49	67	18
(S.D.)	(28)	(24)		(14)	(29)				
Overall									
mean	50	66	16	40	49	9	45	58	13
(S.D.)	(26)	(26)		(22)	(32)				

The main effect of session was significant (ignoring auxiliary type and treatment, children improved in inversion), as was the main effect of auxiliary type (ignoring session and treatment, children inverted more on trained auxiliaries). The interaction between treatment group, auxiliary type, and session was significant (experimental children improved more than quasi-control children, but the differential improvement was limited to untrained auxiliaries).

An ANOVA limited to the trained auxiliaries showed no difference between treatment groups. There was an overall increase in inversion from 50% at pre-intervention to 66% at post-intervention ($F(1, 26) = 23.72$, $M.S.E. = 154$, $p < 0.0001$), but no interaction. As Table 6 shows, QC children showed a gain of 13 percentage points, M children a gain of 21, and IC children a gain of 14.

In contrast, there were group differences for untrained auxiliaries. The overall increase in inversion from 40 to 49% ($F(1, 26) = 5.07$, $M.S.E. = 313.86$, $p < 0.05$) was due to the two experimental groups, as shown by the interaction between treatment group and session ($F(2, 26) = 5.22$, $M.S.E. = 313.86$, $p < 0.02$). QC children showed a loss of 10 percentage points, M children a gain of 19, and IC children a gain of 22. The two experimental groups were equivalent.

In summary, all children increased their rate of subject – AUX inversion when they heard a question with trained auxiliaries. But only the two experimental groups improved on questions with untrained auxiliaries. The experimental groups extended what they knew about inversion to untrained auxiliaries; the quasicontrol group did not.

Analysis of spontaneous speech

Because the children asked few questions, we could not determine whether the children's experimental improvement from pre- to post-intervention was

paralleled by improvement in spontaneous questions. Children averaged about 13 *wh*-questions that included both a verb and a subject; that was the case both at the beginning of the pre-intervention session (before formal testing began) and at the end of the post-intervention session (after formal testing ended). About 70% of questions were WHAT questions (typically of the form 'what is x ?'). Few questions had uninverted word order, but all inverted questions used main V or AUX *be*; no child spontaneously inverted with a modal or *do*. Such data suggest that children spontaneously asked the questions they knew how to ask. When attempting to imitate questions outside their range, during the experiment proper, the children revealed the limits of their knowledge.

DISCUSSION

Experimental children improved significantly more than quasicontrol (QC) children in the completeness and formal structure of the *wh*-questions they repeated. They improved more than QC in including an auxiliary in their imitations and in inverting the auxiliary with the subject. The results are all the more striking in view of the single, small treatment difference between the two experimental groups (modelling [M] and implicit correction [IC]) and the QC group: the former heard the 32 intervention questions twice each and the latter heard the 32 questions once. The benefits of the intervention were measurable 7–10 days later. The important factor, we propose, is the greater opportunity the experimental children had to attend to and parse each sentence.

The two experimental groups could not be distinguished from each other on any measure. The M children's experience of hearing each question twice before attempting to repeat it resulted in the same improvement as the IC children's experience of hearing a question, attempting to repeat it, and hearing it again. That suggests, in line with previous work, that frequency and variety are important input properties, more important than whether the adult models a form for the child or implicitly corrects the child. If the child is focused on the input, any mode of presentation will be successful.

All the children acquired specific information, but only the two experimental groups consolidated a budding auxiliary equivalence class and generalized their knowledge. When they heard sentences with the two TRAINED auxiliaries (*can* and *be*), the children in all three groups improved equally in repeating those same auxiliaries, in including an auxiliary (even if it did not match the target), and in inverting the subject and auxiliary. As it happened, during the pre-intervention session, the children performed better with *can* and *be* than with *will* and *do*. Further, their spontaneous questions were all formed with *be*. Thus, before the experiment began, the children knew more about *can* and *be* than about *do* or *will*. During intervention, the

children practiced with *can* and *be*, leading to improved performance on the last session.

The data for the UNTRAINED auxiliaries (*will* and *do*) inform us about generalization. During the pre-intervention all three groups showed some understanding of the equivalence class of items that can be inverted: all three groups repeated the untrained auxiliaries to the same degree (26%); all three produced any auxiliary to those untrained targets to the same degree (48%); all three inverted to the same degree when imitating questions with those targets (40%). Thus, at the pre-intervention, the children already knew something about AUXes and their behaviour in questions. What the interventions could do is extend and consolidate that knowledge. The results show extension and consolidation only for the two experimental groups. They improved in including an auxiliary and in subject–AUX inversion. The QC group did not improve at all. The M and IC groups consolidated an equivalence class consisting of untrained auxiliaries and other auxiliaries. The QC group did not. None of the groups improved in supplying the specific untrained auxiliary itself, probably because practice on a target is needed to increase imitation of that specific target.

The experimental groups' improvement on untrained auxiliaries suggests that, during the course of the experiment, they developed a more general and abstract understanding of the role of the auxiliary in *wh*-questions and an appreciation for the obligatory nature of inversion. The children's pre-intervention performance and their spontaneous speech suggest that they had fragmentary knowledge of auxiliaries and inversion. The input we provided the experimental groups helped them develop that knowledge further.

Attend and parse

The input differences in this experiment were modest – a total of 64 question tokens for the two experimental groups versus 32 for the quasicontrol children. Why did so few utterances yield reliable differences in performance a week or more after intervention?

On our model, double parsing opportunities have an attentional benefit. On the first hearing of the target the child has to isolate each lexical item, assign each item a meaning, assign a syntactic structure to as much of the sentence as possible, incorporate interpretationally relevant aspects of the context, and compute an overall meaning based on the lexical items, the assigned structure, and the context. Although it is not possible to know how deep children's processing was in our experiment, their errors show that they were not parroting the input. In addition, they were interested in the bear's answers to their questions.

Since the children's pre-intervention performance demonstrated the incompleteness of their syntactic knowledge, we hypothesize that syntactic

processing lagged behind other processing on the first hearing. We chose lexical items the children were likely to know, thus reducing phonological and semantic demands. If parsing is incomplete on the first hearing, the child can benefit from a second, as Valian & Aubry (2002) found. Lexical lookup and computation of overall meaning will require less attention on the second hearing, freeing resources for syntax. The fact that the two experimental groups benefited equally supports the hypothesis that what benefits the child is the increased attention available for parsing, rather than any particular relation between the child's speech and the adult model.

Previous successful intervention studies also presented minimal but concentrated input, and encouraged children to parse the experimenter's input (Malouf & Dodd, 1972; de Villiers, 1984; Roth, 1984). An integration of previous reports with the present experiment supports an attend-and-parse model of input utilization. Children learn by trying out hypotheses about the syntactic structure of their input. If children ignore their input they cannot learn from it. Similarly, if children must attend to multiple aspects of the input simultaneously, they will be less successful in parsing an unmastered structure.

Limitations of the current study

Practical considerations limited us to four sessions with a single experimenter and single set of measures. It is thus possible that the experimental children's improvement was localized to the experimental setting. That is, although the children learned something about auxiliaries and inversion, their new knowledge might be state-dependent. To say that the children's knowledge was state-dependent, however, is only to say that their learning was similar to learning in most domains – more easily accessed in the milieux in which the information was originally encoded. Nevertheless, it would be highly desirable to test children at longer intervals and on other tasks in order to assess the duration and generality of the effects.

Our spontaneous data were too limited to allow us to determine whether the children's knowledge extended to their spontaneous speech. But spontaneous *wh*-questions may be unrevealing: the children's spontaneous speech before the intervention, as well as other spontaneous speech (Valian, Lasser & Mandelbaum, 1992), suggests that children primarily ask questions they know how to ask. Spontaneous questions can appear knowledgeable, but in fact be limited to a few auxiliary elements and a few *wh*-words. When children attempt questions outside their range, as our procedure required, their limited abilities are apparent.

Alternate explanations

The children's improvement cannot be attributed to spontaneous learning occurring outside the experimental setting. If the learning had been

spontaneous and independent of treatment, the QC children would have improved on untrained auxiliaries to the same extent that the experimental groups did, but they did not. Extraneous experimental variables are also unlikely to be responsible for the results. The experimenters did not systematically differ in how many spontaneous questions they asked the children. Demand conditions were equal for all three groups: all children were equally expected to ask questions; all children were equally prompted by the experimenter; all children equally associated the experimenter with the request to ask questions.

Extra processing of some sort by the experimental groups was responsible for their improved performance. Since all groups repeated the target question only once, differences in production cannot be responsible. The extra processing must be connected to hearing the sentence twice. Hearing a sentence twice cannot be better than hearing it once unless the second exposure produces additional processing. On our model, the extra processing allows the child to devote more resources to a syntactic analysis, which was likely to have been scanted on the first parse, leading to a more general appreciation of how *wh*-questions work.

A different way of accounting for the benefits of additional processing is to say that experimental children learned a formula consisting of *when* or *where* followed by *is* or *are* or *can*. Upon hearing *when* or *where*, they followed it with an auxiliary they knew well and deleted from the target sentence the auxiliary they knew less well. That in turn would suggest prior knowledge of the equivalence class of auxiliaries; otherwise, the child would insert an additional auxiliary rather than substituting one. It is thus possible that the mechanism by which attend-and-parse has its effect is a generalization from a formulaic solution to the problem of imitating the target, buttressed by pre-existing but fragmentary knowledge of the class of auxiliaries. Were final performance due to use of a formula, one might expect that experimental children would surpass quasicontrol children in using any auxiliary for trained as well as untrained auxiliaries. Yet all children supplied any auxiliary equivalently for trained auxiliaries. Nevertheless, this is a mechanism that should be specifically tested in future experiments.

A more radical interpretation of our results is that children gained no syntactic knowledge over the course of the experiment. Rather, all the children already had an auxiliary equivalence class and already knew that inversion was required in *wh*-questions. Through processing the target twice, the experimental children received more (covert) practice than quasicontrol children in applying their antecedent knowledge and thus improved their performance more. The limitation of the children's spontaneous questions to main V *be* is some evidence that their knowledge was incomplete at the start of the experiment. Similarly, even four-year-olds accept as grammatical some uninverted *wh*-questions (Stromswold, 1990), again suggesting incomplete

knowledge. Further, we know that it is possible for children to learn a new rule or come to understand a previously poorly known structure in an experiment (Malouf & Dodd, 1972, and Roth, 1984, respectively). Future experiments, in which knowledge can be assessed at the outset, will allow us to compare the effects of intervention on unknown and partially known structures.

Parsing in nature

If our attend-and-parse account is correct, we would expect practices that encourage parsing to be widespread cross-culturally. They seem to be so (see a brief review in Cazden, 1988), as an unintentional byproduct of other parental practices. Self-repetitions and implicit-correction-like replies are widespread. Watson-Gegeo & Gegeo (1986), for example, have described such practices among the Kwara'ae, a group of poor Melanesians in the Solomon Islands whose income comes from subsistence gardening. Kwara'ae parents provide self-repetitions and repetitions of child utterances (probably frequently implicit corrections, given the imperfections of early child speech and parents' tendencies to speak grammatically).

Elicited imitation is cross-culturally common. Schieffelin & Ochs (1983) report that Kaluli mothers sit alongside their child and interact with others in a group on behalf of the child. They produce a sentence and then say to the child, 'say like that'. The Kaluli appear to train features of language *via* a natural form of elicited imitation. The Kwara'ae also make extensive use of elicited imitation (Watson-Gegeo & Gegeo, 1986), as do the Basotho (Demuth, 1986). Elicited imitation is as close as one can come to direct linguistic tuition and simultaneously maintain an agreeable social interaction.

'Slow' learning in nature

If the attend-and-parse model is correct and children can improve rapidly with minimal input, then why do children take so long to master certain structures? Our intervention questions were a minuscule portion of the hundreds of questions the children heard daily. If children can significantly improve their ability to ask questions after hearing 64 of them, why is equivalent improvement in the natural development of questions spread over many months?

Our answer here draws on implications of attend-and-parse and on our analysis of earlier input studies. Learning requires attending to syntactic structure and attempting to parse the input. Yet in their day-to-day lives, very young children may often ignore the syntactic aspect of their input. Meaning, pragmatics, and nonverbal interests all compete for their attention. In our experiment the semantic and communicative import of each sentence was minimal, and in the experimental conditions children heard each sentence

twice, allowing them to direct attention to syntactic form on the second hearing. In nature, children can often bypass unmastered syntactic structures, relying on the meanings of major vocabulary items and constructing a plausible relation among them. In 'Where can Sally play?', the modal can be ignored in most situations. Knowing the meaning of *where*, *Sally*, and *play*, and constructing a scenario in which Sally plays in a location is sufficient to answer the question without constructing a syntactic representation that includes *can* or inversion.

Our experiment demonstrates how quickly children can learn about questions if they concentrate on a single structure and if their input is focused on that structure. In nature, children acquire the syntax of questions along with the syntax of other structures. Their learning is thus diluted, spread out over many structures simultaneously, rather than being concentrated on a single one. *Wh*-questions in nature are commonly interspersed with many partial questions (e.g. 'What about this?', 'Where?'), providing children with input that is neither focused nor maximally informative.

We 'improved' on nature to provide minimal but concentrated and varied exposure to particular structures. Such input helps the child extract and generalize syntactic regularities, but only with the help of frequency. Frequency provides more opportunities for fuller processing. In our experiment, hearing a target question twice led children to generalize to untrained auxiliaries, but hearing it once did not. When children attend to the input and repeatedly attempt to parse it, their performance undergoes a qualitative change. At a minimum, children demonstrate that they can utilize input very effectively to make rapid improvements in their ability to imitate *wh*-questions.

The child's learning mechanism is extremely powerful, and, indeed, must be so in order to cope with the multiple tasks inherent in nature and the diffuse and noisy nature of natural input. The efficiency of the mechanism is an adaptation to the characteristics of the learning environment.

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