

Learnability and Feedback

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Bohannon and Stanowicz (1988) have claimed that contrary to popular belief, children do receive negative evidence about the ungrammaticality of their utterances in the form of recasts, expansions, and repetitions. Bohannon and Stanowicz argue that given such negative evidence, learnability theory shows that natural languages can be learned and that there is no need to postulate innate knowledge based on such arguments. The present article establishes what exactly the claims of learnability theory really entail, and demonstrates that because Bohannon and Stanowicz have shown only partial negative evidence, the results have no bearing on existing formal proofs of learnability; also, the learnability proofs proposed by Gold (1967) actually tell us very little about what may or may not be innate. Finally, it is pointed out that there are cases of language acquisition in which feedback does not appear to occur.

In their recent article, "The Issue of Negative Evidence: Adult Responses to Children's Language Errors," Bohannon and Stanowicz (1988) have attempted to discredit the widely accepted belief that children do not receive negative evidence concerning the ungrammaticality of their utterances. They characterize this claim as being the prime motivation of nativist theory for the postulation of innate knowledge of language in children (e.g., Chomsky, 1972; Pinker, 1984; Wexler & Cullicover, 1980). Demonstrating the availability of negative evidence for children would therefore make it unnecessary to postulate many of the innate constraints.

Bohannon and Stanowicz (1988) have also shown that in a study of adult interactions with 2-year-olds, both parents and other adults reacted differentially to grammatical and ungrammatical utterances from children. In particular, 90% of the exact repetitions followed grammatical utterances and 70% of the recasts and expansions followed ungrammatical utterances. Overall, some 34% of the children's syntactic errors were followed by some form of implicit feedback of this type. It is claimed that such feedback is equivalent, in some sense, to negative evidence. Bohannon and Stanowicz conclude that in order to justify the nativist assumptions, such theorists must "replicate the 'Pharaoh's experiment' of a child isolated from other language users" (p. 688) and demonstrated that language acquisition can still occur in the absence of feedback.

In the present article I do not attempt to evaluate the empirical validity of the data presented by Bohannon and Stanowicz (1988), nor do I intend to contest the claim that such feedback might be instrumental in facilitating acquisition (cf. Nelson, Denninger, Bonvillian, Kaplan, & Baker 1984). Rather, I focus quite specifically on the learnability issues addressed in their article, inasmuch as they appear to provide the theoretical back-

drop for the data. I argue that when considered in the proper perspective, Bohannon and Stanowicz's results, although interesting in their own right, tell us nothing about learnability or innateness.

Gold's Proof

Much of the learnability argument in Bohannon and Stanowicz (1988) is based on Gold's (1967) original proof concerning the identification of languages from certain language classes. Specifically, if a language learner is presented only with *text presentation* (i.e., grammatical strings only), then of the handful of language classes considered by Gold, it can only identify languages from the *finite cardinality* class. This class of languages would not include any language that had infinite numbers of sentences, like, for example, English. On the assumption that children receive input approximating text presentation (i.e., no negative evidence), theorists have postulated that a learner without constraints on the form of the grammar would not be able to acquire the class of natural languages because natural languages are not included in the class of finite cardinality languages.

Gold's (1967) other kind of learner receives *informant presentation*, which includes both positive and negative evidence about the grammaticality of strings of the language. With this kind of input, the learner can identify classes of languages that clearly include the natural languages, plus many more. On the surface, then, it would appear that Bohannon and Stanowicz (1988) are justified in their claim that showing the existence of negative evidence in the child's input would be sufficient to guarantee learnability.

Consider what it means for a class of languages to be learnable in Gold's (1967) sense. First, a few definitions. A *language* is defined as a set of strings (e.g., sentences) composed over some finite vocabulary (e.g., words and grammatical morphemes). The fact that different languages have different vocabulary items is not what makes them different within this framework. Rather, the vocabulary is held constant within the language class, and each language is defined in terms of which combina-

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tions of vocabulary items they allow in sentences. A *class* of languages is primarily defined in terms of the kinds of rules that are allowed in the grammar. For example, whether the language allows phrasal expansion, recursion, re-ordering, or deletion will determine the class to which it belongs.¹

A *learner* is a general computing device (e.g., a Turing machine) that accepts input sentences from the environment and guesses which language they are from. If a new sentence is consistent with the previous guess, the learner will stick with the same guess; otherwise it will try a new language. Notice that the form of the learning function here really says nothing about the kinds of rule-inductive processes with which language acquisition theorists are concerned. For all intents and purposes, the learner already knows the functions (i.e., grammars) that generate the languages within the class. All it has to do is figure out which one it is being presented with.

Given the characteristics of the learner just described, it should be clear that *learning* within this paradigm is not really what we normally associate with this term. Gold's (1967) more appropriate designation was "*language identification in the limit*" [italics added]. The phrase, "in the limit" here denotes the criterion for success. That is, a language has been correctly identified when the learner no longer changes its guess through the presentation of all of the (possibly infinite) strings in the language. If the learner is lucky, the first guess could be correct. Alternatively, it might take several billions of years to come up with the correct guess. In fact, there is no limit on how long it can take the learner to guess the correct language. For any language that requires n guesses, there will always be another language that requires $n + 1$ guesses, where n approaches infinity. Thus, a potentially infinite number of presentations would be required to guarantee identification of all languages within a class. In addition, note that for learnability to be guaranteed in every case, the learner must hear *all* of the sentences in the language for text presentation, plus *all* of the sentences that are not in the language (appropriately labeled) for informant presentation.

Learnability and Learnable Languages

In considering the Gold (1967) paradigm, it is crucial to distinguish between whether a class of languages is formally identifiable and whether particular languages within that class are learnable by humans. For example, the *text-learnable* class of finite languages would include the Boston telephone directory (Pinker, 1981), which only the most accomplished mnemonist could actually learn. However, all of us could learn the infinite language that contains all possible telephone directory listings, on the basis of an elementary set of rules in which each string consists of a person's name, followed by a house number, a street name, and seven digits.

In other words, anyone who has experience with telephone directories could tell whether a particular string is a potential listing within a potential telephone directory. However, we are unlikely to know whether the string is an entry within a particular directory (for all possible entries.) Notice that the infinite language that we would find easy to learn is in the "unlearnable" class of languages under text presentation because it is not

finite. The Boston telephone directory, on the other hand, is finite and, hence, is within the "learnable" class of languages.

Whether a language is in a learnable or an unlearnable class, then, says nothing about whether the language itself is potentially learnable by humans. What Gold's (1967) proof demonstrates is whether each language in a class is, in principle, distinguishable from other languages in the class, on the basis of input. For example, consider two languages: English, and English*, in which the latter arbitrarily excludes one sentence, say, "The antelope eats radishes." These two languages would be indistinguishable under text presentation unless this sentence actually occurred in the input, thus ruling out English*. However, there would be an infinity of other "star" languages within the class that each arbitrarily excluded a different sentence. It is not too hard to show that when one has to consider the class of languages as a whole, it becomes impossible to ensure that the learner will correctly identify the input language for all possible languages that might be presented.

Of course, these star languages are silly languages that children would never consider in learning a natural language such as English. One might be tempted to dismiss such proofs as irrelevant to real issues in real language acquisition. However, what the postulation of innate constraints amounts to is figuring out how to restrict the hypotheses that the human child entertains so that they include only "sensible" choices that will converge on any of the natural languages. The not-so-simple problem is attempting to determine what makes a language sensible in this sense. For example, although English allows one to say *Who did John tell the man that Bill met?*, one cannot say, **Who did John tell the story that Bill met?* (from the declarative: *John told the story that Bill met Fred*). Explaining such exclusions requires complex specification of the structures over which various rules can operate. What Chomsky (1981) has argued is that these constraints are not readily available to the child in the language they hear, and therefore they require some kind of innately restricted hypothesis space.

Is the Feedback Sufficient?

From the earlier description of informant presentation, it can be seen immediately that the notion of *negative evidence* is clearly much more powerful than anything found in Bohannon and Stanowicz's (1988) results. Their input/output was only finite; only 34% of the child's ungrammatical utterances were followed by negative responses (i.e., recasts or expansions), and only 70% of negative responses actually followed ungrammatical utterances. Let me assume (not uncontroversially) that the child is able to infer that recasts and expansions constitute negative evidence, that exact repetitions constitute positive evidence, and that other responses are indeterminate. Because one cannot assume that the child knows a priori what proportion

¹ In Gold's (1967) actual proof, he has characterized language classes in terms of the Chomsky hierarchy (Chomsky, 1963), which is defined either in terms of the kind of machine required to implement the language or in terms of the number of symbols that are allowed on the left- and right-hand sides of a rewrite rule, such as $S \rightarrow NP VP$. These characterizations are formally equivalent, however, to the characterizations I have laid out in a slightly more intuitive format.

of utterances will be followed by accurate feedback, he or she will necessarily make the wrong inference for the 30% of negative feedback that occurs after grammatical utterances.

Within the constraints of Gold's (1967) paradigm, it is clear that the learner presented with such inconsistent information would never guess the correct language. This is because the learner would have received information in the input telling it that certain strings were not in the language, when in fact they were. This would lead the learner to never guess the correct language, inasmuch as it would assume that certain strings from the language were ungrammatical. In fact, such a learner would do worse than a learner who received only text presentation with no feedback. At least that learner could identify languages of the finite cardinality class. Bohannon and Stanowicz's (1988) learner essentially could not identify any class of languages within the framework of Gold's learnability theory.

Although Bohannon and Stanowicz (1988) were not trying to present a proof of learnability within Gold's (1967) framework, they did claim to eliminate arguments based on text presentation within that framework. Clearly, they do not. On the other hand, it could be argued that Bohannon and Stanowicz were not considering Gold's kind of approach to learnability in their attack on nativist assumptions. Rather, something more akin to Wexler and Cullicover (1980) was what they had in mind. It must be admitted that Wexler and Cullicover were concerned with proving learnability in a more realistic framework. Specifically, they were interested in showing how the learner could correctly identify the transformations relating deep and surface structures (Chomsky, 1965). In this light, Bohannon and Stanowicz (1988) observed that "It is interesting that . . . Wexler & Cullicover . . . state that the small amount of information available in denials is sufficient to allow language learning to proceed without innate knowledge" (p. 688). Unfortunately, this statement is quite misleading. Wexler and Cullicover (1980) do not assert that the existence of denials would negate the need for innate knowledge. What they do state is that informant presentation has already been shown to be powerful enough to allow learnability within classes of languages that include the natural languages. The theorist who showed this, of course, was Gold, thus bringing us back to the original criticisms.

Conclusions

There are several points to take away from the present discussion. First, the attempt to mix results from the empirical research with theoretical issues in learnability is misleading in the present case. Although many of the attempts to show the learnability of languages have attempted to provide more realistic kinds of assumptions about acquisition (e.g., Pinker, 1984; Wexler & Cullicover, 1980), the major proof demonstrating learnability with feedback remains within the Gold (1967) paradigm, which appears to bear little similarity to actual language learning scenarios.

Second, the issue of whether a class of languages is learnable from text or informant presentation is quite orthogonal to the issue of whether learning those languages requires innate knowledge. Proving that a particular class of languages is identifiable by a Turing machine does not tell us whether a quite gen-

eral cognitive architecture of the kind that might exist in humans could induce the correct grammar.

The reader should not mistake the current criticism as an attempt to argue that the kind of negative evidence found in Bohannon and Stanowicz (1988) is of no use in actual language learning. One can imagine all kinds of situations in which receiving a recast or expansion might lead the child to revise a rule (cf. Nelson et al., 1984). In fact, the possibility of negative evidence is even noted by Chomsky (1965), who pointed out that certain strings of words might be "classed as nonsentences, as a result of correction of the learner's attempts on the part of the linguistic community" (p. 31).

The point here is simply that this has no bearing on the issue of learnability and, in particular, on whether innate knowledge is required for language acquisition. The reason that Wexler and Cullicover (1980) and Pinker (1984) need innate knowledge in their learnability proofs is primarily because they can't get them to work without such assumptions. As noted earlier, many of the constraints on grammaticality in English arise in highly complex structures that children are unlikely to hear or utter, let alone be corrected on. Also, as Bowerman (1987) points out, even if feedback did occur, it is hard to conceive of what an appropriate recast would be for a sentence such as **Who did John overhear the statement that Mary kicked?*—try it.

The burden of proof is clearly on Bohannon and Stanowicz (1988) to demonstrate that natural languages are formally learnable without innate knowledge when partial and inconsistent feedback is available in the form that they find in their study.² Until such proof can be provided, the judgement on whether there is innateness seems to marginally favor those theories of language acquisition that actually end up learning the language (e.g., Pinker, 1984). We should seriously heed Gleitman's (1981) warning against theories that "account for *the cat is on the mat* and then cross one's fingers" (p. 104).

On a final point, Bohannon and Stanowicz (1988) have concluded that for the nativists to maintain their position, they must replicate the Pharaoh's experiment of isolating children from other language users and show that they can still acquire language. However, the crucial test is not to isolate children from language, but from feedback. This, it would seem, is done in various cultures (and probably by several parents in our own culture). One fairly strong example would be the case of children whose parental language input consists of an unstructured Pidgin language that essentially has no syntax. Such children nevertheless acquire a syntactically structured Creole language. As Bickerton (1981) has pointed out, these children could not be given negative feedback because their parents don't even know the language that their children are acquiring.

Somewhat closer to home, Heath (1983) has provided an account of language learning in the community of Trackton. In

² It may, in fact, be possible to show that learning can occur with inconsistent feedback if that feedback is associated with sentence types rather than tokens, using statistical rather than absolute criteria to determine grammaticality. However, this begs the question of how the child knows that two sentences are of the same type. Presumably, this in itself would require the child to already have a grammar of some sort, and we are left with the question of how that grammar gets learned without innate constraints.

this isolated, rural, Black community in the Piedmont Carolinas, adults have a very different philosophy about language development. Children are not considered fit partners for conversation until they are fully able to talk. Hence, there is very little direct speech to young children except in the form of occasional demands and reprimands. Language input to the young child primarily consists of hearing adults talk to each other. The general philosophy is summed up, somewhat ironically, in the words of Aunt Mae: "Now just how crazy is dat? White folks uh hear dey kids say sump'n, dey say it back to 'em, dey aks 'em 'gain 'n 'gain 'bout things, like they 'posed to be born knowin'" (p. 84). These studies, although somewhat informal in nature, nevertheless serve to remind us that language acquisition succeeds in all kinds of environments. The predilections of middle-class Americans may have little to tell us about the parameters of input and innateness that guarantee that language is learned by all but a few members of the human species.

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