A Conservative Approach to Quantification in Child Language[*]

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1 Introduction

Investigations of sentences containing the universal quantifier *every* have led to qualitatively different conclusions about children's linguistic knowledge. One line of research has uncovered systematic non-adult responses by pre-school and even school-age children (e.g., Inhelder and Piaget 1964). When
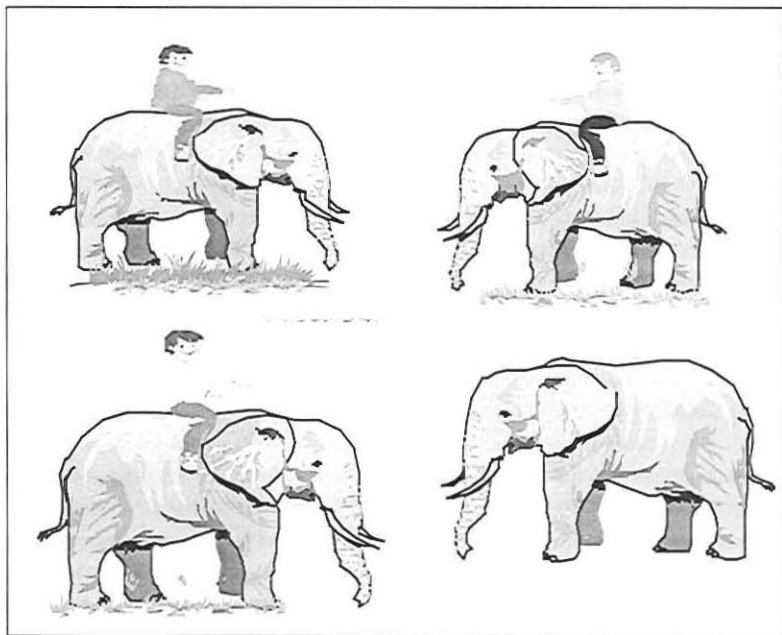

Figure 1. The Extra-Object Condition

shown a picture such as Figure 1, for example, some young children some-
times respond with a negative answer to question (1).

(1) Is every boy riding an elephant?

If asked to justify this answer, children often point to the 'extra' elephant,
i.e., the elephant that is not being ridden by a boy. Since children who re-
spond in this fashion appear to demand symmetry (i.e., a one-to-one relation)
between boys and elephants, this response by children is called *the symmet-
rical response*, or the *exhaustive-pairing response* in the literature. It should
be noted that children who give the symmetrical response to questions like
(1) sometimes give affirmative, adult-like responses in the same condition,
although the symmetrical response is produced more often.

The symmetrical response fails to emerge in other experimental tests,
however. When children were tested using a variant of the Truth Value
Judgment task, Crain, Thornton, Boster, Conway, Lillo-Martin and Wood-
ams (1996) found that children's performance was dramatically improved.
Crain et al. argue that the improvement in children's performance resulted
from satisfying the felicity conditions associated with judgments of truth or
falsity (as in answering Yes/No questions). More specifically, Crain et al.
attribute children's consistent adult-like performance to the satisfaction of
the 'condition of plausible dissent.' Essentially, the point of plausible dissent
was made by Bertrand Russell (1948, p. 138) who stated: "perception only
gives rise to a negative judgment when the correlative positive judgment has
already been made or considered." According to Russell, a negative answer
to the question in (1) would be felicitous if, for example, every boy consid-
ered riding an elephant, but some boy(s) decided to ride something else, say
a dinosaur. Similarly, if some boy(s) considered riding a dinosaur but, in the
end, every boy decided to ride an elephant, then an affirmative answer would
be felicitous.

Based on Russell's observation, Crain et al. asked children to verify
sentences as descriptions of stories that were acted out in front of the child.
In the course of the story, a possible outcome was established, but events
took a different turn, such that the actual outcome and the possible outcome
were not the same. Children's adult-like performance in responding to sen-
tences containing a universal quantifier in such contexts was attributed to
this design feature of the Truth Value Judgment task. Children's non-adult
behavior in previous research was attributed to the failure to provide a possi-
ble outcome, that is, a reason for asking the question in the first place.

There have been alternative accounts of the disparate research findings
(e.g., Gordon 1996; Drozd and van Loosbroek 1998). These accounts attrib-

ute the differences in children's performance across tasks to the salience of the objects that figure into children's interpretations. On this view, the difference in findings can be attributed to which set of objects, the denotation of the subject N or that of the object N, is foregrounded in the experimental context. Discussing the Truth Value Judgment task, Gordon (1996) raises the possibility that the improvement in children's responses might derive from the fact that the context provided by the stories in the Crain et al. study made the set denoted by the subject N, the boys, prominent; whereas in earlier work the set denoted by the object N was prominent. On this interpretation of the findings, children behave like adults when the context directs their attention to the denotation of the subject N, whereas they produce non-adult responses if the context draws their attention to the denotation of the object N (see Gordon, 1996, p. 217). In fact, the study by Crain et al. (1996) attempted to make the denotation of the object N salient in two ways: (a) by "highlighting" the extra-objects and (b) by directing children's attention to them at the end of each trial (see p. 125). Nevertheless, the issue is worth pursuing further, if only because the alternative accounts contend that children's non-adult performance is derived from a non-adult grammar.

In view of learnability problems that can arise if child grammars differ from those of adults, much recent work in developmental psycholinguistics has adopted the continuity assumption (Pinker 1984; Crain 1991; Crain and Pietroski, in press). Essentially, the continuity assumption anticipates that child language will differ from the local language only in ways in which adult languages can differ from each other. The continuity assumption supposes that children and adults share a common core of linguistic knowledge. To the extent that empirical studies of child language suggest that children exceed the boundary conditions of Universal Grammar, the continuity assumption encourages careful scrutiny of the findings. Wherever possible, explanations of different patterns of behavior for children and adults should invoke minimal differences in linguistic principles.

One way to minimize differences is to embrace conclusions from crosslinguistic research. Crosslinguistic research contributes to the continuity assumption in two ways. First, parametric variation among languages establishes those points at which child language may differ from that of the local language. Second, crosslinguistic research establishes the boundary conditions of Universal Grammar, namely the innate linguistic principles that define the space of possible human languages. Learners explore this space, influenced by the environment, until they stabilize on a grammar equivalent to that of adult speakers in the linguistic community. Adopting the continuity assumption, we expect children to try out grammars with features found in adult languages elsewhere on the globe. However, we do not expect them to

try out grammars with features that are not compatible with any of the world's languages.

Crosslinguistic research on formal semantics has led to the proposal that all natural language determiners are conservative, including the universal quantifier *every*. Of all the logically possible relations that could obtain between determiner meanings and the meanings of the phrases that contain them, the language faculty has apparently evolved such that all determiners in natural language are conservative. Accounts of differences in the behavior of children and adults should not compromise putative linguistic universals, such as the conservativity of determiner meanings, in the absence of compelling empirical evidence. We do not believe that there is compelling evidence that children's determiner meanings violate conservativity, though this is suggested in recent studies of children's understanding of sentences with the universal quantifier.

These observations invite us to look more closely at the different explanations of children's non-adult linguistic behavior. To this end, we report the findings of two experiments designed to investigate the extent to which salience versus plausible dissent is relevant in children's interpretation of sentences with the universal quantifier. Both experiments made the set denoted by the object N highly salient. At the same time, Experiment I satisfied the felicity conditions associated with the target sentences. If salience were relevant, children's non-adult interpretation of the quantifier *every* should emerge. If satisfying the felicity conditions suffices to eliminate non-adult responses, by contrast, then children are expected to perform as well as adults do, regardless of the salience of the set denoted by the object N. Experiment II was designed to test a prediction of the most recent account of children's non-adult behavior, the 'weak quantification' account, to which we now turn.

2 Is *many* Conservative?

According to the account advanced by Drozd and van Loosbroek (1998), children interpret *every* as a weak quantifier, on a par with the weak quantifier *many*. It is often assumed that the weak quantifier *many* is ambiguous. Consider (2), from Westerståhl (1985).

(2) Many Scandinavians have won the Nobel prize in literature.

It has been suggested that one reading of (2) evaluates the number of Scandinavians who have won the Nobel prize, with *many* applying to the denotation of the subject N. The other purported reading evaluates the number

of prize winners who are Scandinavian, with *many* applying to the denotation of the VP. The two interpretations of (2) can be paraphrased as in (3) and (4); the reading in (4) is apparently referred.

(3) Many Scandinavians are prize winners
    (Scandinavians ∩ prize winners) ∈ MANY (Scandinavians)
(4) Many of the prize winners are Scandinavians.
    (Scandinavians ∩ prize winners) = MANY (prize winners)

As the semantic representation in (4) indicates, this reading makes the weak quantifier *many* an apparent counter-example to the putative linguistic universal that all natural language determiners are conservative:

A determiner meaning is ***conservative*** iff:
$Y \in DET(X)$ iff $Y \wedge X \in DET(X)$
(where X, Y are sets, DET is a function from sets into set of sets, and ∧
= set intersection)

Conservative determiners make these valid: $D(A)(B) \Leftrightarrow D(A)(A \wedge B)$. For example:

Few Americans smoke ⇔ Few Americans are Americans who smoke
Every Italian eats pasta ⇔ Every Italian is an Italian who eats pasta
No German drinks Bud ⇔ No German is a German who drinks Bud

The conclusion that *many* violates conservativity derives, in part, from the observation that people judge (5) (a shortened version of (2)) to be true in circumstances in which they judge (6) to be false. The diagnostic of conservativity suggests that (5) and (6) should be true in the same circumstances.

(5) Many Scandinavians are prize winners.
(6) Many Scandinavians are Scandinavians who are prize winners.

Notice that (7) is a logically equivalent diagnostic of conservativity; but people judge (7) to be true in the same circumstances as (5).

(7) Many Scandinavians are prize winners who are Scandinavians.

This suggests that the form of (6), i.e. the order of NPs, gives the illusion that *many* is not conservative in sentences like (2) and (5). Barwise and Cooper (1981) make a related observation.

3 Is *every* Conservative?

According to Drozd and van Loosbroek, children's non-adult interpretation of sentences with *every* results from an ambiguity involving the universal quantifier in children's grammars. They claim that *every* and *many* behave in a similar way for 4- and 5-year-old children. As a consequence, a sentence like (8) is ambiguous between two readings, depending on which N, subject or object, is in the restrictor of the quantifier.

(8) Every boy is riding an elephant.

The proposal is to analyze the universal quantifier *every* as if it had a non-conservative meaning, like the weak quantifier *many*. As we saw with *many*, the interpretation at issue hinges on an analysis in which the subject N and the object N are reversed, such that the subject N resides in the nuclear scope, whereas the object N moves into the restrictor. However, in sentences with the universal quantifier and a transitive VP, it does not suffice to reverse the arguments. A reversal of NPs would result in converting the sentence *Every boy is riding an elephant* into *Every elephant is riding a boy*. Instead, the entire VP must be restructured. For example, the VP "is riding an elephant" must be restructured either as a passive "is being ridden by a boy" or as an object-extraction construction, such as "what a boy is riding." Hence, the non-conservative reading of (8) requires an analysis like that in (9):

(9) EVERY [elephant] [[λx (boy is riding x)]
(elephant $\cap$ λx [x is ridden by a boy]) $\in$ EVERY (elephant)

The semantic representation in (9) makes the sentence *Every boy is riding an elephant* true iff every elephant is being ridden by a boy. This analysis accounts for children's negative responses to questions like (1).

In addition to the reading in (9), Drozd and van Loosbroek propose that children have access to the adult interpretation, as in (10).

(10) EVERY [boy] [λx (x is riding an elephant)]
(boy $\cap$ λx [x riding an elephant]) $\in$ EVERY (boy)

When the denotation of the subject N is in the restrictor, as in (10), children respond in the same way as adults do. Here, the determiner, *every*, is conservative. The adult interpretation in (10) is assigned by children, according to Drozd and van Loosbroek, if their attention is drawn to the set de-

noted by subject N; that is, if the set of boys is discourse-active. On this account, the adult reading was made prominent in so-called Rich Context tasks, as in the Crain et al study. Alternatively, children assign the non-adult interpretation, as in (9), if the set denoted by the object N is discourse-active, as in the so-called Minimal Context tasks used in research with static pictures.

4 Critique of the Weak Quantification Account

We have three concerns with the weak quantification account. First, the VP "is riding an elephant" must be structurally recast by children, in order for the analysis to provide the truth conditions associated with the exhaustive-pairing response. The VP must be interpreted as if it had a different syntactic structure, such as that corresponding to "is ridden by a boy" or "what a boy is riding." This kind of restructuring violates the continuity assumption. Continuity is violated because the analysis amounts to the claim that adults access only a compositional interpretation for sentences with the determiner *every*, where the determiner is conservative, whereas children access a non-compositional, non-conservative interpretation in addition to the adult interpretation, if the discourse encourages the non-adult reading.

On the weak quantification account, children assign (at least) two meanings to sentences with the universal quantifier and a transitive VP, whereas adults assign only one. This raises a second concern: learnability. In the course of language development, children must expunge non-adult semantic representation from their grammars. It is difficult to see how this could be done on the present account, because the environmental input would always be consistent with one of children's interpretations, namely the adult interpretation. One way to 'unlearn' a non-adult interpretation would be for learners to keep track of the absence of input corresponding to the non-adult interpretation. Another alternative involves negative evidence, or some substitute for it. Drozd and van Loosbroek suggest that children are unable to access the adult interpretation if the set denoted by the object N is discourse-active. If so, then the non-adult interpretation could be expunged by negative semantic evidence, namely evidence that the non-adult interpretation is not acceptable for adult speakers, even when the object N is discourse-active. It is unlikely, however, that such evidence is sufficiently ubiquitous in the input to guarantee that every child who adopts the errant semantic analysis will encounter it.

This brings us to the third concern with the account. The concern is with extra-agents, rather than extra-objects. On the adult reading of the sentences under consideration, the universal quantifier has scope over the subject N.

For one thing, the inference that plausible dissent is not effective rests on negative findings, which are generally not grounds for accepting an experimental hypothesis (see Crain 2000).

We chose to examine the same issue using a different research strategy and a different technique, the Truth Value Judgment task. This task has been found to produce reliable results in previous research. On this task, children who have linguistic competence were found to perform at a level approaching that of adults, i.e. 100% accuracy (see Crain and McKee 1985, Crain and Thornton 1998). The Truth Value Judgment task involves two experimenters: one acts out stories in front of the child using toy characters and props; the other manipulates a puppet, e.g. Kermit the Frog, who watches the stories along with the child. At the end of each story, the puppet tells the child what he thinks happened in the story. The child's task is to decide whether the puppet "said the right thing." If the child thinks the puppet was right, she rewards him with a coin; if the child thinks the puppet was wrong, she gives him a reward of lesser value, as a 'reminder' to pay closer attention. Whenever the child indicates that the puppet was wrong, the child is asked to explain "what really happened." This follow-up procedure enables the experimenter to ensure that the child is rejecting the puppet's statements for the right reasons.

Experiment I: The extra-object condition. An experiment using the Truth Value Judgment task was conducted to determine the extent to which salience was responsible for children's adult-like behavior in the Crain et al. study. In the experiment, the denotation of the object N was made highly salient and, at the same time, the condition of plausible dissent was satisfied. If salience is the critical factor, then children should interpret the universal quantifier *every* in the same non-adult fashion as described in previous research. By contrast, if children's non-adult interpretation emerges only in infelicitous tasks, children should interpret the universal quantifier in the same way as adults do, because the condition of plausible dissent is satisfied, regardless of the salience of the denotation of the object N.

To illustrate the task, let us describe a typical trial. One of the stories was about a rodeo competition. The story involved three farmers, four horses and two dinosaurs. When the set of characters is introduced to the child subject, it is pointed out that one of the four horses had no saddle and is probably a wild horse. Each farmer has to choose an animal to ride in the rodeo. Here is how the story line unfolds in real time. One farmer considers riding a dinosaur, because he knows he will win the competition if he can ride a dinosaur, but the dinosaur is quite angry so the farmer decides to ride one of the horses. First, he considers riding the wild horse, but it proves to be un-

friendly, so he decides to ride one of the other horses. (The condition of plausible dissent is satisfied when the farmer considers riding a dinosaur.) In the remainder of the story, the two remaining farmers also consider riding a dinosaur and the wild horse, but they too realize the risk involved in riding these animals. In the end every farmer rides a 'regular' horse. When the story is completed, the child can see in the experimental workspace that every farmer is riding a horse and also that no farmer chose to ride the wild horse. At the completion of the story, Kermit the Frog utters the target sentence, preceded by the linguistic antecedent as in (11).

(11) This was a story about three farmers, two dinosaurs and four horses and one of them was a wild horse! I know what happened. Every farmer rode a horse.

Sixteen children ranging in age between 3;10 to 6;3 (mean age: 5;1) participated in the experiment. Each child was presented with one warm-up, two fillers and three target sentences. All the children attended the Center for Young Children at the University of Maryland at College Park.

The results are not as expected under the hypothesis that the salience of the denotation of the object N is the critical factor in children's judgments. Children correctly accepted sentences like *Every farmer rode a horse* on 43 trials out of 48 (90%). In short, children rarely produced non-adult responses, regardless of the salience of the denotation of the object N. Presumably, this pattern of adult-like behavior was manifested by children because the condition of plausible dissent was satisfied on each trial. Therefore, the study replicates the findings by Crain et al (1996).

Experiment II: The extra-agent condition. The goal of Experiment II was to evaluate one of the predictions implied by the Weak Quantification account: children's acceptance of a universal quantification in what we call the extra-agent condition. As we observed, when children access the adult reading of sentences with the universal quantifier, the existence of extra-objects is not relevant. By analogy, in stories that highlight the set denoted by the object N, the existence of extra-agents should not be relevant. On the weak quantification account, therefore, children are expected to accept a sentence like *Every boy is riding an elephant* in a context in which there is a boy who is not riding an elephant, as long as every elephant is being ridden by a boy. We call this the extra-agent condition. The extra-agent condition was constructed using pictures in the present study, to evaluate the proposal by Drozd and van Loosbroek using the same methodology as they did.

Two experimenters participated in the study. One presented the pictures to the child and to Kermit the Frog, who was manipulated by the second experimenter. On each trial the first experimenter directed the child's attention to the set denoted by the object N, in order to encourage the child to access the non-adult interpretation, if this reading was made available by the child's grammar. Then, Kermit described the picture and the child's task was to judge whether or not Kermit's description was correct.

To illustrate, on one trial the child was presented with the picture of four tigers and three balloons. Three of the four tigers were holding a balloon, so there was an 'extra' tiger in the picture. The experimenter pointed to each of the balloons, and then made a special point of the fact that there was a beautiful butterfly on each balloon. In this way, the set denoted by the object N was made highly salient. Children were then asked to evaluate the sentence (12), uttered by Kermit the Frog:

(12) Every tiger is holding a balloon.

Nineteen children, ranging in age between 3;08 and 5;10 (mean age: 4,11), participated in the experiment. Each child was presented with three target sentences and two fillers. These children correctly rejected the target sentences 46 times out of 51 trials (90%). In short, children did not behave as predicted by the weak quantification account, in the extra-agent condition.

6 Conclusion

The findings of these experiments reveal children's adult understanding of the universal quantifier *every*. There is (still) no reason to believe that the results provided by Crain et al. (1996) were due to an experimental artifact, peculiar to the Truth Value Judgment task. The findings leave open the possibility that determiner meanings are conservative in child grammars, just as they are in adult grammars. This is reassuring, in light of the learnability problems that children would confront if they were to adopt non-adult grammatical principles, which take them beyond the boundary conditions imposed by Universal Grammar.

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