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QUANTIFIER SPREADING:
PILOT STUDY OF PRESCHOOLER'S "EVERY"

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1.1 Introduction

Ever since the ground-breaking work of Inhelder & Piaget (1964), accounts of how children use quantifiers have generally been taken either as theories of the development of logical competence or as accounts of the performance in children of such higher-order cognitive processes. With a few exceptions (Donaldson & Lloyd, 1974; Matthei & Roeper, 1974), the observed phenomena are rarely considered from a linguistic perspective.

This study focuses on a peculiarity in the usage of the quantifier "every" by preschoolers. Our main objective is to determine if there is any evidence that linguistic principles, rather than general cognitive principles, have bearing on the observed phenomenon.

1.2 The Phenomenon

It is well-established in the literature\(^1\) that universal quantification for children between the ages

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\(^1\) Previous studies of universal quantification have dealt almost exclusively with "all". With this quantifier Inhelder & Piaget (1964) observed the phenomenon in question even with 8-year-olds.
of 3 and 5 differs from that of adults in at least one sharply contrastive sense. In adult quantification, under the wide scope reading of "every", a sentence such as "Every mouse is in a cup" can be characterized, fairly theory-independently, as describing a situation in which cups are distributed among mice in such a way that each mouse has got at least one. This distribution may be symmetrical in that there is a one-one correspondence of cups to mice, or it may be asymmetrical because one or more cups are "left over" after every mouse has been assigned at least one cup. This is what "every" means for the adult. In the case of preschoolers, however, it seems as if symmetrical distributivity were not an optional but an obligatory concomitant of universal quantification. Not only must every mouse have a cup but also every cup must belong to a mouse. Thus, for example, if shown a picture such as in (1) and asked "Is every mouse in a cup?", children showing the phenomenon answer "no". Moreover, when asked why they give this answer, the children invariably point to the empty cup and say something such as "That one isn't".

(1)
Is every mouse in a cup?
No
Why not?
Because that one is not
(points to empty cup)

Approximately 80% of 30 odd children we tested with items like (1) responded in this way, alluding to the extra, agent-less object as the reason for their negative response. We describe this special reading of "every" by saying it is constrained by a principle of obligatory symmetrical distributivity. A priori, however, it is not obvious that the phenomenon really should be analyzed in terms of distributivity at all. From the point of view of developmental psychology, it may be a nondistributive mental operation of some sort, one quite different from that of adult universal

2. We will consider later the collective/narrow scope reading.
3. Of course, it may be asymmetrical in other ways too; e.g., one mouse sitting in all the cups (stacked concentrically).
quantification, that really underlies the phenomenon, even though on the whole it manifests itself in much the same manner as that of adult universal quantification. This claim is the null hypothesis, given the psychological accounts in the literature (viz. Inhelder & Piaget, 1964).

We call the phenomenon 'quantifier spreading'. The term alludes to the notion that the child's reading of "Is every mouse in a cup?" results from its being mapped onto "Is every mouse in every cup?", a form in which "every" has "spread" to the indefinite object NP where it seems to function somewhat as a "resumptive quantifier" in the sense of May (1989).

2.1 The Experiment

The central focus of the experiment was to determine whether or not varying the linguistic context would affect quantifier spreading. If it did, we reasoned, then an adequate explanation of the facts would require reference to linguistic principles of one sort or another (as well as reference to suited theories of language-acquisition and of parsing). On the other hand, if the phenomenon remained constant in sharply differentiated linguistic contexts, this would argue against the appropriateness of a linguistic approach, given the null hypothesis.

2.2 Basic Design

The greatest contrast of linguistic context was that between quantifier spreading within a simple sentence (the sentential context) and spreading across a sentence boundary (the discourse context). The means of testing for the first have already been explained: shown a picture such as in (1), the subject is asked a simple yes/no question about it. The question instantiates a sentential context as it initiates the experimental task.

To test for quantifier spreading in the discourse context, the subject was told a short 'story', a text consisting of two simple sentences such as "Every window is opened. A woman is peeking out", and then shown a picture such as in (2) and asked whether or not it matched with what had been said. The experimental task was initiated by questions such as: "Does this

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4. Ordering the text before the picture made it harder for the children to ignore our words and respond only to the picture.
picture go with the story?", "Is this the right picture for the story?", or "Does this go with what I said?". The issue was whether or not "every" in the first sentence would 'spread' to the indefinite NP "a woman" in the second, such that children would require a symmetrical distribution of women over windows---a woman peeking out of each window---in order to satisfy the truth conditions of this text.

(2)
Every window is open.
A woman is peeking out

Does this picture go with the story?

Although the matching task of the discourse context item was formally equivalent to an experimental task used successfully in previous work (cf. Donaldson & Lloyd, 1974), since it was more complex than simply answering a question of a picture, we ran an initial series of warm-up items to teach it. It may be objected that the matching task was biased in favor of a negative response, since the picture never matched exactly (e.g. in (2) there is a woman walking outside the house who is never mentioned in the text). However, this bias, if it really existed for the children, favors the null hypothesis, since a negative response here would signal spreading. Thus, by allowing this bias, we strengthen the evidence in support of a linguistic hypothesis for quantifier spreading in so far as, despite the bias, more spreading is found in the sentential than the discourse contexts.

In addition, we considered the effect of varying the relative order of the quantified and the indefinite NPs. Either "every" would be in construction with the leftmost NP (e.g. "Is every mouse in a cup?")---giving rise potentially to right spreading---, or "every" would be in construction with the leftmost NP (e.g. "Is a mouse in every cup?")---giving rise potentially to

5. Varying the form of the question discouraged lexically based, fixed misconceptions about the matching task.
left spreading. The first we called an every/a-type item; the second an a/every-type item. We have already discussed how the every/a-type item works in the sentential and discourse contexts. With a/every-type items, the same experimental tasks are used, but the pictures must show extra agents rather than extra objects, as shown in (3).

(3) sentential discourse

Is a dog holding every bone? A dog got up. Every cat jumped.

In the case of a/every-type items, a negative response was not by itself sufficient to indicate the presence of left spreading. This is because there is an adult interpretation of the a/every-type question for which the correct response is "no". For example, under the type of reading in question, the sentence "Is a dog holding every bone?" would elicit a "yes" response only if its associated picture showed just one dog holding all of the bones. Furthermore, this interpretation seems to be the preferred one for many adults. For this reason, the a/every-type items required the follow-up question "Why not?" Only when the children referred to the extra agent that didn't have an object did we take their response to indicate left spreading.

As for a/every-type items in the discourse context, we did not concern ourselves with the possibility that there might be a bias for negative responses here since, again, it would only have favored the null hypothesis.

6. The narrow scope/collective reading of "every".
Finally, we also assessed quantifier spreading into and out of a relative clause (the relative clause context). Here, right-spreading meant the quantifier in a matrix subject was 'interacting' with an indefinite object NP inside a relative clause that was modifying the matrix subject. Left spreading was just the inverse of this. The same experimental task was used for this type of item as for the sentential context; (4) shows the kinds of pictures and sentence/texts that were used.

(4) every/a a/every

Is every whale that's lifting a boat smiling?
Is a waiter that's carrying every glass falling?

Right spreading in a sentential context served as the main control in this experiment. On the basis of similar earlier work (see references in introduction) and our own preliminary work, we strongly expected to find quantifier spreading here. The key questions were whether it would also be found (i) with every/a-type items in the discourse context, and (ii) with a/every-type items in the sentential context.

2.3 Some Assumptions

One of our basic assumptions is that in the face of multiple readings for a given sentence/text as long as the truth conditions are satisfied by the picture for at least one of these readings the subject is compelled to answer in the affirmative. This is true for adults, even if the reading which is satisfied by the picture is the less preferred one, and we have no reason to suppose the pragmatics to be different for children. On the contrary, we suspect the urge to

7. Though they sometimes tried to make us rephrase the question, adults never said "no" when "yes" was possible.
answer "yes" whenever possible is even stronger with young children.

This is not to say we believe that children can always keep in mind the multiple readings of an ambiguous sentence. It is possible that even though a child 'knows' all the available readings of a sentence he or she may still be unable to entertain two of them at once. Conceivably, after choosing one of a set of possible readings on the first exposure to a type of ambiguous sentence this choice is steadfastly clung to in all subsequent exposures to the same sentence type. This tendency to get 'fixated' about something, which it seems Inhelder & Piaget (1964:36 & passim) would have taken to show the 'irreversibility' of a given mental operation, appears to be very common among young children. We believe it definitely shows up in this experiment in connection with a control for the collective reading of "every" (see section 5.2). However, even if the gross incidence of quantifier spreading may be affected by a tendency of the child to get fixed ideas, this does not provide evidence that quantifier spreading is purely an artifact of some performance process since in principle the child should just as easily become fixated on the adult-like reading of "every" as on the quantifier spreading interpretation. The use of some sort of perceptual strategy for dealing with "every" should apply equally to either reading. In short, the question of whether or not quantifier spreading is linguistically constrained is independent of the question of how this phenomenon of getting fixed ideas arises.

We assumed that possible differences in parsibility between a discourse and a sentential context item could only arise from linguistic factors, not from general performance constraints such as limitations on memory or attention span, etc. In other words, we assumed the child has no more trouble hearing/remembering two consecutive simple sentences than he or she has hearing/remembering one.

2.4 Materials & Procedure

The 4 to 10 warm-up items introduced the matching task (rehearsed until it was clear that it had been

8. For an interesting description of a particular case of this 'fixed idea' phenomenon in relation to the comprehension of "all" and "some" see Smith, 1979:442.
understood correctly), checked for basic comprehension of "every" (see section 3), and showed the subject that negative responses were in principle as acceptable as affirmative responses.

The main body of the experiment consisted of 4 discourse context, 4 relative context and 6 sentential context items. Each of these sets was divided into an equal number of every/a- and a/every-type items. Other items served various control functions. The experiment was 'pseudo-randomized', i.e. arranged in a maximally diversified order9, so as to keep the child's attention and reduce the likelihood of inducing a response bias.

2.5 Four Special Control Items

TYPE I: negative and positive response elicitation items to check comprehension and attention, for example (5).

(5) negative elicitation

Every bird is standing.
An egg hatched.....

............................................
Is this picture okay?

9. We avoided the juxtaposition of items that were similar visually, verbally or with respect to expected adult responses.
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TYPE II: items checking whether the presence in the picture of extraneous objects or agents (not referred to) might elicit a negative response in the sentential context, as in (6).

(6) extraneous agents & objects

Is every girl licking a candy?

TYPE III: items that explored whether having more than one extra object in the picture would inhibit spreading, as in (7).

(7) two extra objects

Is every dog eating a bone?

TYPE IV: items testing the subject's knowledge of distributive and collective readings (see sections 3 & 5.2)

Responses to type II control items suggested that the presence of extraneous entities in the picture had no significant influence on quantifier spreading. On the other hand, responses to type III control items indicated that increasing by one the number of extra, agent-less objects inhibited spreading slightly. About 1/3 of all subjects showed a slight decrease in spreading here.

3.1 Subjects

The experiment was run on 40 boys and girls ranging between the ages of 3-0 and 5-7. The mean age of the 20 children included in the study was 4-3. Those excluded from the study were children who failed controls of type I or who failed to respond as an adult.
for both pictures in (8) when asked "Does every boy have a balloon?"\(^{10}\).

(8)  
\begin{align*}
\text{a.} & \quad \begin{array}{c}
\text{b.}
\end{array} \\
\end{align*}

All of the children we interviewed, except one 3-year-old and one 2-year-old (excluded from the study), answered in the negative when asked "Does every dog have a bone?" for a picture similar to the one on the left in (3).

4.1 Results

The tables in (9) show overall average incidences of quantifier spreading, as signalled by the response "no". The higher the percentage the more often, on average, the typical child would reject a picture for failing to depict a symmetrical distribution of agents and objects.

(9)  
\begin{align*}
\text{a.} & \quad \text{every/a} \\
\text{sentential relative clause discourse} & \quad 84\% \quad 69\% \quad 28\% \\
\text{b.} & \quad \text{sentential} \\
\text{every/a} \quad \text{a/every} & \quad 84\% \quad 90\% \\
\text{c.} & \quad \text{overall (right & left spreading together)} \\
\text{sentential relative clause discourse} & \quad 87\% \quad 58\% \quad 28\%
\end{align*}

The comparison of spreading for every/a- and a/every-type items in the table in (9.b) (linguistic context is held constant) suggests that there is no

\(^{10}\) Only 11 of the 40 children we interviewed actually failed these tests; another 9 have been excluded only because they were not tested for spreading in all 3 linguistic contexts.
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significant difference between right- and left-spreading. On the basis of this, we collapse the categories every/a and a/every to arrive at the main finding, shown in (9,c).

5.1 Conclusion & Analysis
The evidence of this pilot study strongly suggests, we feel, that linguistic principles play a role in the phenomenon. Placing a sentence boundary between the quantified NP and the indefinite NP dramatically inhibited quantifier spreading.

5.2 Distributive & Collective readings
Before considering some initial linguistic hypotheses, we should mention a few basic assumptions of ours about the semantics of universal quantification for these 'spreading children'. First, we believe that the spreading child has no trouble with distributivity per se. That is, they all seemed to have the essential ingredient for the distributive reading, namely the ability to enumerate a set exhaustively. We often found that test items would trigger an overt enumeration behavior on the part of a child. Before answering "yes" or "no", many children first counted off the agent-object pairs in the picture, pointing to each, one at a time (e.g."This cup, this cup, this cup, not this cup...no"). Furthermore, it was precisely the younger children who did this most often (86% of 3-year-olds; 29% of 4-year-olds; 43% of 5-year-olds). The fact that children tend to enumerate in this manner seems to us to argue against the view that they lack the ability to entertain the mental representation that corresponds to the distributive reading of "every" and are only capable of a strictly collective or holistic apprehension of sets. Nonetheless, this appears to be Inhelder & Piaget's view of the matter: "Insofar as a collection is itself an intuitive entity (because the young child cannot differentiate between the logical relations of classes of individuals and the sub-logical relations of part and whole) its general properties belong to the collection as a whole and not separately to its individual members." (Inhelder & Piaget,

11. A significant number of younger children would only enumerate, without actually answering "yes" or "no" (we had to exclude them from the study).
12. Percentages based on all 40 subjects (the numbers are misleading since an older child who enumerated did so only occasionally; a younger child did so consistently.)
1964:98) Although this analysis has a certain plausibility when the property in question is, say, blueness, it is not very clear what is intended by saying that for the spreading child a sentence such as "Every mouse is in a cup" is true only when the property of being in a cup inheres in the set of mice "as a whole and not separately to its members". If it is simply the claim that the children have an obligatory narrow scope reading of "every"---a reading we will call the "adult collective reading"---, then it is simply false. Control item type IV consisted of pictures showing symmetrical pairings of agents and objects presented with both every/a- and a/every-type sentential context items. All the children answered "yes" for both types, thereby showing that they did not have a "strong" adult collective reading. If they had, they would have answered "no" to the question "Is an X in every Y?". Furthermore, when presented with the control item in (10), 76% of the children answered in the negative.

(10)

Does a boy have every balloon?

We suspect that the children's tendency not to recognize the adult collective reading for the item in (10) may have had been largely induced by the experiment itself since other preliminary work of ours had shown that children of this age group were in principle capable of entertaining the adult collective reading.

With these considerations in mind, we turn now to a presentation of some of the ideas that have emerged as initial working hypotheses for a linguistic account of quantifier spreading.

5.3 Flip-flop Hypothesis

The Flip-flop Hypothesis is the proposal that quantifier spreading arises from an interchange of the
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positions of the quantified and the indefinite NPs. Thus, in the case of right spreading, a sentence such as "Every mouse is in a cup" is reanalyzed in the child's grammar as "A mouse is in every cup", with the object, rather than the subject, NP becoming the restrictive term. The every/a-type items are then false with adult semantics under a wide scope reading of "every". The left-spreading situation is just the opposite. The dependence of spreading on linguistic context follows, then, from a syntactic clause-mate constraint on this operation of 'flipping' the quantified NP.

Although this proposal gets the right readings without tampering with the semantics it has both theoretical and empirical difficulties. Assuming that flipping is optional but also strongly preferred, the problem is explaining what motivates it. We can't argue that left spreading is flipping motivated by a need to conform to some 'canonical structure' of universal quantification whereby the quantifier must be sentence initial, because then we are at pains to explain right spreading, where flipping is away from this canonical structure. There is an empirical problem too. We found that when shown a picture similar to the one on the left in (3) and asked "Does every dog have a bone?" all the children said "no", just as an adult would. They indicated the extra, boneless dog as their reason for responding in the negative. The problem for the Flipflop Hypothesis is that without an additional stipulation it falsely predicts an affirmative response in this situation.

As a partial account, explaining only left-spreading, the Flipflop Hypothesis might gain in plausibility if right spreading remained constant across linguistic contexts while left-spreading varied. However, as the table in (11) indicates, there is little evidence that this is the case (the difference between 62% and 47% in the relative clause context is not significant).

(11)  

<table>
<thead>
<tr>
<th></th>
<th>sentential relative clause</th>
<th>discourse</th>
</tr>
</thead>
<tbody>
<tr>
<td>every/a</td>
<td>80%</td>
<td>62%</td>
</tr>
<tr>
<td>a/every</td>
<td>87%</td>
<td>47%</td>
</tr>
</tbody>
</table>
5.4 Adverbial Quantifier Hypothesis

The Adverbial Quantifier Hypothesis has two parts. First, following Matthei & Roeper (1974), it is posited that "every" behaves syntactically like a sentential adverb. Secondly, adopting a modified version of the tripartite hypothesis of Heim (1982), it is posited that this adverbial "every", which now looks much like the adult "always", unselectively binds variables in both the subject and object NP position of the matrix sentence, the latter being a variable intrinsically. The clause-boundedness of quantifier spreading, then, is explained as following from a general constraint that tripartite structures can only be formed of sentences. Thus, for example, for the spreading child the logical form of "Every mouse is in a cup" would be as shown in (12).

(12) $\text{Every mouse is in a cup}$

The salient problem with this analysis is that, as is, the semantics yield the wrong reading. It is not the case that the children reject a picture such as in (1) because instead they want to see all the mice sitting together inside the topmost of a set of concentrically stacked cups. To get the spreading reading from the logical structure in (12) it would be necessary to posit some sort of additional constraint (e.g. a constraint on what assignment functions of the quantifier are accessible to the child). Alternatively, one might simply posit a special definition of "every". In either case, though, it becomes unclear how insightful the analysis in (12) is.

A more promising alternative, perhaps, is to posit the existence of a Davidsonian event variable for "every" to bind. Under this version of the Adverbial Quantifier Hypothesis (12) is reformulated as (13).

13. Thanks to Paul Portner for this suggestion.
(13) Every mouse is in a cup

\[Q \rightarrow \text{EVERYe} \]
\[R \quad \text{there's(e) a cup} \]
\[S \quad \text{a mouse is(e) in a cup} \]

i.e. for every event e such that there's a cup, a mouse is in a cup

A problem with this version of the Adverbial Quantifier Hypothesis is that although it seems to capture the spreading reading, it offers no explanation of why it is that there's(e) a cup should get into the restrictive clause rather than, say, there's(e) a mouse. In so far as this allows for the possibility that perceptual or cognitive mechanisms come into play in establishing the restrictive clause, the hypothesis doesn't seem to go much beyond Donaldson & Lloyd's suggestion that "...the child derives from the experimenter's words a notion of the kind of question he is to consider; but he derives the precise question that he does consider from his own encoding of the physical array..." (1973:83)
REFERENCES


