Age differences in the acquisition of quantifiers: Evidence from English and Korean[*]

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Abstract

This paper reports experimental finding which shows age differences in the acquisition of universal quantifiers. From comparable experiments of English and Korean 4 to 7 year-old children, it was found that in both groups younger children at the ages of 4 and 5 performed significantly better than the older children at the ages of 6 and 7. This finding gives rise to the classic pattern of a U-shaped developmental curve. On the view that some aspects of pragmatics are mastered late in acquisition, later than syntactic knowledge, it is assumed that the high rate of spreading errors by older children can be attributed to the interference of pragmatic factors, rather than to lack of grammatical knowledge. It is therefore argued that the errors made by younger children and the errors made by older children have to derive from different sources: the former are attributable to a deficiency of relevant grammatical knowledge, whereas the latter are due to the interference of pragmatic factors, even though the relevant grammatical knowledge is available.

1 Introduction

This paper reports experimental finding which shows age differences in the acquisition of quantification. It is well known that young children give a different interpretation from adults to sentences with a universal quantifier such as *every*, *each* or *all*, in contexts which do not satisfy a one-to-one relationship between agents and objects. For example, in a situation in which there are three bears holding a honeypot each and an extra honeypot not being held by a bear, as in (1):

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(1) bear-honeypot bear-honeypot
bear-honeypot honeypot

children say "no" to the question (2),

(2) Is *every* bear holding a honeypot?

pointing to the remaining object 'honeypot' as the reason for their negative response. This has often been called 'right spreading (or forward spreading)' in previous research.

In the converse situation where there is an extra bear without a honeypot, as in (3):

(3) bear-honeypot bear-honeypot
bear-honeypot bear

and confronted with the question in (4):

(4) Is a bear holding every honeypot?

children also deny that a bear is holding every honeypot because of the presence of the isolated bear. This is called 'left spreading (or backward spreading)'.

A number of previous researchers[1] have observed this behaviour in children learning languages such as English, French, Chinese, Dutch, Japanese, Catalan, etc. and have tried to explain why it happens and how children interpret universal quantifiers. Some of them have tried to explain it from a purely cognitive point of view, and some have tried to explain it on the basis of linguistic principles rather than of general cognitive principles. For detailed discussion of these theoretical analyses, see Kang (2000). I am here interested in focusing on individual data from my experiments on English and Korean children in terms of four different age groups, to see whether there is any age difference in their interpretation. For this purpose, I will briefly introduce the details of my experiments, then highlight the individual children's performance in terms of the four age levels, and finally I will discuss the findings as an example of the classic U-shaped

[1] Inhelder & Piaget (1958/1964), Donaldson & Lloyd (1974), Roeper & Matthei (1974), Bucci (1978), Donaldson (1978), Freeman et al. (1982), Freeman & Stedmon (1986), Philip & Takahashi (1990), Philip & Aurelio (1990), Roeper & de Villiers (1991), Philip (1991; 1992; 1995), Drozd & Philip (1992), Boster & Crain (1993), Philip & Verrips (1994), Crain et al. (1996), Brooks & Braine (1996), Drozd (1998), etc..

developmental curve, as discussed, for example, by Karmiloff-Smith (1992), Grimshaw & Rosen (1990) and Grodzinsky & Reinhart (1993).

2 Experiments: English and Korean Children

2.1 Subjects

I carried out comparable experiments in English and Korean with regard to children's interpretation of universal quantifiers. Experiment I included 59 English primary school children, 22 boys and 37 girls, ranging in age from 4;5 to 7;5 with a mean age of 5;8. There were 9 children in the 4 year old group; 25 in the 5 year old group; 19 in the 6 year old group; and 6 in the 7 year old group. They were all from the same primary school in South-East London. The four-year-olds belonged to the Reception Class; and the five to seven year-olds to the Lower School (mixed between Year 1 and Year 2). They all spoke only one language (English). Experiment II included 62 Korean kindergarten and primary school children in Korea, 27 boys and 35 girls, ranging in age from 4;3 to 7;7 with a mean age of 5;6. There were 15 children in the 4 year old group; 27 in the 5 year old group; 16 in the 6 year old group; and 4 in the 7 year old group. The four-and five-year-olds and some of the six-year-olds were all from the same kindergarten in Pusan, Korea, and some of the six and seven year-olds were from the same primary school in Seoul, Korea. They were all monolingual Korean children.

2.2 Test sentences and control contexts

All the test sentences were composed of simple structures with a transitive (active) verb or an intransitive verb with a prepositional phrase. The test sentences included twenty-seven different structures which fell into ten groups, labelled according to the predicted outcome (right or left-spreading) and/or in terms of the properties of the various noun phrases:

Group 1: RT: Right Spreading-Transitive
[a quantifier *every*, *each* or *all* in subject position and an indefinite article *a*+noun in object position, with a transitive verb]
Is/Are *every*/*each*/*all* (the) bear(s) holding *a* honeypot? (English)[2]
modun/kakkak-uy/modun kom(tul[3])-i kkultong-ul tulgo isseoyo? (Korean)[4]

Group 2: RTP: Right Spreading-Transitive-Plural NP
[a quantifier *every*, *each* or *all* in subject position and a plural NP in object position, with a transitive verb]
Is/Are *every*/*each*/*all* (the) bear(s) holding honeypot*s*?
modun/kakkak-uy/modun kom(tul)-i kkultongtul-ul tulgo isseoyo?

Group 3: RINT: Right Spreading-Intransitive
[a quantifier *every*, *each* or *all* in subject position and an indefinite article *a*+noun in object position of PP, with an intransitive verb]
Is/Are *every*/*each*/*all* (the) baby(ies) behind *a* mummy elephant?
modun/kakkak-uy/modun aki khokkiri(tul)-ka(i) umma khokkiri-tuye isseoyo?

Group 4: LT: Left Spreading-Transitive
[an indefinite article *a*+noun in subject position and a quantifier *every*, *each* or *all* in object position, with a transitive verb]
Is *a* bear holding *every*/*each*/*all* (the) honeypot(s)?
kom-i *modun/kakkak-uy/modun* kkultong(tul)-ul tulgo isseoyo?

Group 5: LTP: Left Spreading-Transitive-Plural NP

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[2] The same types of sentences were constructed for the different pictures by substituting the relevant words. For example, the sentence *Is every caterpillar carrying a ladybird?* was made for the picture [caterpillar-ladybird] and *Is every train pulling a coach?* for the picture [train-coach].

[3] *-tul* is the plural marker in Korean. However, in Korean both expressions with and without the plural marker are acceptable. Here the Korean equivalent of English *every* is spelt out as *modun* and that of *all* as *modun* (NP)-*tul*, though the contrast in Korean is one of preference rather than strict grammaticality.

[4] Korean also has universal quantifiers with functions similar to the English quantifiers. It contains strong and weak quantifiers with semantic properties like English, and most quantifiers in Korean can float in a sentence like adverbials, such as *all* or *each* in English. The Korean equivalent of *every* is *'modun'*; of *each* is *'kakkak(-uy)'*; and of a*ll* is *'modwu'* (in the case of the use as an adverbial) or *'modun'* (in the case of the use as a modifying adjective). The Korean quantifier *'nwukwuna'* might be considered to be equivalent to English *'every'* here in light of its individual property, rather than bearing a group meaning, but it is not included because it is generally used to modify 'persons', so that its use with animals or things sounds awkward, and likewise, because it is only used as a floated quantifier.

[a plural NP in subject position and a quantifier *every, each* or *all* in object position, with a transitive verb]
Are bear*s* holding *every*/*each*/*all* (the) honeypot(s)?
komtul-i *modun/kakkak-uy/modun* kkultong(tul)-ul tulgo isseoyo?

Group 6: LTtheNPs: Left Spreading-Transitive-the+NPs
[the+NPs in subject position and a quantifier *every*, *each* or *all* in object position, with a transitive verb]
Are *the* bear*s* holding *every*/*each*/*all* (the) honeypot(s)?
ku komtul-i *modun/kakkak-uy/modun* kkultong(tul)-ul tulgo isseoyo?

Group 7: LINT: Left Spreading-Intransitive
[an indefinite article *a*+noun in subject position (of the existential *there is* construction) and a quantifier *every, each* or *all* in object position of PP, with an intransitive verb]
Is there *a* baby behind *every*/*each*/*all* (the) mummy elephant(s)?
aki khokkiri-ka *modun/kakkak-uy/modun* umma khokkiri(tul) tuye isseoyo?

Group 8: Bare Plurals
[a plural NP in subject position and a singular NP (or a plural NP) in object position, with a transitive verb (without a quantifier)]
Are bear*s* holding *a* honeypot/honeypot*s*?
komtul-i kkultong(tul)-ul tulgo isseoyo?

Group 9: *The*+NP*s*-Transitive
[a definite article *the*+NP*s* in subject position and a singular NP (or a plural NP) in object position, with a transitive verb]
Are *the* bear*s* holding *a* honeypot/honeypot*s*?
ku komtul-i kkultong(tul)-ul tulgo isseoyo?

Group 10: *The*+NPs-Intransitive
[a definite article *the*+NPs in subject position and a singular NP (or a plural NP) in object position of PP, with an intransitive verb]
Are *the* babie*s* behind *a* mummy elephant/mummy elephant*s*?
ku aki khokkiri*tul*-i umma khokkiri(tul) tuye isseoyo?

Six different contexts were prepared:

Context 1: extra object & extra different agent
(There are three bears holding a honeypot each, an extra honeypot not being held, and a piglet alone.)

Context 2: different agent (visual symmetry)
(Three bears are holding a honeypot each, and a piglet is also holding a honeypot.)
Context 3: many to one, extra different agent
(There are three bears, among which just one bear is holding all three honeypots and the other two are not, just standing, and a piglet alone.)
Context 4: extra agent
(There are four bears, among them three bears are holding a honeypot each, and a bear alone without a honeypot.)
Context 5: different object (visual symmetry)
(There are four bears, in which three bears are holding a honeypot each and one bear is holding a bunch of flowers.)
Context 6: many to one, extra object & extra different agent
(There are three bears, among them just one bear is holding three honeypots and the other two are not, just standing, a piglet alone, and an extra honeypot not being held.)

For the sentences belonging to Groups 1, 2, 7 and 9 Contexts 1 and 2 have the positive (adult) response "yes" as the right answer, but Contexts 3, 4, 5 and 6 have the negative (adult) response "no" as the right answer. In contrast, in the case of the sentences of Groups 3 and 4, Contexts 3, 4 and 5 yield "yes" as the right answer, but Contexts 1, 2 and 6 yield "no" as the right answer. For the sentences of Groups 5 and 6, Contexts 4 and 5 yield "yes" as the right answer, but Contexts 1, 2, 3 and 6 give the negative response "no" as the right answer. For the sentences of Group 8, Contexts 1, 2, 4 and 5 have "yes" as the right answer, but Contexts 3 and 6 have "no" as the right answer. Finally, for the sentences of Group 10, Contexts 3, 4 and 5 have "yes" as the right answer for the sentence *Are the babies behind a mummy elephant?*, and Contexts 4 and 5 have "yes" as the right answer for the sentence *Are the babies behind mummy elephants?*.

2.3 Materials and procedures

Children were shown pictures individually and asked Yes/No questions via the use of a tape-recorder. There were 24 pictures corresponding to the six contexts: the sets of [bear and honeypot]; [caterpillar and ladybird]; [train and coach]; and [baby and mummy elephant]. The same pictures were used in Experiments I and II.

When the experimenter showed a child a picture, she encouraged him or her to describe it by asking questions such as *What can you see here?*, *What are they doing?*,

How many bears are there?, *How many honeypots are there?*, etc. Children typically enumerated each item in the picture, for example, "this bear (pointing to each item with their finger) is holding a honeypot, this bear is holding a honeypot, this bear is holding a honeypot as well, but this honeypot has no bear, there is no bear on this honeypot, or nobody is holding this honeypot, and this piglet is alone, he is not holding a honeypot, he is lonely," etc. Therefore it is clear that the children were conscious of the details of the picture before they listened to the test question. For the proposition 'every bear is holding a honeypot' corresponding to the sentence *Is every bear holding a honeypot?*, Contexts 3, 4, 5 or 6 each provide a situation which demonstrates the negation of the proposition. When children were shown those contexts, they described them, using a negative, for example, "these two bears are not holding a honeypot, this bear is holding all the honeypots, and also this piglet is not holding a honeypot" for Context 3; "this bear is not holding a honeypot" for Context 4; and "this bear is not holding a honeypot, he is holding flowers" for Context 5, and so on. The children spontaneously suggested that in those contexts not every bear is holding a honeypot. Then the other experimenter played the question on the tape recorder. When a child was not sure of the answer, the question was repeated. When a child answered 'no', the follow-up questions "Why not?" or "Why did you say "no"?" were asked. The responses were ticked 'yes' or 'no', and notes were jotted down on the blank side of the test paper. All the responses and comments by each child were also tape-recorded.

The interviews were carried out on two separate occasions with an interval of around one week between each session. Thirty-five simple questions, each with different pictures, were asked of a child in one session in the order of the sets [bear-honeypot], [caterpillar-ladybird], [train-coach] and [baby-mummy elephant]. Among the thirty-five questions, around ten questions were distracting sentences which were inserted among every two or three test sentences. These were to prevent children from giving stereotyped responses to the test questions, and also by giving simple sentences which require general knowledge, to have an idea whether they were rational in their responses to the questions, for example, *How many red stars are there?*, *Which circle is the biggest?*, *What sign is this?*, etc.

2.4 Results and Discussion

One of the general findings from both Experiments is that in the case where the right answer was "no", that is, in the case of pictures which did not correspond to the stimulus sentence, the majority of children responded correctly, giving the negative response "no". The use of "false pictures" induces clear negative responses. On the other hand, when the right answer was "yes", i.e. in the case of pictures which correspond to the test

sentence, high figures of quantifier spreading errors were found. The contexts which yield "yes" as their right answers are our main concern, because they are the paradigm examples of quantifier spreading.

For the purpose of this paper, I ignore the findings of the different lexical items (universal quantifiers such as *every*, *each* and *all*, bare plurals, *the*+NP*s*), the different syntactic positions (a quantifier in subject position and in object position) and the different syntactic structures (transitive and intransitive). For the discussion of these variables, again see Kang (2000). Here I concentrate on individual children's performance on the different stimulus sentences to see if there is any difference in their performance according to the four different age groups. The individual data are shown in Table 1 (English) and Table 3 (Korean) respectively:

<Table 1> **Experiment I: 59 English Children**

Rows: child Columns: control group (test sentences) Figures: correct responses (out of total trials given)

Shaded columns in the table show the 100% correct responses achieved.

Child/ Group	1 (1,2,3)	2 (7,8,9)	3 (20,21,22)	4 (4,5,6)	5 (11,12,13)	6 (16,17,18)	7 (23,24,25)	8 (10,14)	9 (15,19)	10 (26,27)	Total	Age
1	2(3)	1(1)	1(2)	3(3)	0(1)	1(1)	1(2)	2(3)	1(1)	NONE	12(17) 71%	4;8
2	2(3)	0(1)	0(2)	1(3)	0(1)	0(1)	0(2)	0(3)	0(1)	NONE	3(17) 18%	5;3
3	1(3)	0(1)	0(2)	1(3)	0(1)	0(1)	0(2)	0(3)	0(1)	NONE	2(17) 12%	6;0
4	1(3)	0(1)	0(2)	1(3)	0(1)	0(1)	0(2)	1(3)	1(1)	NONE	4(17) 24%	7;3
5	2(2)	5(5)	3(3)	2(5)	3(3)	2(2)	1(1)	2(2)	NONE	0(1)	20(24) 83%	4;8
6	2(2)	5(5)	2(3)	3(5)	2(3)	2(2)	1(1)	2(2)	NONE	1(1)	20(24) 83%	5;5
7	2(2)	4(5)	2(3)	0(5)	1(3)	2(2)	0(1)	1(2)	NONE	0(1)	12(24) 50%	5;9
8	0(2)	1(5)	0(3)	0(5)	0(3)	0(2)	0(1)	0(2)	NONE	0(1)	1(24) 4%	6;7
9	NONE	NONE	1(3)	0(1)	0(2)	0(3)	1(2)	1(2)	1(2)	0(1)	4(16) 25%	5;2
10	NONE	NONE	1(3)	0(1)	2(2)	2(3)	0(2)	1(2)	1(2)	0(1)	7(16) 44%	5;8
11	NONE	NONE	0(3)	0(1)	1(2)	0(3)	0(2)	2(2)	2(2)	1(1)	6(16) 38%	7;2
12	2(4)	NONE	1(1)	2(2)	1(1)	1(1)	1(3)	2(4)	2(2)	NONE	12(18) 67%	4;6
13	1(4)	NONE	0(1)	1(2)	0(1)	0(1)	0(3)	1(4)	1(2)	NONE	4(18) 22%	5;9
14	1(4)	NONE	1(1)	0(2)	0(1)	1(1)	0(3)	1(4)	1(2)	NONE	5(18) 28%	5;9
15	1(4)	NONE	1(1)	1(2)	0(1)	1(1)	0(3)	1(4)	1(2)	NONE	6(18) 33%	6;7
16	0(1)	5(6)	1(1)	1(5)	0(2)	0(1)	1(2)	1(1)	1(2)	NONE	10(21) 48%	4;8
17	0(1)	1(6)	0(1)	0(5)	0(2)	0(1)	1(2)	0(1)	1(2)	NONE	3(21) 14%	5;8
18	1(1)	4(6)	1(1)	0(5)	1(2)	0(1)	0(2)	0(1)	1(2)	NONE	8(21) 38%	7;1
19	1(2)	NONE	2(3)	3(3)	0(2)	2(3)	1(3)	2(2)	1(1)	1(1)	13(20) 65%	4;8
20	0(2)	NONE	0(3)	2(3)	1(2)	1(3)	0(3)	1(2)	1(1)	0(1)	6(20) 30%	6;1
21	0(2)	NONE	1(3)	2(3)	0(2)	0(3)	0(3)	1(2)	1(1)	0(1)	5(20) 25%	6;6
22	3(3)	2(2)	1(1)	1(2)	1(1)	2(2)	1(1)	2(2)	1(1)	NONE	14(15) 93%	4;6
23	2(3)	1(2)	1(1)	0(2)	0(1)	1(2)	0(1)	0(2)	1(1)	NONE	6(15) 40%	5;8
24	1(3)	2(2)	0(1)	0(2)	0(1)	1(2)	0(1)	0(2)	1(1)	NONE	5(15) 33%	6;2

25	2(2)	0(3)	1(2)	1(4)	0(2)	NONE	0(2)	1(2)	2(2)	1(1)	8(20) 40%	4;4
26	0(2)	0(3)	1(2)	0(4)	0(2)	NONE	0(2)	1(2)	1(2)	0(1)	3(20) 15%	5;8
27	0(2)	0(3)	0(2)	0(4)	0(2)	NONE	0(2)	1(2)	1(2)	0(1)	2(20) 10%	6;5
28	0(1)	1(1)	0(1)	2(3)	0(2)	0(3)	1(3)	2(2)	1(1)	NONE	7(17) 41%	4;8
29	1(1)	0(1)	0(1)	2(3)	0(2)	0(3)	0(3)	2(2)	0(1)	NONE	5(17) 29%	5;6
30	0(1)	0(1)	0(1)	2(3)	0(2)	0(3)	0(3)	1(2)	0(1)	NONE	3(17) 18%	6;8
31	1(3)	NONE	0(2)	0(1)	0(2)	0(3)	0(2)	3(4)	1(1)	1(1)	6(19) 32%	5;2
32	2(3)	NONE	0(2)	1(1)	1(2)	1(3)	0(2)	3(4)	1(1)	1(1)	10(19) 53%	5;9
33	3(3)	NONE	1(2)	1(1)	1(2)	1(3)	0(2)	3(4)	0(1)	0(1)	10(19) 53%	6;7
34	1(1)	4(5)	1(3)	1(4)	0(1)	1(1)	0(2)	1(2)	1(1)	NONE	10(20) 50%	4;4
35	1(1)	2(5)	0(3)	0(4)	0(1)	0(1)	0(2)	1(2)	0(1)	NONE	4(20) 20%	5;8
36	1(1)	2(5)	0(3)	0(4)	0(1)	0(1)	0(2)	1(2)	0(1)	NONE	4(20) 20%	6;8
37	1(2)	0(1)	0(4)	1(3)	0(3)	0(2)	0(1)	1(2)	0(2)	0(1)	3(21) 14%	5;3
38	1(2)	0(1)	0(4)	1(3)	0(3)	0(2)	0(1)	1(2)	0(2)	1(1)	4(21) 19%	6;2
39	0(2)	1(1)	NONE	1(2)	1(2)	1(2)	NONE	1(3)	0(1)	0(1)	5(14) 36%	5;3
40	0(2)	0(1)	NONE	0(2)	0(2)	0(2)	NONE	2(3)	1(1)	0(1)	3(14) 21%	6;8
41	0(2)	0(1)	NONE	0(2)	0(2)	0(2)	NONE	1(3)	0(1)	0(1)	1(14) 7%	7;3
42	2(2)	2(2)	2(2)	3(3)	1(1)	1(1)	1(1)	3(3)	1(1)	NONE	16(16)100%	5;3
43	1(2)	0(2)	0(2)	0(3)	0(1)	0(1)	0(1)	0(3)	0(1)	NONE	1(16) 6%	5;8
44	1(2)	0(2)	0(2)	0(3)	0(1)	0(1)	0(1)	1(3)	0(1)	NONE	2(16) 13%	6;2
45	0(1)	2(3)	0(2)	0(4)	0(2)	0(3)	0(2)	0(2)	1(1)	NONE	3(20) 15%	5;1
46	1(1)	3(3)	1(2)	2(4)	1(2)	2(3)	1(2)	2(2)	1(1)	NONE	14(20) 70%	6;5
47	1(1)	0(3)	1(2)	1(4)	0(2)	0(3)	0(2)	0(2)	0(1)	NONE	3(20) 15%	7;1
48	1(2)	NONE	1(2)	0(2)	0(2)	0(2)	1(3)	0(3)	1(2)	0(1)	4(19) 21%	5;3
49	1(2)	NONE	0(2)	0(2)	0(2)	0(2)	1(3)	3(3)	2(2)	0(1)	7(19) 37%	6;1
50	1(2)	NONE	0(2)	0(2)	0(2)	0(2)	0(3)	0(3)	1(2)	1(1)	3(19) 16%	6;3
51	3(3)	1(2)	1(2)	0(2)	1(2)	0(1)	0(2)	3(3)	1(1)	NONE	10(18) 56%	5;2
52	3(3)	1(2)	0(2)	0(2)	0(2)	0(1)	0(2)	1(3)	1(1)	NONE	6(18) 33%	6;3
53	1(3)	0(2)	0(2)	0(2)	1(2)	0(1)	0(2)	1(3)	0(1)	NONE	3(18) 17%	7;0

54	0(2)	1(4)	0(1)	1(4)	1(2)	0(2)	0(1)	2(2)	NONE	1(1)	6(19) 32%	5;1
55	1(2)	4(4)	1(1)	2(4)	1(2)	0(2)	1(1)	2(2)	NONE	1(1)	13(19) 68%	5;8
56	0(2)	1(4)	0(1)	0(4)	0(2)	0(2)	0(1)	0(2)	NONE	0(1)	1(19) 5%	6;1
57	NONE	NONE	0(1)	0(1)	0(3)	0(3)	0(2)	3(4)	1(2)	0(1)	4(17) 24%	5;3
58	NONE	NONE	0(1)	0(1)	0(3)	0(3)	0(2)	0(4)	0(2)	0(1)	0(17) 0%	5;6
59	NONE	NONE	0(1)	0(1)	0(3)	0(3)	0(2)	0(4)	1(2)	0(1)	1(17) 6%	6;9
Total	56(115) 48%	56(113) 50%	31(110) 28%	46(169) 27%	22(98) 22%	26(110) 24%	15(110) 14%	71(151) 47%	40(73) 55%	10(30) 33%	373(1,079) 35%	

Table 2: Numbers of children who made all their responses right for each group (in the first row); numbers of children who made all their responses wrong for each group (in the second row); and numbers of children who made mixed responses, that is, sometimes wrong and sometimes right (in the third row)

Group	1 (1,2,3)	2 (7,8,9)	3 (20,21,22)	4 (4,5,6)	5 (11,12,13)	6 (16,17,18)	7 (23,24,25)	8 (10,14)	9 (15,19)	10 (26,27)	Total
All right	16	10	10	6	5	10	5	14	22	10	108
All wrong	15	16	31	30	41	37	41	15	16	20	262
Mixed	22	14	15	23	13	9	10	30	14	0	150

<Table 3> **Experiment II: 62 Korean Children**

Rows: child Columns: control group (test sentences) Figures: correct responses (out of total trials given)

Shaded columns in the table again show the 100% correct responses achieved.

Child/ Group	1 (1,2,3)	2 (7,8,9)	3 (20,21,22)	4 (4,5,6)	5 (11,12,13)	6 (16,17,18)	7 (23,24,25)	8 (10,14)	9 (15,19)	10 (26,27)	Total	Age
1	3(3)	0(1)	1(2)	1(3)	1(1)	0(1)	1(2)	2(3)	0(1)	NONE	9(17) 53%	4;6
2	2(3)	1(1)	1(2)	2(3)	1(1)	1(1)	0(2)	1(3)	1(1)	NONE	10(17) 59%	5;4
3	1(3)	0(1)	0(2)	0(3)	0(1)	0(1)	0(2)	0(3)	0(1)	NONE	1(17) 6%	5;7
4	2(3)	0(1)	0(2)	1(3)	0(1)	0(1)	0(2)	0(3)	0(1)	NONE	3(17) 18%	7;0
5	2(2)	5(5)	3(3)	3(5)	3(3)	2(2)	1(1)	2(2)	NONE	1(1)	22(24) 92%	4;4
6	2(2)	3(5)	0(3)	0(5)	0(3)	0(2)	0(1)	1(2)	NONE	0(1)	6(24) 25%	5;5
7	0(2)	2(5)	0(3)	0(5)	0(3)	0(2)	0(1)	0(2)	NONE	0(1)	2(24) 8%	6;0
8	1(2)	4(5)	1(3)	1(5)	0(3)	1(2)	0(1)	2(2)	NONE	0(1)	10(24) 42%	7;6
9	NONE	NONE	3(3)	1(1)	2(2)	2(3)	2(2)	2(2)	2(2)	0(1)	14(16) 88%	4;6
10	NONE	NONE	0(3)	0(1)	0(2)	0(3)	0(2)	1(2)	1(2)	0(1)	2(16) 13%	5;4
11	NONE	NONE	0(3)	0(1)	0(2)	0(3)	0(2)	1(2)	0(2)	0(1)	1(16) 6%	5;5
12	NONE	NONE	0(3)	0(1)	0(2)	0(3)	0(2)	0(2)	0(2)	0(1)	0(16) 0%	7;0
13	3(4)	NONE	1(1)	1(2)	0(1)	1(1)	2(3)	2(4)	1(2)	NONE	11(18) 61%	4;3
14	4(4)	NONE	1(1)	2(2)	1(1)	1(1)	3(3)	2(4)	1(2)	NONE	15(18) 83%	5;1
15	3(4)	NONE	0(1)	0(2)	0(1)	0(1)	0(3)	2(4)	0(2)	NONE	5(18) 28%	6;0
16	1(4)	NONE	0(1)	0(2)	0(1)	1(1)	0(3)	1(4)	1(2)	NONE	4(18) 22%	6;8
17	1(1)	5(6)	1(1)	3(5)	2(2)	1(1)	1(2)	1(1)	2(2)	NONE	17(21) 81%	4;8
18	0(1)	4(6)	0(1)	1(5)	0(2)	1(1)	0(2)	0(1)	1(2)	NONE	7(21) 33%	5;4
19	1(1)	5(6)	1(1)	0(5)	2(2)	1(1)	1(2)	0(1)	1(2)	NONE	12(21) 57%	5;6
20	0(1)	1(6)	0(1)	0(5)	0(2)	0(1)	0(2)	0(1)	1(2)	NONE	2(21) 10%	7;2
21	0(2)	NONE	0(3)	1(3)	0(2)	0(3)	0(3)	1(2)	0(1)	0(1)	2(20) 10%	4;8
22	2(2)	NONE	3(3)	3(3)	2(2)	3(3)	3(3)	2(2)	1(1)	1(1)	20(20) 100%	5;0

23	2(2)	NONE	1(3)	2(3)	1(2)	0(3)	1(3)	2(2)	1(1)	1(1)	11(20) 55%	5;8
24	3(3)	2(2)	0(1)	2(2)	1(1)	2(2)	1(1)	2(2)	1(1)	NONE	14(15) 93%	4;5
25	0(3)	2(2)	1(1)	1(2)	0(1)	0(2)	0(1)	0(2)	0(1)	NONE	4(15) 27%	5;5
26	1(3)	1(2)	0(1)	1(2)	0(1)	1(2)	0(1)	0(2)	0(1)	NONE	4(15) 27%	5;7
27	2(2)	3(3)	2(2)	3(4)	2(2)	NONE	1(2)	2(2)	2(2)	1(1)	18(20) 90%	4;6
28	2(2)	3(3)	1(2)	2(4)	2(2)	NONE	0(2)	1(2)	2(2)	1(1)	14(20) 70%	5;3
29	0(2)	1(3)	1(2)	0(4)	0(2)	NONE	1(2)	1(2)	1(2)	0(1)	5(20) 25%	6;0
30	1(1)	1(1)	1(1)	3(3)	2(2)	2(3)	3(3)	2(2)	1(1)	NONE	16(17) 94%	4;5
31	0(1)	1(1)	0(1)	2(3)	1(2)	2(3)	0(3)	2(2)	0(1)	NONE	8(17) 47%	5;7
32	0(1)	1(1)	0(1)	1(3)	0(2)	0(3)	0(3)	1(2)	1(1)	NONE	4(17) 24%	6;1
33	2(3)	NONE	1(2)	1(1)	2(2)	2(3)	0(2)	3(4)	1(1)	0(1)	12(19) 63%	4;8
34	3(3)	NONE	2(2)	1(1)	2(2)	3(3)	1(2)	4(4)	1(1)	1(1)	18(19) 95%	5;3
35	0(3)	NONE	0(2)	0(1)	1(2)	1(3)	0(2)	2(4)	0(1)	0(1)	4(19) 21%	6;6
36	1(1)	2(5)	1(3)	1(4)	0(1)	0(1)	0(2)	1(2)	0(1)	NONE	6(20) 30%	4;2
37	1(1)	0(5)	0(3)	0(4)	0(1)	0(1)	0(2)	1(2)	0(1)	NONE	2(20) 10%	6;0
38	1(1)	2(5)	2(3)	0(4)	0(1)	0(1)	0(2)	0(2)	1(1)	NONE	6(20) 30%	6;0
39	2(2)	1(1)	3(4)	2(3)	3(3)	2(2)	1(1)	2(2)	2(2)	1(1)	19(21) 90%	5;4
40	2(2)	1(1)	1(4)	0(3)	1(3)	1(2)	0(1)	1(2)	1(2)	0(1)	8(21) 38%	6;0
41	2(2)	1(1)	0(4)	0(3)	0(3)	0(2)	0(1)	1(2)	1(2)	0(1)	5(21) 24%	6;7
42	2(2)	1(1)	NONE	2(2)	2(2)	2(2)	NONE	3(3)	1(1)	1(1)	14(14)100%	4;4
43	2(2)	1(1)	NONE	1(2)	2(2)	1(2)	NONE	1(3)	1(1)	0(1)	9(14) 64%	5;3
44	0(2)	1(1)	NONE	2(2)	1(2)	0(2)	NONE	1(3)	1(1)	0(1)	6(14) 43%	6;3
45	1(2)	0(2)	0(2)	0(3)	0(1)	0(1)	0(1)	0(3)	0(1)	NONE	1(16) 6%	5;3
46	1(2)	0(2)	0(2)	1(3)	0(1)	1(1)	0(1)	0(3)	0(1)	NONE	3(16) 19%	5;8
47	1(2)	0(2)	0(2)	0(3)	0(1)	0(1)	0(1)	0(3)	0(1)	NONE	1(16) 6%	6;4
48	0(1)	2(3)	0(2)	0(4)	0(2)	0(3)	0(2)	2(2)	0(1)	NONE	4(20) 20%	4;4
49	NONE	1(3)	NONE	0(3)	0(2)	0(2)	NONE	0(2)	NONE	NONE	1(12) 8%	5;1
50	1(1)	2(3)	2(2)	0(4)	0(2)	0(3)	0(2)	0(2)	0(1)	NONE	5(20) 25%	5;7
51	2(2)	NONE	1(2)	0(2)	0(2)	0(2)	0(3)	1(3)	1(2)	0(1)	5(19) 26%	5;3

52	2(2)	NONE	1(2)	0(2)	2(2)	2(2)	1(3)	3(3)	2(2)	1(1)	14(19) 74%	5;7
53	1(2)	NONE	0(2)	0(2)	0(2)	0(2)	0(3)	0(3)	1(2)	0(1)	2(19) 11%	6;3
54	3(3)	1(2)	1(2)	0(2)	1(2)	1(1)	0(2)	3(3)	1(1)	NONE	11(18) 61%	4;6
55	1(3)	1(2)	0(2)	0(2)	0(2)	0(1)	0(2)	0(3)	1(1)	NONE	3(18) 17%	5;4
56	1(3)	NONE	NONE	0(1)	0(1)	0(1)	0(1)	0(1)	NONE	NONE	1(8) 13%	6;6
57	0(2)	3(4)	0(1)	1(4)	0(2)	0(2)	0(1)	1(2)	NONE	1(1)	6(19) 32%	4;7
58	2(2)	3(4)	1(1)	1(4)	1(2)	1(2)	1(1)	2(2)	NONE	0(1)	12(19) 63%	5;3
59	0(2)	2(4)	0(1)	2(4)	0(2)	0(2)	0(1)	1(2)	NONE	0(1)	5(19) 26%	6;7
60	NONE	NONE	0(1)	0(1)	0(3)	1(3)	0(2)	2(3)	3(5)	0(1)	6(19) 32%	5;0
61	NONE	NONE	0(1)	0(1)	1(3)	0(3)	0(2)	1(3)	3(5)	0(1)	5(19) 26%	5;8
62	NONE	NONE	0(1)	0(1)	0(3)	1(3)	0(2)	0(3)	3(5)	0(1)	4(19) 21%	6;8
Total	73(117) 62%	70(118) 59%	39(114) 34%	52(176) 30%	43(116) 37%	41(115) 36%	25(112) 22%	72(151) 48%	47(86) 55%	10(32) 31%	471(1137) 41%	

Table 4: Numbers of children who made all their responses right for each group (in the first row); numbers of children who made all their responses wrong for each group (in the second row); and numbers of children who made mixed responses, that is, sometimes wrong and sometimes right (in the third row)

GROUP	1 (1,2,3)	2 (7,8,9)	3 (20,21,22)	4 (4,5,6)	5 (11,12,13)	6 (16,17,18)	7 (23,24,25)	8 (10,14)	9 (15,19)	10 (26,27)	Total
All right	26	15	13	9	18	16	8	17	20	10	152
All wrong	13	7	30	30	36	31	41	19	18	22	247
Mixed	15	19	14	23	8	12	9	26	15	0	141

Tables 1 and 3 observe a significant generalization. If we identify the children by age group, we see the result in Table 5:

<Table 5> Details of the four different age groups and error rates: Experiment I (English) and Experiment II (Korean, shown in parentheses)

age group	no. of subjects	mean age (yr;mth)	error rate (%)
4	9 (15)	4;8 (4;5)	36 (37)
5	25 (27)	5;6 (5;4)	65 (55)
6	19 (16)	6;7 (6;3)	74 (77)
7	6 (4)	7;2 (7;1)	76 (79)

For the four different age groups, as shown in Table 5, the overall error rates from Experiment I are 36% in the four year old group (9 children); 65% in the five year old (25); 74% in the six year old (19); and 76% in the seven year old (6). There are significant differences between the error rates for the different ages ($p=.002$), with the evidence for this coming from the difference between the 4-year olds and the rest (no significant differences are found between the rest). The statistical analysis was a one way analysis of variance on the logistically transformed error rates for the 59 children with age as a 4-level factor. Similar differences are also found in Experiment II. The error rates are 37%, 55%, 77% and 79% in the order of the four age groups, 4 (15 children), 5 (27), 6 (16) and 7 (4). The differences are similar to the English data, with an overall test for differences giving $p<.001$, and now we have significant differences (with $p<.05$) between the 4-year olds and each of the others, and between the 5 year olds and each of the others (but not between 6 and 7).

As shown in Table 5, the pattern of error rates is basically the same in both experiments, with $4 < 5 < 6\&7$ in the order of the degree of spreading errors, it is just that the 5 versus 6 comparison is significant for the Korean children, but does not quite reach significance for the English data. What is of interest here is that the older children made more spreading errors than the youngest. If we have a close look at the individual children's data on all the trials given, more interesting results are found: the highest rates of correct responses are made by the youngest, 4 and 5 year old, children and, in contrast, the lowest rates of correct responses are made by the oldest, 7 year old, children. Let us have a look at the distribution of children in each age group, based on the rate of their correct responses.

<Table 6> Experiment I: numbers of English children at four levels, based on the rate of their correct responses

Age group/ Rates of correct responses	100-75%	74-50%	49-25%	24-0%
4	2	4	3	
5	2	4	8	11
6		2	6	11
7			2	4
Total	4	10	19	26

Table 6 shows that 4 children performed markedly better than the others and, more interestingly, they are the younger children at ages around 4 and 5. If we specify each of them here, child no. 42 made 100% correct responses through all the trials (16 correct responses out of 16 trials) and she is 5 years and 3 months old. Child no. 22 made 93% correct responses (14 out of 15). He made only one error in Group 4 (the case of left spreading with a transitive verb, e.g. *Is a bear holding every honeypot?*), and he is only 4 years and 6 months old. Child no. 5 made 83% correct responses (20 out of 24). She made 3 errors in Group 4 and 1 error in Group 10 (*the*+NPs with an intransitive verb, e.g. *Are the babies behind a mummy elephant?*), but performed perfectly on all the other groups. She is also 4 years and 8 months old. Child no. 6 also made 83% correct responses (20 out of 24) and she is 5 years and 5 months old. On the other hand, strikingly, the oldest children performed badly, for example, child no. 41 is 7 years and 3 months old and she made only 1 correct response out of 14 trials; child no. 47 is 7 years and 1 month old and she made 3 correct responses out of 20 trials; and child no. 53 is 7 years old and he made 3 correct responses out of 18 trials.

This interesting result is also mirrored in the Korean children's performance, as shown in Table 7:

<Table 7> Experiment II: numbers of Korean children at four levels, based on the rate of their correct responses

Age group/ Rates of correct responses	100-75%	74-50%	49-25%	24-0%
4	7	4	2	2
5	4	7	9	7
6			6	10
7			1	3
Total	11	11	18	22

The eleven high scorers over 75% are all 4 or 5 year old children, and all the oldest 6 and 7 year old children made low percentages of correct responses, less than 50%, as shown in the table. To specify their results individually, child no. 42 made 100% correct responses, 14 out of 14, and she is only 4 years and 4 months old, and the other six 4 year old children got 1 or 2 answers wrong, leading the scores up to around 90% correct responses. Child no. 22 also made 100% correct responses, 20 out of 20, and he is just 5 years old, and the other three 5 year old children made 1 or 2 errors out of the total trials, leading to the scores 95% or 92% of correct responses. That is, the youngest 11 children performed nearly perfectly in the Korean experiment, just as in the English experiment. Here again, the oldest four 7 year old children performed badly: child no. 12 got all the responses wrong, 0 out of 16 (0%); child no. 20 got 2 right out of 21 (10%); child no. 4 got 3 right out of 17 (18%); and child no. 8 got 10 right out of 24 (42%).

This distribution of the numbers of children based on the rate of correct responses between each age group, represented in Tables 6 and 7, shows part of the classic pattern of a U-shaped developmental curve, which has been demonstrated as a general phenomenon in acquisition (or in maturation) in the relevant literature on child development. This finding is reminiscent, for example, of Karmiloff-Smith's (1992) Representational Redescription Hypothesis. In the next section, I will briefly introduce her hypothesis.

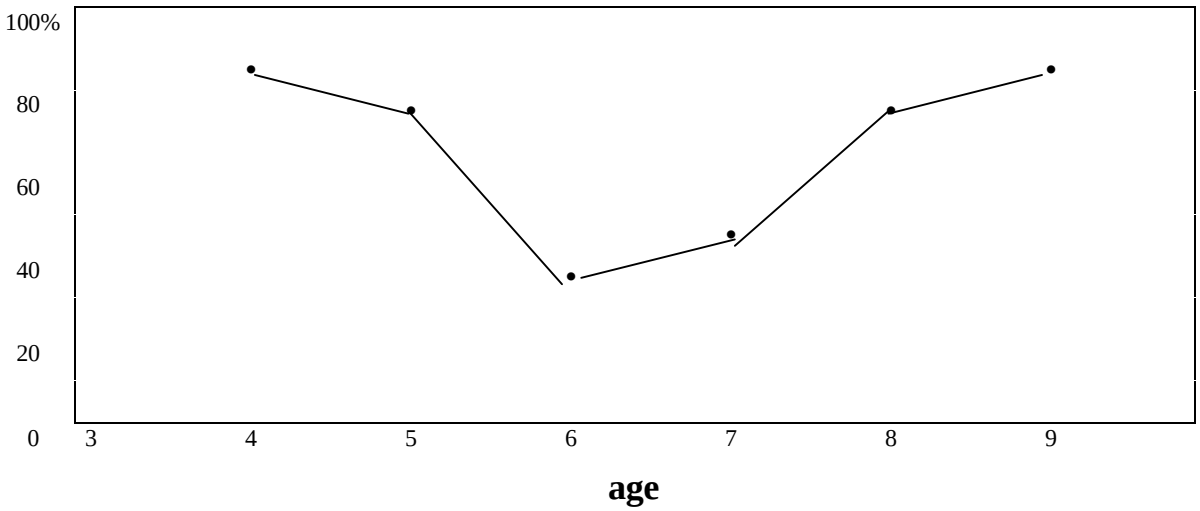
3 Karmiloff-Smith's (1992) Representational Redescription Hypothesis

According to Karmiloff-Smith's RR hypothesis, child development typically involves three recurrent phases. Information which is initially available to the child is only in the form of an *implicit* representation (*I*) and this implicit information is successively

reanalysed through the three phases of *explicit* representation (*E1*, *E2*, *E3*), making that information more accessible. During the first phase the child gets information from the external environment, creates "representational adjunctions" (in her term, which "neither alter existing stable representations nor are brought into relation with them", p.18) and adds new representations to the existing stock. This initial learning is internally data driven and domain specific. In the second phase, the current state of the child's representations of knowledge in a microdomain predominates over information from the incoming data. This predomination, that is, the disregard for features of the external environment leads to errors and gives rise to a decrease in successful behaviour. Finally, during the third phase, "internal representations and external data are reconciled, and a balance is achieved between the quests for internal and external control, resulting in a U-shaped developmental curve. In the case of language, for example, a new mapping is made between input and output representations in order to restore correct usage." (Karmiloff-Smith, 1992, p.20)

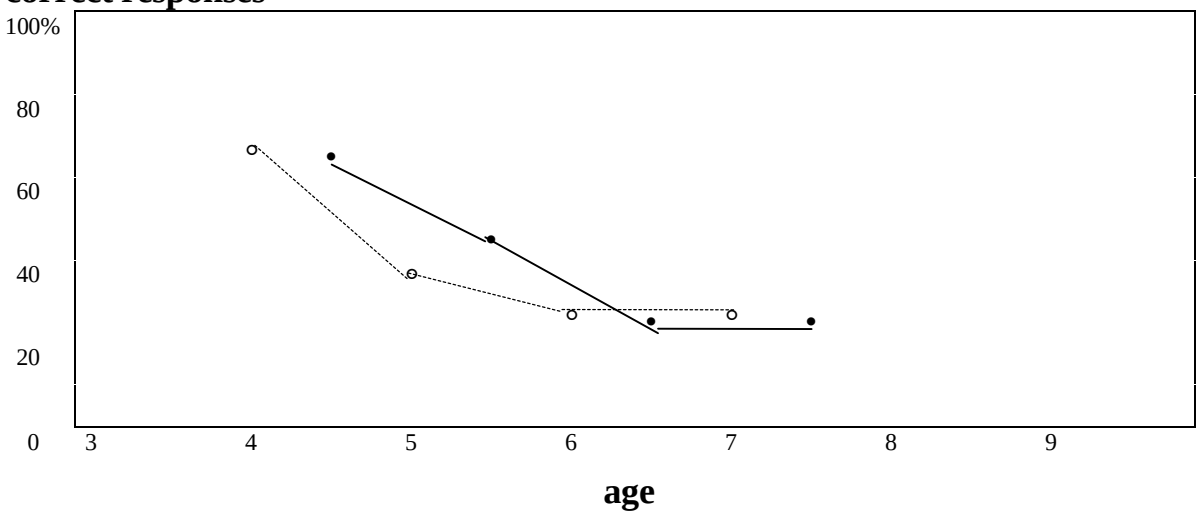
A typical example of this hypothesis is provided by her results for the behaviour of young children, aged from 4 to 9, attempting to balance blocks of different shapes and sizes on a metal support. In her experiments some blocks balanced at their geometric centre; others, which looked identical, had been filled with lead at one end and so balanced off-centre, and yet others had a weight visibly glued at one end so that they balanced off-centre as well. The youngest 4-year-olds perform far more successfully than 6- or 7-year olds, and the 8 to 9 year olds succeed in balancing all the types of blocks, as do the youngest group, in the experiments. This behavioural change is diagrammed in Figure 1 below:

Figure 1 Behavioral change (Karmiloff-Smith, 1992: 19)



The current experimental data, represented in Tables 6 and 7, shows a similar behavioural curve, as shown in Figure 2, although it shows only part of the U-shape because the experiments only covered the age groups up to 7:

Figure 2 Correct responses in percentage to all the test sentences between four different age groups (° English data; • Korean data)



The U-shape will be complete on the assumption that the children will indeed give correct adult-like answers at a later age. I leave this issue for future research, covering age groups older than 7.

4 The deployment of pragmatic considerations

An interesting alternative interpretation of these experimental results can be derived from Grimshaw & Rosen's (1990) argument that knowing a linguistic rule and obeying it have to be distinguished. They challenge the position of previous researchers concerning the acquisition of binding, which holds that young children do not have knowledge of Principle B of the binding theory (cf. Lust (1986) and Wexler & Chien (1985)). Through their own experiment on Principle B and C violations, they demonstrate that children know all aspects of Binding Principle B, the coreference aspects and its variable-binding aspects, that is, children are innately endowed with the knowledge, as also reviewed and argued by Grodzinsky & Reinhart (1993), and argue that experimental results indicating that children do not know the coreference aspects of the standard binding theory are due to performance factors that mask this knowledge. They comment that "children need not obey the binding theory, in order to demonstrate knowledge of the binding theory" (G&R 1990, p.189). Where children's performance differentiates between grammatical and ungrammatical cases, this indicates that they know the rule in question. Their account is compatible with my current experimental findings in which children showed significantly different performance between the contexts which do match to target test sentences (yielding 'yes' as their right answer) and those which do not match to them (yielding 'no' as their right answer). Their performance differentiates between the former and the latter. Further, the youngest children, around the age of 4, and the younger 5 year olds, performed significantly better than the older children. From the results, it can be assumed that children as young as 4 years old have appropriate knowledge of quantification. However, the existence of spreading errors at the ages of 4 and 5 (the rest of the children in the age groups 4 and 5, that is, 30 children except the 4 superior children in Experiment I and 31 children except the 11 superior children in Experiment II) indicates that the relevant syntactic rules have not been completely mastered yet at this stage.[5] In addition, however, pragmatic factors seem to be operating here. I assume that aspects of the acquisition of quantification, just like the coreference aspects of Principle B, involve pragmatic considerations.

[5] See Kang (2000) for discussion of the relevant syntactic rules, the functional status of quantifiers and their syntactic position as a left-branch item.

It has been reported that pragmatic effects appear late in acquisition, later than syntactic knowledge. For example, Grodzinsky & Reinhart (1993) report that they appear around the age of 6. On this view, children may make mistakes on certain tasks, even though they have the relevant grammatical knowledge, because the mistakes are due to pragmatic factors. From the evidence of the current experiments, where some children as young as 4 years old performed perfectly on all the different groups, it can be assumed that children at the age of 4 can have grammatical knowledge of quantification, say, the status of a quantifier as a functional head of DP and the Left-Branch Condition. In contrast, it can be assumed that the experimental results leading to the poor scores on the tasks, especially by the older 6 and 7 year old children, and also the fact that they gave many more 'no' responses, are to be attributed to pragmatic factors. On this view, the errors made by younger children and the errors made by older children have to derive from different sources. The former are attributable to a deficiency of grammatical knowledge, whereas the latter are due to the interference of pragmatic factors, even though relevant grammatical knowledge is available.

Here I argue that the pragmatic factors are a function of the central systems. On the basis of their interpretation of the stimulus pictures, children are preoccupied with the individual entities available in the picture and find specific items from it, matching one to one between agents and objects, when they listen to the test sentence. The visual input plays a predominant role in children's comprehension. At the same time, the quantifier, for example, *every*, in the test sentence is salient enough to provide them with enough information in a mismatching situation to make them answer in the negative without thinking further. Children take the quantifier to be salient, introducing new information. As a result they overgeneralise its scope to include objects which, while not mentioned, are depicted. As for the phenomenon of quantifier spreading, in the process of integrating conceptual representations and representations produced by the language faculty, pragmatic (cognitive) influence is stronger than syntactic influence; that is, conceptual factors are more strongly acting than grammatical factors. On this view, it is hypothesised that learning in at least three domains is needed for children's development: first, they need to acquire syntactic knowledge; second, they need to master the pragmatic considerations; and finally, they need to learn that pragmatics cannot overrule syntax. The majority of children involved in the current experiments, at the ages of 6 and 7, are in the second phase in which they are struggling with pragmatic misunderstanding. I assume that from the evidence of the current experimental data, children at the age of 4 (at latest 5) have syntactic knowledge of quantification, but this knowledge is masked by the emergence of pragmatic consideration around the age of 6. Conceptual representations predominate over grammatical knowledge, leading to the spreading errors. Gradually, as soon as they learn the third phase, when their

grammatical knowledge becomes sufficiently established to get rid of the overruling pragmatic facts, the phenomenon of quantifier spreading should disappear. While it is not obvious that Karmiloff-Smith's explanation of the behavioural mastery (in terms of the transition from an *implicit* to an *explicit* form of representation) generalises to the syntactic domain, (for discussion, see also Smith, 1994), some version of her account may well be relevant in the current 'mixed' domain where both visual and linguistic stimuli have to be integrated.

5 Conclusion

I conclude that age-related differences in spreading errors in the interpretation of quantifiers by children have to be explained from two different sources. The finding from the current experiments that younger children at the ages of 4 and 5 performed significantly better than the older children at the ages of 6 and 7 gives rise implicitly to the classic pattern of a U-shaped developmental curve. On the view that pragmatic considerations are mastered late in acquisition, later than syntactic knowledge, it is assumed that the high rate of spreading errors by older children is attributable to the interference of pragmatic factors. In other words, the errors by younger children at the ages of 4 and 5 are attributed to a deficiency of relevant grammatical knowledge, whereas the errors by older children at the ages of 6 and 7 are due to the interference of pragmatic (cognitive) considerations which cause some confusion in the use of their existing grammatical knowledge. From this perspective, I claim that children need at least three phases of learning to cope with quantification: the relevant grammatical knowledge; then the deployment of pragmatic considerations; and finally understanding of the fact that pragmatics cannot overrule existing grammatical knowledge. From the current experimental results, it seems that this mastery does not happen until after 7 years or so.

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