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Young children's difficulty with adjectives modifying nouns*

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ABSTRACT

In two experiments we tested the hypothesis that children have a basic problem in mastering the attributive relation because it involves a two-step logical–semantic integration process of the head-noun and the attributive adjective. Hebrew-speaking children were asked to interpret highly familiar adjective–noun combinations by selecting a photo that depicted the correct referent. In Experiment 1 there were four choices for each adjective–noun pair: correct object/correct property, correct object/wrong property, wrong object/correct property, wrong object/wrong property. 170 children (1;6–4;4) participated. Analyses of errors and spontaneous self-corrections indicated that children initially ignored the adjective and based their responses only on the noun. In Experiment 2, in addition to the 4-choice condition, there were two simpler conditions with only two choices: the correct object/correct property, and either the correct object/wrong property, or the wrong object/correct property. 30 children (1;9–4;11) were tested. The children, and in particular the lowest-scoring third of the sample, did significantly better in the 2-pictures conditions. The results suggest that young children do possess a basic adjective vocabulary and can use it in simple discriminations, but have a considerable difficulty in integrating the information furnished by the adjective with information furnished by the noun.

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INTRODUCTION

Why is attribution complicated?

The aim of the present study was to explore the possibility that children experience special difficulties in the acquisition of the attributive adjective–noun relation because of its complicated logical structure. Logicians such as Montague (1974: 211–13) have pointed out that attribution is not the intersection of the set defined by the head and of the set defined by the modifier; rather, it consists of the definition of a subset within the set defined by the head of the combination. Namely, an attributive adjective (with a few exceptions) generates a subkind of the referents of the common noun. If we translate logical linguistics to psycholinguistic processing, it follows that the meaning of a referential expression consisting of an attributed noun must be computed in two stages: first, the noun must be interpreted, creating a category of kinds of objects; then, the adjective must be interpreted relative to the noun, creating a subset of the object category consisting of such objects that also possess the property designated by the adjective. In adults, this two-step procedure has been automatized and it is performed without conscious awareness of its separate stages. It is expected that the multi-step procedure and the complex integration of information involved in the generation of a subset would be a source of difficulty for children faced with adjectival modification.

Relative to attribution, other kinds of grammatical relations are much simpler to compute. Valency-required complements such as subjects, direct objects or dative objects of verbs contribute to the meaning of the word-combination pieces of information required *a priori*, that get their interpretation from the semantics of the verb. Each verb contributes a finite list of dependent 'slots' to the sentence which have to be filled in parsing the sentence. The semantic relation between a head and an *a priori* complement is thus much more straightforward than the optional modificatory relation such as exists between a noun head and an attributing adjective, where the modifier is the element defining its semantic contribution to the combination (Hudson, 1990: 202–11).

Another way to express the same complication is to point out that attribution reverses the natural hierarchy between logical functors and their arguments: in this grammatical relation, the logical functor is not the syntactic head of its logical argument but rather its syntactic dependent (Vennemann, 1977). This reversal is expected to increase the complexity of the developmental task of mastering the attributive grammatical relation (Ninio, 1995). In addition, the acquisition of adjectives as vocabulary items could also be negatively affected by their complicated pattern of syntactic behaviour: while in attributive word combinations, the adjective is dependent on the noun, in predicative word-combinations, adjectives are the

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syntactic heads of the noun. This means that children do not receive from the input an unambiguous message about the nature of the semantic contribution of adjectives to the sentences they appear in.

The complicated two-step process involved in the attributive use of adjectives predicts that children's difficulties with it would be manifested in two ways: avoidance of the construction in spontaneous production; and errors showing a failure to complete the two-step process in comprehension. In the following, these expectations are presented in detail and the existing evidence is reviewed.

Delayed production of attributive adjective–noun combinations in spontaneous speech

As to production, it is expected that children would not spontaneously produce attributive adjective–noun combinations in their speech at the earlier stages of development but that such word-combinations would be delayed relative to other kinds. The lateness of emergence and the avoidance of use of such word combinations would indicate their high level of difficulty for the young child.

The results of previous studies on children's acquisition of adjectives and attribution indicate that young children are indeed late in producing attributive noun–adjective word combinations in their spontaneous speech, relative to other types of word combinations. The mastery of adjectival attribution lags behind the expression of other kinds of grammatical relations such as predication and complementation, including predication with adjectives. This delay has been commented on in many discussions of children's early multiword speech. For example, Braine (1976: 76) commented that his subjects' early adjective–noun combinations were not used attributively but in all probability, predicatively. He said Jonathan's attributive-like expressions such as *big stick* or *little stick* were comments on properties of indicated objects, and were used to predicate size. Formally, they were equivalent to sentences, and did not create noun-phrases consisting of modified nouns. He suggested that for utterances like *hurt plane* or *old stick* the best paraphrase is with a copular sentence: 'the plane is hurt', 'the stick is old'.

Similarly, Tomasello (1992) reported that his subject Travis did not incorporate modified nouns into her initial three-word combinations, and that there were virtually no adjective-modified nouns in her longer utterances for a considerable period. This was rather surprising as Travis did produce adjective–noun combinations in her two-word stage. However, a close inspection of the relevant utterances in the corpus revealed that in all probability these expressed a relation of predication by the adjective and not a relation of modification. For example, the sentence *Good beer*, said on her

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stealing a sip from a bottle at 1;7.04, seems much more likely to be a claim that the beer was good or tasty than a claim that the beer she sipped was of a good rather than a bad kind. In fact, none of Travis' two-word combinations with an adjective, whether pre- or post-nominal, functioned contrastively, to refer to a specified alternative out of two or more possible referents for the common noun.

Evidence for the developmental lag of attribution also comes from two studies explicitly dealing with this subject, in which children's spontaneous productions with adjectives were classified into predicative and attributive uses. Nelson (1976) found that adjectives in the speech of children aged 2;0 to 2;6 were mostly predications. She based the classification into predicative vs. attributive adjectives mainly on the placement of the adjective relative to the noun – i.e. postnominal placement was classified as predicative. In addition, she classified adjectives appearing by themselves as single-word utterances as predicative. Children in the early stages of generating word combinations, with an MLU of 1·0–2·5, produced mostly predicative utterances; attributive uses increased in frequency as MLU increased. In the more advanced group (MLU 2·5–4·5) their frequency rose to about 60%. Nelson summarises (1976: 28–9) that at first, adjectives are used to comment on transient states of objects, not as a mode of classification.

In a second study (Hasman, 1995; Ninio, 1995) the focus was on children's multiword utterances and single-word uses of adjectives were not included in the analysis. The spontaneous speech of Hebrew-speaking children was examined for the use of adjectives. The speech corpora were collected in a staggered longitudinal study of the acquisition of Hebrew (Ninio, 1984) in which 24 children were observed once every two months, a third of the sample each between the ages of 1;0–1;10, 1;6–2;4 and 1;10–2;8. There were no modified nouns in the children's spontaneous speech before 1;10, and in fact 8 of the children never produced a single utterance of the relevant kind before the observations ended. By contrast, the earliest age at which predicative uses of adjectives were observed was 1;6, and the majority produced their first exemplar at 1;10 or before. Predicative uses of adjectives emerged significantly earlier than attributive uses (in 15 of 16 children, $p < 0{\cdot}001$ by binomial sign test). In addition, by the time the first exemplar of attributive uses of adjectives appeared, all the children had already produced multiword combinations involving other kinds of predicate words, and it is clear that attributive word-combinations lagged behind predication and valency-complementation in children's spontaneous productions.

The major weakness of the production studies is that the categorisation of adjective–noun word-combinations into predicate vs. attributive is often speculative rather than well-grounded. Nelson's (1976) study, for example, rather begged the question that all single-word utterances consisting of an adjective were predicative. Even when a study concentrates solely on

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multiword combinations such as Hasman (1995), the clear cases are often outnumbered by the ambiguous ones. It may be obvious that when an adjective accompanies a personal pronoun or a demonstrative such as 'this', the result is a predicative construction. But in the case of adjective–common noun combinations, the classification into predicative or attributive use is far from clear, even with the best of contextual documentation.

We might summarize that previous studies have indicated that there is in all probability a developmental delay of attributive adjective–noun combinations in production, but it is very difficult to prove this conclusively due to the difficulty of classifying young children's spontaneous utterances with adjectives and nouns as predictive or attributive.

The way to avoid the classificatory problem is to focus on comprehension rather than production. Children's linguistic skills regarding the interpretation of attributive adjective–noun combinations have not been previously investigated and the present study was carried out to address this question for the first time.

It is worth mentioning that there have been in the last decade numerous studies of the development of adjectives in young children (e.g. Gelman & Markman, 1985; Waxman & Klibanoff, 2000; Mintz & Gleitman, 2002 and more). The question these studies address is not the acquisition of attribution but the word-to-concept mapping problem raised by adjectives as lexical items; their goal is to find out whether children know that adjectives refer to properties of objects and not, for example, like nouns, to the objects themselves. Nevertheless, the results of the present study and those of the mapping studies are expected to shed light on each other, and this theme will be discussed at the appropriate time.

The hypotheses of the present study regarding children's comprehension of attributive adjective–noun combinations

The goal of the present study was to explore the possibility that young children experience special difficulties in the comprehension of attributive adjective–noun word-combinations and that their difficulties can be tied to the complicated two-step process which, according to the theory, the interpretation of attribution demands. In Experiment 1, we presented children with four colour photographs of extremely familiar everyday objects with varying natural attributes, each foursome representing two objects crossed with two attributes. We described one of the pictures with an adjective–noun combination using extremely familiar nouns and adjectives, and asked the child to point to the picture. The task of the child was to choose the picture described, from among the four alternatives.

The strategy was to eliminate, *a priori*, the possibility that children fail at the task because they do not know the words used, because the objects are

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unfamiliar or because the properties look odd on the relevant objects. The nouns and adjectives we used were culled from among the earliest words observed in spontaneous speech. All the depicted object-attribute combinations were natural ones, such as white and black shoes, long and short dresses and the like, including objects most likely to be familiar to children at this age group. We hoped by this strategy to make the task as easy as possible, if only the child knew how to interpret an attributive adjective–noun combination. The comprehension task, in other words, was geared to the mastery level of a beginner.

Given our hypothesis that the source of the difficulty with interpreting attribution is the complexity of the two-step process, in the first place we expected to see that, in a comprehension task, children make errors that reflect a tendency not to go through the correct two-step procedure but to stop with the creation of the first, object, category. To remind ourselves, the first step in the interpretation process necessary for comprehending an attributed noun is the generation of an object category; only then is it possible to generate a sub-category of the object-set, taking into account the property represented by the adjective. Hence if children cannot go through a two-step procedure but only a one-step one, it is most likely that they would consistently base their interpretation only on the noun of the word-combination, ignoring the adjective completely. Such a comprehension strategy would result in random choices as far as the property conveyed by the adjective is concerned, while the choices would be much more accurate with respect to the referent of the noun, whether it is an object label or a shape-label.

A second possibility, much less likely, is that children would ignore the noun and base their choice of referents only on the adjective. This means that in a forced-choice situation, the child would pick randomly one of the stimulus objects possessing the relevant property. For example, when asked to point out a red candy, they would randomly choose either a red candy or a red block, but not other-coloured objects. According to the model of two-step interpretation we have embraced, this kind of choice is quite unlikely and expected to be very rare: properties are secondary to objects, and children should find it difficult to make a choice based on partially understanding that they were asked to find 'something red'. Thus the two kinds of reduction errors are expected to be asymmetrical in children's performance in a comprehension task: the choice of correct objects but with incorrect properties is expected to be a frequent error, while the choice of incorrect objects but with the correct property is expected to be rare.

In addition, the 'two-stage model of difficulties' also predicts that even if young children understand that they have to compute the meaning of the adjective–noun combination in two ordered stages, they may have difficulty with the automatization of the two-step process. Namely, the children

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might arrive at the correct interpretation eventually, but will do it in two separate moves instead of a single streamlined one like adults and older children do. In the first move, they will choose solely on the basis of the noun, so the choice will be correct on the object-set but the choice of the attribute will be random – correct on half the choices but incorrect on the other half. In the second move, children will process the adjective, check the property on their first choice, and if the first choice was of the wrong attribute, and if they are given the opportunity, they will correct themselves and choose the right combination of object and attribute.

To summarise our expectations regarding the two measures analysed in this study, namely, children's first choice and their self-corrections, we expect that their first choice will be object-oriented while their subsequent self-corrections will be attribute-oriented. Thus the patterns of correct response and errors constituting the first choice will show the traces of an asymmetrical focus on getting the object-category right, while their self-corrections will deal, disproportionally, with getting the property right, and most will be a correction of a previous wrong choice of property with the correct object.

Attribution in Hebrew

In the present study, the children studied were Hebrew-speakers. As there is large crosslinguistic variation in the size of the form-class of adjectives (Dixon, 1977) as well as in their syntactic behaviour (Lehmann, 1984), it is worth noting that adjectives in Hebrew are very similar to their English or French counterparts. There is a large open class of adjectives in Hebrew, some related to verbs roots but many derived from nouns, e.g. *rashi*, 'chief' from *rosh*, 'head'. As in English, adjectives can play a predicative as well as an attributive role *vis á vis* the noun. In both cases, the adjective agrees in gender and number with the head-noun. The attributive adjective is post-nominal. For example, the phrase 'big teddy' translates to the Hebrew *dubi gadol*, *dubi* is 'teddy' and *gadol* is 'big'. Although Hebrew is moderately flexible in its word-order as far as the positioning of the verb's complements (subject, direct object, indirect object) are concerned, the ordering of the noun-phrase is quite rigid, and it is impossible to change the relative order of the head noun and the adjective-modifier. In addition, Hebrew does not require a copula in the present, and the canonical order of the predicative combination with the noun and adjective is the same as the attributive, resulting in an almost identical word-combination. The single difference is in the articles: in the attributive combination, when the referent is definite, both noun and adjective get the pro-clitic article *ha-* as in *ha-dubi ha-gadol* '*the big teddy*', while in the predicative combination the subject-noun but not the predicate adjective get the article: *ha-dubi gadol* '*the teddy*' [*is*] *big*'.

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These are relatively subtle differences and a young child might not register the unstressed clitic article at all. It follows that young children might be unable to distinguish attributive and predicative combinations of noun and adjective for some time, which probably contributes to the developmental difficulty of acquiring adjectives.

EXPERIMENT 1

METHOD

Subjects

In Experiment 1, 170 Hebrew-speaking children (1;6–4;4) were tested for their comprehension of attributed nouns. The children were recruited for the most part through kindergartens and other daycare establishments, both urban and rural. Parents completed a short demographic questionnaire describing the child's gender, birth date, birth order and number of siblings; the languages besides Hebrew spoken at home, as well as the parents' level of education. The first 70 children (reported in Ninio, 1995) were between 1;7–4;4, half of them male, half female. The other 100 (51 male, 49 female) fell into 5 age groups (1;6–1;11, 2;0–2;5, 2;6–2;11, 3;0–3;5, 3;6–4;0), 20 per group, with an approximately equal number of males and females. The mean age of the children in the complete sample was 2;8 (*S.D.* 8·3 months). The sample was heterogeneous with respect to children's number of siblings and birth orders and the parents' educational level.

The procedure and stimulus materials were pretested on 12 children, 1;8–3;7, of the same background as the actual sample.

Stimuli

The stimuli were 12 big cardboard pages (28 cm × 38·5 cm) showing a square array of 4 colour photographs (10 cm × 15 cm) each, in a 2-by-2 design of two objects crossed with two attributes, e.g. a big teddy, a small teddy, a big clock and a small clock. The placement of the pictures in the square was randomised.

Children were asked to point to one of the pictures, referred to by an adjective–noun combination such as 'Show me the big teddy'. Table 1 presents the stimulus nouns and adjectives used. All the nouns and adjectives were highly familiar. They were culled from the words most frequently produced in early Hebrew mother–child conversations, as observed in naturalistic home observations (Ninio, 1984).

PROCEDURE

The experiment was conducted in individual sessions. The experimenter and child sat facing each other at a table. The experimenter placed the

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TABLE 1. *Stimulus nouns and adjectives used in the 4-picture comprehension experiment*

	Nouns		Attributes	
	Hebrew	Gloss	Hebrew	Gloss
1	*naal*, *gerev*	shoe, sock	*levana*, *shora*	white, black
2	*regel*, *naal*	foot, shoe	*nekiya*, *meluchlechet*	clean, dirty
3	*dubi*, *shaon*	teddy, clock	*katan*, *gadol*	small, big
4	*ima*, *yalda*	mommy, girl	*era*, *yeshena*	awake, asleep
5	*bakbuk*, *sal*	bottle, basket	*male*, *rek*	full, empty
6	*limon*, *ale*	lemon, leaf	*yarok*, *cahov*	green, yellow
7	*sukariya*, *kubiya*	candy, block	*aduma*, *khula*	red, blue
8	*yeled*, *lecan*	boy, clown	*sameax*, *acuv*	happy, sad
9	*yalda*, *buba*	girl, doll	*aruma*, *levusha*	naked, dressed
10	*kapit*, *simla*	spoon, dress	*kcara*, *aruka*	short, long
11	*tapuax*, *avatiax*	apple, watermelon	*shalem*, *hatuch*	whole, cut
12	*iparon*, *makel*	pencil, stick	*kacar*, *aroch*	short, long

cardboard pages one by one before the child so that the photographs were oriented toward the child, and asked the child to point to one of the pictures, using the Hebrew version of the format 'Show me the AN' ('*Tare li et ha*-NP'), e.g. 'Show me the big teddy' ('*Tare li et ha-dubi ha-gadol*') or a where-question, e.g. 'Where is the big teddy?' ('*Efo ha-dubi ha-gadol?*').

The questions were randomized with respect to the pictures, so that for a particular stimulus page, a quarter of the sample was asked to point out each of the four alternative pictures. In addition, the order of the pages was randomized, and two different orders were used, each for half of the sample. In total, there were 8 different design conditions differing by page order and the pictures asked about, to which the sample was randomly allocated.

The experimenter recorded children's choices of picture and any non-trivial utterance. Children were not given feedback on the correctness of their choices. Spontaneous corrections were recorded but not commented on. There was no time pressure on the children and a particular cardboard page was removed and a new one placed before the child when it was clear that the child had finished dealing with the old page. If a child did not respond, the experimenter asked the same question again, not varying the wording of the request. A few children refused to complete the test, and they were not included in the sample. Children who did not answer some of the questions after attending to the relevant pictures but who then continued to cooperate on the test were included in the sample, with their unanswered questions counted as failures. In the whole sample, there were a total of 6 unanswered questions.

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RESULTS AND DISCUSSION

Success rate

Level of success at the task was estimated on the basis of the children's first choice. The average correct score based on children's first choice was 7·08 out of a possible 12, namely, 59·0% (*S.D.* 21·1). Checking the individual results, it appeared that the vast majority of the children failed at one or more of the 12 items of the comprehension task. Only 10 children of the 170 tested got a perfect score of 12. Their ages were between 3;0–4;4, mean 3;8 (*S.D.* 5·3 months). There were 48 children in the sample who were 3;0 or older; even at this older age range only about a fifth of the children managed to achieve a perfect score. Children's final choice was slightly more correct: the average success rate was 65·4% (*S.D.* 20·1).

The correct score had a significant correlation with age ($r = 0{\cdot}58$, $p < 0{\cdot}01$). The correlation, although significant, is not a very good predictor of the success of individual children as age explains only 34% of the variance in the scores. The correct score based on the final choice had a slightly lower correlation with age ($r = 0{\cdot}52$, $p < 0{\cdot}01$), age explaining only 27% of the variance in the scores. The correct-object-wrong-attribute scores had a $r = -0{\cdot}413$ correlation with age; the correct-attribute-and-incorrect-object scores had $r = -0{\cdot}26$, and the all-incorrect scores, $r = -0{\cdot}40$; all three significant at $p < 0{\cdot}01$.

Analysis of the errors in children's first response

The next set of analyses were aimed at explicating why the children erred in the comprehension task. The first analysis is of the errors children committed. We predicted that the errors in children's first response would be mainly in the attribute rather than in the object selected. The 4-picture task is built so that one distractor (or incorrect alternative) shows the same object as the correct picture but with a different attribute; the second distractor shows a different object but with the asked-for attribute; the last distractor shows a different object with a different attribute. The analysis thus can reveal if the children's erroneous responses nevertheless satisfy the identity of the object asked for, the identity of the attribute, or neither. Table 2 presents the distribution of responses in the sample.

Table 2 shows that the most frequent error was pointing to the picture that showed the same object as the experimenter asked for, but which had a different attribute (56·2% of all errors on the average). The mirror-image error in which the attribute requested was correct, but the object was wrong, was much less frequently made (25·3% of all errors). The difference between the two kinds of errors was highly significant by Wilcoxon signed ranks test ($z = -7{\cdot}196$, $n = 136$, $p < 0{\cdot}001$). In fact, the latter response was

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TABLE 2. *Distribution of responses in the 4-picture comprehension experiment* (n = 170)

Response	Mean # (*S.D.*)	Mean % (*S.D.*)	Percent of all errors
Correct noun and correct adjective	7·1 (2·5)	59·0 (21·1)	
Errors:			
Correct noun and wrong adjective	2·8 (1·9)	23·0 (15·6)	56·2
Wrong noun and correct adjective	1·2 (1·1)	10·4 (9·1)	25·3
Wrong noun and wrong adjective	0·9 (1·0)	7·6 (8·8)	18·5
Total	12		

barely more frequent than the choice of the all-wrong distractor which was correct neither on the object nor the attribute (18·5% of all errors).

We also examined the pattern of errors within children. There were 160 children who made at least one error in the task. In 111 children (69·4%) there were more errors on the attributes than on the objects, in 25 children (15·6%) there were more errors on the objects than on the attributes, and in 24 children (15·0%) there were the same number of errors of the two kinds. The difference is highly significant by binomial test ($z = -7{\cdot}29$, $p < 0{\cdot}001$). As we predicted, the majority of children erred more on the attributes they picked than on the objects.

In order to explore more closely the relation between the different kinds of errors and the rate of success, we plotted the average number of different errors as a function of the number of correct choices out of 12. Figure 1 presents the results.

Throughout the scale and with one small exception in the higher scores' range, the tendency to pick the picture with the correct attribute but the incorrect object was not higher on the average than the tendency to pick the completely incorrect distractor. These alternatives each accounted for 2 answers or less (out of 12), the tendency to choose them decreasing slowly to zero as the correct score increased from 2 to 12. The similarity of these two alternatives suggests that picking a picture with the correct attribute but the incorrect object was a random choice, just like picking the completely incorrect distractor, and that it was made when children failed at the relevant question.

By contrast, the tendency to pick the distractor in which the correct object was depicted but with the wrong attribute, accounted for a full half of the answers produced by the lowest-scoring children. This tendency decreases linearly as we progress towards the all-correct end of the scale. It is evident that a higher number of correct answers is strongly associated with a lower number of incorrect answers of the correct-object/incorrect-attribute type: The correlation between them is $r = -0{\cdot}752$. By comparison,

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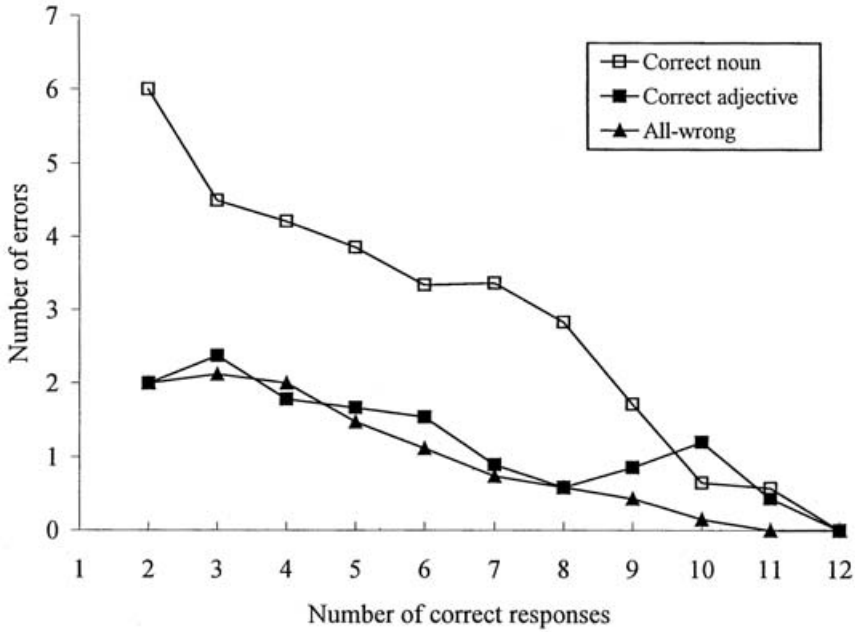


Fig. 1. Errors as function of number of correct responses.

the correlation of number of successes with the other partly erroneous answer, namely, correct-attribute-and-incorrect-object, is only $r = -0{\cdot}44$, showing that the increase in successes is much less strongly associated with the decrease in this type of error than in the correct-object-only kind. (The two types of partly-correct answers do not correlate significantly, $r = -0{\cdot}101$.) This suggestion is followed up in detail in the next section.

Using adjective information vs. noun information in the choice of pictures

The frequent choice of pictures showing the correct object but with an incorrect attribute by the less successful children in the sample lends support to the hypothesis that these children do not pay attention to the adjective. The first way to test the hypothesis formally is to compare children's overall success in picking a picture showing the object referred to by the noun, with their overall success in picking a picture showing the attribute referred to by the adjective. We expected that correct-noun choices would outnumber correct-adjective choices, at all levels of task performance except for the perfect one.

For each child, we computed two new scores: a correct Noun score, the percent of correct choices of the object whether or not they are also correct

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on the attribute; and a correct Adjective score, the percent of choices correct on the attribute, whether or not they are also correct on the object. In the whole sample, the mean percent of correct Noun choices was 82·0% (*S.D.* 13·9), while the mean of correct Adjective choices was 69·4% (*S.D.* 18·9). The difference was tested using a Wilcoxon signed ranks test and found to be highly significant ($z = -7{\cdot}196$, $n = 136$, $p < 0{\cdot}001$).[1]

There was a floor effect for the Noun scores: There were no children who picked less than 5 pictures where the object was the correct one, so the minimum was a 41·7% correct rate. By contrast, the range of Adjective scores was much larger, 2 to 12. We might summarise that at the age range tested (1;6–4;0) children are much more successful in identifying the object referred to by a noun than picking out a property referred to by an adjective.

Second, on the hypothesis that attention to adjectives is crucial to correct performance of the comprehension task, it is expected that the proportion of Adjective choices will strongly predict the success rate. This was found to be correct: the tendency to make correct Adjective choices explained 82% of the variability in the comprehension task; the correlation coefficient was $r = 0{\cdot}90$ ($p < 0{\cdot}001$). By contrast, correct Noun choices explained only 45% of the variability in the comprehension task ($r = 0{\cdot}67$, $p < 0{\cdot}001$).

In order to be sure that the pattern of results was not due to children's age, the same correlations were re-computed, this time controlling for age. The results were extremely similar to the above, and only slightly lower: the tendency to make correct Adjective choices explained 74% of the variability in the comprehension task, age-controlled; the correlation coefficient was $r = 0{\cdot}86$ ($p < 0{\cdot}001$). The correct Noun choices explained only 34% of the variability in the comprehension task, age-controlled ($r = 0{\cdot}58$, $p < 0{\cdot}001$). The ratio between the percent of variance explained by the two factors remained very similar; around twice as much attributable to the Adjectives than to the Nouns, whether or not we controlled for age. The results of the correlation analyses show once again that age, by itself, is not a factor explaining the differential correct rate of nouns and adjectives in this study and its relation to the success of the comprehension task. As controlling for age did not significantly alter the pattern of results, in the following we shall continue presenting the original scores, regardless of the age of children.

Figure 2 presents the average Noun and Adjective choices as a function of total correct scores.

[1] This is the same test that was reported above for the difference between the number of errors in which the object was correct but the attribute wrong, and the errors in which the attribute requested was correct but the object was wrong.

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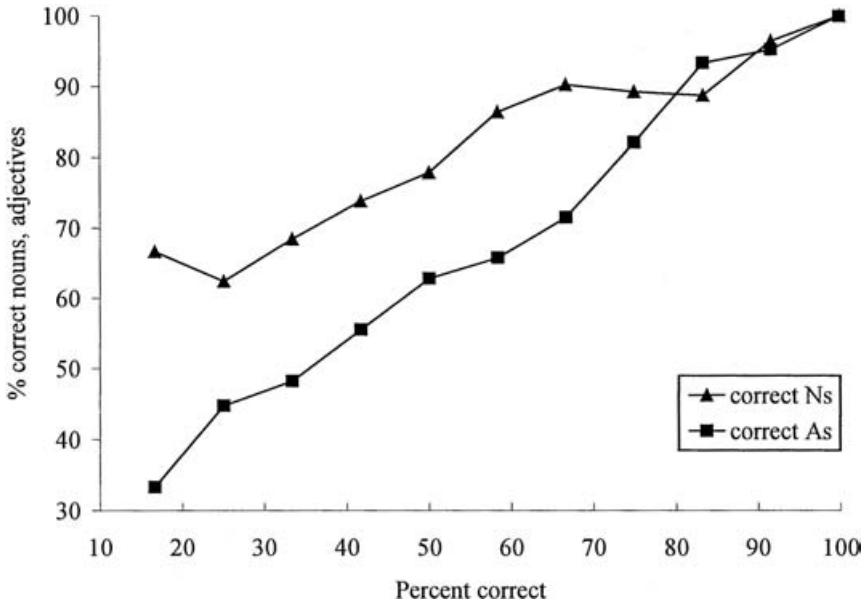


Fig. 2. All responses correct at least on the noun or the adjective.

Figure 2 shows that the children with very low correct scores fail at the task not because they do very badly on the nouns but because they perform extremely badly on the adjectives. This is, of course, expected on the basis of the correlation coefficients presented above. The difference between the success rate on nouns and adjectives becomes smaller as the children succeed better on the comprehension task ($r = -0{\cdot}41$, $p < 0{\cdot}001$). Repeating this correlation when age was controlled for resulted in a very similar coefficient ($r = -0{\cdot}36$, $p < 0{\cdot}001$).

It seems that the factor restricting children's ability to answer the comprehension request correctly is their failure to identify the referent of the adjective. The results support our hypothesis that at the start of development, initially children IGNORE the adjective and base their answers solely on the noun of the request. Increased success in the comprehension task appears mostly to be due to increased attention to the adjective-word, taking it into consideration when choosing between the correct picture and the one showing the same object but with a different attribute.

To further test this possibility, we estimated the conditional probability of choosing the correct attribute given that the child has chosen the correct object, as well as the parallel conditional probability for correct objects. In order to make it possible to focus on the weakest performing children, we divided the sample into thirds, according to the total number of correct

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TABLE 3. *Conditional probabilities of correct attribute and correct object in three thirds of the sample in the 4-picture comprehension experiment*

Sub-sample	*n*	Probability of correct attribute given correct object	Probability of correct object given correct attribute
Lowest third	57	0·53	0·72
Middle third	57	0·68	0·86
Upper third	56	0·91	0·93

choices out of 12. The average success rates in the 3 thirds were 37·0, 56·6 and 83·8%. Table 3 presents the results.

In the lower third of the sample the children apparently picked at RANDOM one of the pictures showing the correct object, choosing either the correct picture or the alternative with the same object but a with a different attribute. In the same subgroup, the conditional probability of the correct object being picked given the correct attribute was higher by 20%. The difference was tested using a Wilcoxon signed ranks test and found to be highly significant ($z = -5{\cdot}13$, $n = 48$, $p < 0{\cdot}001$). Similar results were obtained when comparing the conditional probabilities in the middle third of the sample ($z = -5{\cdot}46$, $n = 51$, $p < 0{\cdot}001$). However, in the highest third of the sample there were no significant differences between the conditional probabilities of the adjective and the noun ($z = -0{\cdot}67$, $n = 37$, $p > 0{\cdot}05$). In order to test the interaction of the difference between the conditional probabilities and the subsample, a difference score was computed for each child: conditional-probability-of-correct-attribute minus conditional-probability-of-correct-object. The means of these scores were compared between the lowest third of the sample and the middle third, using a t-test approximation. The difference was not significant ($t(112) = 0{\cdot}165$, $p > 0{\cdot}05$). Then, the middle third and the highest third of the sample were compared, and here the difference was highly significant, with the highest-scoring subsample having significantly lower differences between the conditional probabilities than the middle sample ($t(111) = 5{\cdot}56$, $p < 0{\cdot}001$). These results support the possibility that poorly-performing children base their first answers solely on the noun in an attributed-noun expression, ignoring the adjective. Mid-performing children increase their reliance on the adjective, but still much less than on the noun. Only the high-performing children pay equal attention to the noun and the adjective.

The analysis of spontaneous self-corrections

The results up till now support the notion that development of the comprehension of attributed nouns consists of children's increasing the probability of paying attention to the adjective as well as the noun. These results were

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TABLE 4. *Self-corrections by children in the 4-picture comprehension experiment* (n = 292)

Change	Element changed	Number of corrections (%)	Number of children
Improving the match		**219 (75·0)**	
Noun-correct to All-correct	attribute	133 (45·5)	79
Adjective-correct to All-correct	object	36 (12·3)	29
All-wrong to Noun-correct	object	12 (4·1)	11
All-wrong to Adjective-correct	attribute	18 (6·2)	17
All-wrong to All-correct	object and attribute	20 (6·8)	17
Spoiling the match		**61 (20·9)**	
All-correct to Noun-correct	attribute	39 (13·4)	35
All-correct to Adjective-correct	object	10 (3·4)	9
Noun-correct to All-wrong	object	3 (1·0)	3
Adjective-correct to All-wrong	attribute	6 (2·1)	6
All-correct to All-wrong	object and attribute	3 (1·0)	3
No change in degree of match		**12 (4·1)**	
Noun-correct to Adjective-correct	object and attribute	7 (2·4)	6
Adjective-correct to Noun-correct	object and attribute	5 (1·7)	5
TOTAL		**292**	**118***

* Number of children making at least 1 change of any kind.

obtained using children's first choice of pictures. We have hypothesized that concentration on the noun and the object-set it refers to represents the first phase of the two-step process of computing the meaning of an attributed noun. We now turn to testing our second hypothesis, according to which some children who fail at the task, may be able to complete the second step of the two-step process in which the adjective restricts the object-set, but they will do it only as an overt second response following the initial choice of the correct object-set. This hypothesis is to be tested by an analysis of children's spontaneous self-corrections which were made following their initial choice.

Of the 170 children of the sample, 118 changed their initial response to one or more of the questions, producing 292 self-corrections in all. Children's second and further choices were mostly an improvement on their original responses (75%), whether in terms of the object, the attribute, or both, but there was also quite a significant percentage (21%) of self-corrections which worsened the quality of the match between the question and the picture chosen. Only a few self-corrections (4%) switched between two partially correct responses. Table 4 presents the detailed data. It is worth noting that even when self-corrections are also taken into account, the percent correct score in the sample was only about 65% on average.

Of all spontaneous self-corrections which brought about an improvement in the match of the chosen picture to the request, 178 were corrections of an

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error in the attribute, 73 were corrections of an error in the object, so that of a total of 251 improvements, 70·9% were related to the attribute. This is not, by itself, surprising, as the original choice of an attribute was worse than that of the object, so there were more incorrect attribute-choices to correct in the first place. However, the proportions recur when we look at the negative changes that spoiled an originally correct choice: of a total of 76 worsening changes, 53 or 69·7% were self-corrections in the attribute, and only 23 in the object. Obviously, we cannot use the same frequency explanation as for positive changes, as now there were FEWER originally correct attribute responses to spoil. It is more likely that the stronger tendency to change the responses with respect to the attribute, both positively and negatively, reflects the hypothesised second-step concentration on the attribute, after the first response focussed almost exclusively on the object.

The most frequent move of self-correction, 133 or 45·5% of all changes, was to replace a response which was correct on the noun but incorrect on the attribute, with a response which was correct on the noun and also correct on the attribute. Other types of self-corrections were much less frequently made. The fact that this was the favourite self-correction is not an artefact of the high frequency of the response which was being replaced, namely, the choice of a picture only correct on the noun. This response could have been replaced by two other possible choices but very seldom was: the move from the Noun-correct to an all-wrong choice was made only 3 times, and the move to a picture which was wrong on the object but correct on the attribute, 7 times. In other words, the favourite spontaneous change of response apparently represents a voluntary and non-random self-repair process, consisting of remedying an initial error in the choice of the adjective which the child is capable of correcting.

The mirror-image of this type of self-repair is the one in which a child initially picks a picture showing the correct attribute but with an incorrect object, then repairs the error of the object in a subsequent move. Such corrections were made in 36 cases, i.e. in 12·3% of the time there was any self-repair. This route of arriving at a correct answer is much less often observed in the sample than the object-first, attribute-later one discussed above.

SUMMARY

The results of Experiment 1 show that young children under 4;0 indeed have difficulties in comprehending adjective–noun attributive combinations, even when they are tested with a basic, highly frequent noun and adjective vocabulary and with coloured pictures showing everyday objects. The difficulty seems to lie specifically in the interpretation of the modification grammatical relation, namely, in the syntax and semantics of the combination,

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and not in the lexicon. It appears that children have a specific problem with integrating the noun information with the attributive-adjective information.

The pattern of results supports a model of performance in which children, when faced with a referential expression consisting of an attributed noun, initially ignore the modifying adjective and concentrate on matching the noun of the question with a picture showing the referred-to object. The self-correction results suggest that in many cases, children who base their answer solely on the noun, do possess the adjective-information necessary for a correct answer but are unable to utilise it at the same time that they generate the noun-based response. They apparently can make a correct choice based on either the noun or the adjective, but not on the two simultaneously. They can narrow down their original choice, based on the noun, to the correct alternative, but only in a subsequent step in which they chose between two pictures showing the same noun-named object, on the basis of the adjective. Their difficulty, then, can be narrowed down to the need to make these two steps simultaneously and covertly, as part of a single schema of interpretation of the attributed-noun. The adjective by itself would not cause a processing difficulty, and the reason why it is so much less well represented in children's responses to the 4-picture comprehension task is that they have a preference – based on the logic of attribution – to base their initial answer on the noun.

If this conclusion is correct, this means that children should do well in choice situations in which they are presented with attributed nouns but in which they can base their choice on the adjective alone, without having to integrate it with the noun. Such a situation occurs when the choice is among identical objects, differing only in their attributes. Under our analysis, when children are shown a big teddy and a small teddy and asked to point to the big teddy, they can safely ignore the noun of the request and concentrate on the property conveyed by the adjective. Their success rate in this situation should be much higher than the correct-rate for adjectives in the 4-picture situation, because the task allows treating the adjectives as individual referential terms and does not require them to combine the adjective with a noun in an attributive relation. In addition, the success rate in this condition should be identical to the success rate in the mirror-image condition in which two stimuli differ only on the object but not on the attribute. The advantage of nouns over adjectives found in Experiment 1 should disappear in the two-picture conditions.

These binary choices should be easy for children even if the elicitation question uses an attributed noun as before: they seem to make single-component choices anyway, ignoring the other word even when this leads to errors. Their difficulties should be manifested only in situations when the task calls for *bona fide* and unavoidable processing of the adjunct relation, as

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in the 4-picture, two-object choice task of Experiment 1. In order to test this possibility, a second experiment was carried out.

EXPERIMENT 2

Although the findings of Experiment 1 were suggestive, they did not show conclusively that children's problems with attribution were due to their difficulties with combining the meaning of the noun and the adjective rather than due to their not having the adjective words in their vocabulary. In order to narrow down the source of the problem more directly, another experiment was conducted with a within-child design which was hoped would help tease apart the lexical and the syntactic components of the attribution task. Under the hypothesis that children's problems are syntactic–semantic and not lexical, we expected them to perform better in a simple binary choice task requiring either the identification of the noun alone (with attribute controlled) or the identification of the adjective alone (with the noun controlled). Such tasks can be performed without having to actually interpret the attributed noun expression.

In Experiment 2 we placed the children in two conditions. The first was the same situation as in Experiment 1, requiring a choice among 4 pictures. The second was a condition in which only pairs of the original pictures were presented, differing either on the object or on the attribute. In the two-picture condition, we used exactly the same elicitation request as in the 4-picture condition, e.g. 'Show me the big teddy', so as to equate the apparent processing required to interpret a modified noun. However, because the 2-picture stimuli contrasted either the object or the attribute but not both, it was not strictly necessary to comprehend the whole phrase consisting of the attributed noun in order to respond correctly. If children indeed tended to try to solve the 4-picture comprehension task without it and hence made mistakes, this strategy could actually succeed in the 2-picture condition.

METHOD

Subjects

In Experiment 2, 30 Hebrew-speaking children (1;9–4;11) were tested for their comprehension of attributed nouns. The sample was similar in demographical characteristics to the earlier sample, except that the children were 4 months older on the average ($M = 3;2$, *S.D.* 9·8 months).

Stimuli

The stimuli were cardboard pages (28 cm × 38·5 cm) showing 4 or 2 colour photographs each. A complete stimulus set to be presented to each child

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TABLE 5. *Two-picture stimuli of Experiment 2 derived from the 4-picture stimuli*

	Four-picture stimuli pages	Two-picture stimuli pages		
	Original pictures	Derived set 1	Derived set 2	Contrast
1	white shoe, white sock, black shoe, black sock	white shoe, black shoe	white sock, black sock	adjective
2	clean foot, clean shoe, dirty foot, dirty shoe	clean foot, dirty foot	clean shoe, dirty shoe	adjective
3	small teddy, small clock, big teddy, big clock	small teddy, big teddy	small clock, big clock	adjective
4	wakeful mommy, wakeful girl, sleeping mommy, sleeping girl	wakeful girl, sleeping girl	wakeful mommy, sleeping mommy	adjective
5	full bottle, full basket, empty bottle, empty basket	full basket, empty basket	full bottle, empty bottle	adjective
6	green lemon, green leaf, yellow lemon, yellow leaf	green leaf, yellow leaf	green lemon, yellow lemon	adjective
7	red candy, red block, blue candy, blue block	red candy, red block	blue candy, blue block	noun
8	happy boy, happy clown, sad boy, sad clown	sad boy, sad clown	happy boy, happy clown	noun
9	naked girl, naked doll, dressed girl, dressed doll	naked girl, naked doll	dressed girl, dressed doll	noun
10	short spoon, short dress, long spoon, long dress	short spoon, short dress	long spoon, long dress	noun
11	whole apple, whole watermelon, cut apple, cut watermelon	cut apple, cut watermelon	whole apple, whole watermelon	noun
12	short pencil, short stick, long pencil, long stick	short pencil, short stick	long pencil, long stick	noun

was composed of 12 pages with 4 pictures each, and 12 pages with 2 pictures each. In 6 of the latter, the two pictures showed the same object but with a differing attribute (e.g. yellow leaf, green leaf); in the other 6, the pictures showed two different objects with a shared property (e.g. yellow leaf, yellow lemon).

The 4-picture set were the 12 pages which had been used in Experiment 1. They showed 4 pictures each in a 2-object × 2-attributes design. (For details see Table 1.) The 2-picture stimuli were derived from the 4-picture set, using copies of the same photographs. Each 2-picture page retained only a single contrast of the original, either a contrast of attributes for the same objects, or objects with the same attributes. For example, from the 4-picture page showing a yellow leaf, a green leaf, a yellow lemon and a green lemon, we generated two 2-picture stimulus pages with identical objects but contrasting colour, one showing a yellow lemon and a green lemon, the other a yellow leaf and a green leaf. Half of the original pages were divided into two new pages by the objects shown, the other half were divided by the attributes. Table 5 lists the pictures used in the 4-picture

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condition, and the two 2-picture stimuli derived from them. Overall, two balanced sets of 12 pages were created, each used with half of the sample.

Randomization

Two versions of the 4-picture stimuli were prepared, and two versions each of the two 2-picture sets listed in Table 5. The versions differed in the target picture asked about for each page, as well as in the order of the pages, which was randomized for each version. The combination of one of the 4-picture versions with one of the 2-picture versions comprised a complete stimulus set. The combinations were constrained so that a child was never asked an identical question (focusing on an identical picture) in the 4-picture and the 2-picture parts of the experiment.

PROCEDURE

The children were tested in two conditions in a randomized order. One condition consisted of 12 pages of 4-picture stimuli, the other, 12 pages of 2-picture stimuli. The procedure was identical in all other respects to that of Experiment 1.

RESULTS AND DISCUSSION

Comparison with the results of Experiment 1

The children of Experiment 2 did better on the 4-picture task than the children of Experiment 1 (Experiment 2: $M = 68{\cdot}9$, $S.D. = 20{\cdot}9$; Experiment 1: $M = 59{\cdot}0$, $S.D. = 21{\cdot}1$). The reason is probably the older age of the second sample. As in Experiment 1, the correct score on the 4-picture task had a significant correlation with age ($r = 0{\cdot}72$, $p < 0{\cdot}01$). A comparison of the scores by age group showed that the two samples were comparable in their average success rates.

The pattern of correlations predicting the 4-picture correct score was almost identical to that achieved in Experiment 1: the tendency to make correct Adjective choices correlated very highly with the scores of the comprehension task ($r = 0{\cdot}92$, $p < 0{\cdot}001$), while the correct Noun choices had a more moderate correlation with the comprehension scores ($r = 0{\cdot}63$, $p < 0{\cdot}001$). (When controlling for age, the coefficients were $r = 0{\cdot}84$, $p < 0{\cdot}001$ for correct Adjectives, and $r = 0{\cdot}56$, $p < 0{\cdot}01$ for correct Nouns, the controlling having only a slight impact on the results.) The respective correlation coefficients in Experiment 1 were 0·90 and 0·67. The similarity in these patterns of correlations shows there is a good replication of the results of the first experiment, and that in the sample of Experiment 2, as in Experiment 1, the correct interpretation of the adjectives is the key to the development of the comprehension of attributed nouns.

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TABLE 6. *Results of Experiment 2: percent correct responses in the two conditions and the results of Wilcoxon significance testing of differences*

Condition	Percent Correct (*S.D.*)	% Ns correct (*S.D.*)	% As correct (*S.D.*)	Difference % N–% A correct	Wilcoxon
2-picture	86·9 (10·6)	88·9 (12·6)	86·1 (15·8)	2·8 (18·6)	$W=-62$, $N=17$, $p>0{\cdot}05$, NS
4-picture	68·9 (20·9)	86·7 (11·9)	77·5 (19·8)	9·2 (19·2)	$W=-72$, $N=24$, $p<0{\cdot}05$
Difference 2–4pct	18·6 (15·3)	2·2 (13·3)	8·6 (14·8)	6·4 (21·7)	$W=-86{\cdot}5$, $N=26$, $p<0{\cdot}05$
Wilcoxon	$W=-9$, $N=25$, $p<0{\cdot}005$	$W=-63{\cdot}5$, $N=19$, $p>0{\cdot}05$ NS	$W=-30$, $N=20$, $p<0{\cdot}005$		

Differences between the 4-picture and the 2-picture conditions

Table 6 presents the detailed results of Experiment 2, including the results of Wilcoxon signed ranks tests of the significance of the differences between conditions (1-tailed), the difference between nouns and adjectives (2-tailed) and the interaction of condition with nouns vs. adjectives (2-tailed).

Children did much better in the 2-picture condition than in the 4-picture condition: there was a significantly higher success rate (87 vs. 69%). Only 3 children achieved a perfect 12 score on the 4-picture task. By comparison, 7 children, or about a quarter of the sample, achieved a perfect score on the 2-picture task. This result supports the hypothesis that children who make mistakes in the 4-picture comprehension task may still be able to operate with adjectives if the task does not rely on understanding the attributive grammatical relation.

The higher success rate by itself is not conclusive evidence that there is something specifically problematic in the processing demands of the 4-picture condition to do with the computing of the attributive grammatical relation. The 4-picture condition involves a choice of one out of 4 alternatives, while the 2-picture condition requires a choice only between two alternatives. The random choice baseline is 25% in the 4-alternative condition and 50% in the 2-alternative one; this by itself can account for the higher success rate in the latter.

However, there are good reasons to discount the alternative explanation that the difference between the two conditions lies in the greater chance of

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random success in the binary choices, or in some other crude processing differential which is unrelated to the issue of adjectives and attribution. First, there were significantly different results achieved with respect to the nouns and the adjectives of the experiment: there were no differences between the two conditions on the success rate of nouns while there were significant differences on the success rate of adjectives. Namely, the different demands of the two conditions selectively affected the performance rate on the correct choice of attributes, but did not affect the rate of correct choice of objects in the 4-picture condition relative to the 2-picture one.

Second, the success rates of nouns and adjectives were significantly different in the 4-picture condition (with nouns being better), but did not differ in the 2-picture condition. Namely, the lower identification rate of adjectives relative to nouns was specific to the 4-picture condition, and did not recur in the 2-picture control condition. It is important to remember that the 4-picture and the 2-picture stimuli used the same pictures and the same nouns and adjectives; the only difference was in the number of alternatives presented.

Taken together, the results show that there is an interaction between number of alternatives and type of information (noun or adjective) in their effect on the success rate: children did much better on the 2-picture task, and the locus of the effect is in the better performance with regard to adjectives. This interaction was found to be statistically significant. The whole difference between conditions and between nouns and adjectives was accounted for by the interaction between part-of speech and experimental condition, and there was no leftover main effect for either.

No such differential effects are expected on a model of brute processing-difficulty making for the differential overall success rate, as nouns and adjectives are completely parallel in their *a priori* probabilities in this experiment. These results strongly support the hypothesis that children have some specific problems with combining noun and attribute information.

Similar conclusions are reached from the differential effects of performance level on the results of the two tasks. Figure 3 present the results of the experiment in the lowest, middle and highest thirds of the sample, defined according to the total score they received on the two conditions of the experiment, namely, the total of the 4-picture and the 2-picture correct scores.

The results show that the locus of the difference between the correct scores of the 2-picture and the 4-picture tasks is the lower and middle thirds of the sample, whereas in the highest third there was no difference in the rates of success in the two conditions. Similarly, the locus of the differences in the correct Adjective scores between the 2-picture and the 4-picture conditions is the lower and middle thirds of the sample, whereas in the highest third there was no difference in the rates of success in the two

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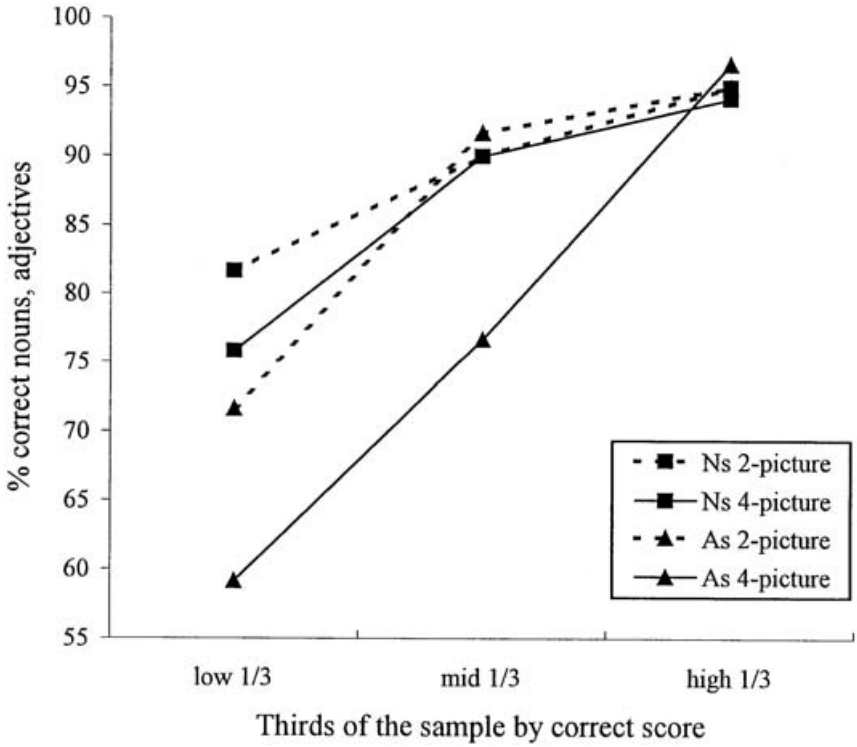


Fig. 3. Correct nouns and adjectives in 4-picture and 2-picture conditions.

conditions. There was no difference in the correct Nouns in any of the sub-samples.

The difference in the success rates of Nouns and Adjectives in the 4-picture condition was confined to the lowest third of the sample. There was no difference between these rates in any of the sub-samples in the 2-picture condition. All differences were tested by Wilcoxon signed ranks tests.

To summarise, the detailed analysis of the results in the three thirds of the sample revealed that the interactive effect of condition and part of speech applies mostly to poorly performing children. These children did much better on the two-picture task than on the 4-picture one; and the core of their improved performance is in the adjectives rather than, non-selectively, in both the adjectives and the nouns.

These results strengthen the conclusion reached on the basis of the analysis of the performance of the complete sample, namely, that the pattern of results cannot be accounted for in terms of simple processing differentials between the 2-picture and the 4-picture tasks. The results only agree with

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an interpretation that ties the poorer performance in the 4-picture comprehension task to the specific difficulty it poses in requiring the combination of noun and attribute information.

Self-correction

A further support for this conclusion is provided by the self-correction data. Children in Experiment 2 made a total of 26 spontaneous changes, 21 in the 4-picture condition, and 5 in the 2-picture condition. The most frequent type of self-correction was the one most favoured also in Experiment 1, namely, to replace a response which was correct on the noun but incorrect on the attribute, with a response which was correct on the noun and also correct on the attribute. This accounted for 15 or 57·7% of all self-corrections, similar to the findings of Experiment 1. The self-correction data imply that a choice which is correct on the noun but incorrect on the attribute is one that children are often capable of remedying in a further move, thus suggesting that the initial error represents a problem of integrating the noun information with adjective information rather than a lack of knowledge of the adjective word.

Young children's strategies to solve comprehension problems

Our findings imply that children initially solve the two kinds of cognitive-linguistic tasks – the two-picture one and the 4-picture one – by focusing on a single word of the referential phrase to base their choice on. This is a highly successful strategy in a two-picture situation when the alternatives contrast either on the noun information or the adjective information but never on both. Apparently, their knowledge of adjectives is sufficient in order to perform adequately when they can choose between two identical objects differing only on the attribute denoted by the adjective.

However, this single-dimension selection strategy does not serve children well when they are faced with stimuli differing on two dimensions, both in the objects shown and in the properties of these objects. In order to perform correctly in this 4-choice situation, the children need to combine the noun and the adjective information in the question, and thus compute the value of the referential expression consisting of the attributed noun. Apparently, poorly performing children cannot switch to an integrative comprehension strategy but, rather, continue to base their choices on a single dimension/word, either on the adjective, or, more often, on the noun alone.

SUMMARY AND CONCLUSIONS

The results of the two experiments suggest that young children below 4;0 do possess basic adjective vocabularies and can use them in simple

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single-dimensional discriminations, but have a considerable difficulty in interpreting the combination of noun and adjective in an attributive referential expression. It appears that this difficulty is syntactic-semantic, or maybe even logico-syntactic, and does not follow from a problem in the acquisition of adjective terms *per se*.

A very frequent pattern observed in the study was making a first choice based entirely on the noun and not taking the adjective into consideration at all. Many of the children however subsequently corrected themselves by adding the adjective information. Logicians tell us this is indeed the sequence of operations involving adjectival modification. The results support the notion that the complete mastery of modification involves the AUTOMATIZATION of this process. Adults and better-performing children no longer go through an overt two-step procedure, first identifying the group of objects referred to by the noun, then restricting the reference to the objects having the correct attribute; rather, they perform the two steps as one, instantly and without awareness.

The automatization of the two-step process marks the emergence of a new logical operation, that of subtype-formation. What were originally two independent choices sequentially ordered, now turns into a single integrated choice based on both the noun and the adjective, in the correct logical relationship of head and its modifier. The mastery of the syntax of attribution emerges interwoven with the mastery of its logic.

Connection to word-to-concept mapping studies

The results of this study connect to one of the most robust findings of the experimental studies of the acquisition of adjectives, the so called 'shape bias'. As mentioned in the Introduction, there have been in the last decade numerous studies of the development of adjectives in young children (e.g. Gelman & Markman, 1985; Au & Laframboise, 1990; Waxman, 1990; Hall, Waxman & Hurwitz, 1993; Waxman & Markow, 1998; Klibanoff & Waxman, 1999, 2000; Klibanoff, 2001). These studies address the word-to-concept mapping problem raised by adjectives and their goal is to find out whether children know that adjectives refer to properties of objects and not, like nouns, to the objects themselves. As a rule, in these studies children are first taught a novel adjective (a nonce-word or an infrequent word), and then it is tested how they extend the adjective to a new stimulus. For example, Smith, Jones & Landau (1992) showed two groups of three-year-old children an unfamiliar geometrical object coated with random spatters of red, green, blue and white paint, and introduced it by a sentence using a nonce word (e.g. *dax*) either as a noun (*This is a dax*) or as an adjective (*This is a dax one*). Subsequently, the children were presented with a set of 5 other objects, 4 of which differed from the target either in shape or colour,

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and they were asked for each test item in the Noun condition, *Is this a dax?* or, in the Adjective condition, *Is this a dax one?*. Success in correctly inferring the form class of the novel word was measured by the children extending it to same-shaped, differently coloured test objects in the Noun condition and to same-coloured, differently shaped test objects in the Adjective condition. Namely, the sentence-frame *This is a dax one* is expected to lead children to infer that the nonce-word *dax* refers to a property and not, for example, to a kind of object.

The main finding of these studies is that very young children do not consistently discriminate between nouns and adjectives, linking both to object categories. Such a 'shape bias' has been found for children as young as 0;11 (e.g. Waxman & Booth, in press) and as old as 2;0, 3;0, or 4;0 (Au & Markman, 1987; Heibeck & Markman, 1987; Markman & Wachtel, 1988). Around 2;0, children start to differentiate adjectives from nouns, at first linking them both to objects and to properties (Smith *et al.*, 1992; Waxman, 1999; Waxman & Booth, 2001), then dropping object-interpretations altogether. However, even at 4;0 children only succeed in consistently extending novel adjectives to similar-propertied stimuli in especially favourable conditions, demonstrating that the 'shape bias' survives until quite late in development.

According to our results, the linking problem found in these studies could be the result of children's difficulties with the comprehension of adjective–noun attributive combinations, as comprehending the input sentences is a precondition for learning the novel adjective. If children do not understand the syntax of attribution, or understand how adjectives in general function in combination with nouns, they might not be able to make use of the 'syntactic bootstrapping' opportunities presented to them in the novel-adjective studies. Namely, they might not be able to interpret the introductory sentence *This is a dax one* cited above as pointing to an attributory functioning of the unknown word *dax*. Indeed, they might not be able to interpret the attributive combination of such a sentence in any way. In this case, instead of computing the two-step attributive combination which they cannot yet master, they could simply ignore the word *one* and treat the sentence as equivalent to *This is a dax*. If young children (mis) interpret the introductory sentence in such a way, it is not surprising that they extend *dax* to a same-shaped object, the error appearing to be due to a 'shape bias' but in fact representing a basic problem with understanding the sentence.

According to our suggestion, the mistaken linking could reflect children's problem with going beyond the first, object-oriented, substage of the interpretation of adjective–noun attributive combinations when presented with input sentences introducing novel adjectives. This proposal is supported by the finding that object-attribution for the adjectives depends on the noun

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involved: the error is much less likely if the objects involved are familiar and the child knows their name, as the familiarity effect found for example by Hall *et al.* (1993) demonstrates.

Most relevantly, in a recent study Mintz & Gleitman (2002) found that two- to three-year-olds succeed in an adjective-learning task only when they are provided with a clear specification of the object type whose properties are referred to by the adjective. Such clear indication of the object-set is given by a common noun rather than by a pronoun such as 'one' or a generic noun such as 'thing'; the use of a specific noun rather than a pronoun or a generic noun in the training expression introducing the novel adjective is a requirement for success in the learning task for such young children. Mintz & Gleitman interpret their results in terms of the phenomenon of 'semantic tailoring', by which relative adjectives such as the dimensional adjectives 'big' and 'small' get their range of possible values from the standard established by the noun (e.g. Allerton, 1982: 25–8). They claim that for relative adjectives, the establishment of the taxonomical set of the noun is a prerequisite for interpreting the adjective; this, however, does not quite explain why the noun-effect should be observed in their study in which the adjectives used were not relative ones.

According to the hypothesis of the present study, however, all adjectives operate by establishing a subset within the set defined by the head noun of the combination (Montague, 1974). If this conception of the psycholinguistic processing involved in attribution is correct, it can account for the findings of Mintz & Gleitman (2002) as well as for other findings in the literature that tie the success or failure of learning a novel adjective to parameters connected to the ease of establishing the relevant object-set on the basis of the noun of the combination (e.g. Gelman & Markman, 1985; Waxman & Markow, 1998; Klibanoff & Waxman, 2000; Klibanoff, 2001).

The linking studies differ from the comprehension paradigm employed in the present study in the kind of errors expected as a result of children's difficulty with interpreting the syntax of attributed nouns. In a teaching situation, when the adjective-word is novel and unknown to the child (as *dax* in the example above), children can reduce the two-step process to a one-step one by ignoring the noun while 'promoting' the adjective-word to the status of an object-label. As properties are secondary, dependent, and subordinate to a primary object-set, a property-interpretation is not a viable option for a single word serving as the whole of the referential expression: the object-set needs to be established first. Such a comprehension strategy would result in a mistaken categorization of novel adjectives as if they referred to kinds of objects rather than to kinds of object properties. This strategy, however, cannot apply when the adjectives are not freshly taught but already familiar, and the task is not one of extending the adjective to a new referent but, rather, a comprehension task. In this situation it is

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expected that children at the lower levels of mastery of attribution will tend to make 'errors of omission' in which the object is correct but the attribute is wrong, but not the opposite errors, as indeed was found in the present study. In other words, children's syntactic difficulties with attribution may be evidenced in different ways in different tasks, depending on the specific parameters of the task.

In this vein, our findings predict that young children would be successful in choice situations involving adjectives as long as the alternatives contrast only on the adjective information but not on both the noun information and the adjective information. This could be the reason why, according to the studies by Waxman & Markow (1998), Klibanoff & Waxman (2000) and others, children first succeed in interpreting novel adjectives as marking properties of objects only within a familiar basic-level object category, and only later extend them across different categories (see also Gelman & Markman, 1985; Taylor & Gelman, 1988; Waxman, 1990; Klibanoff & Waxman, 1999). For example, Waxman & Markow (1998) taught infants aged 1;9 rare adjectives like 'citron'. The children did not succeed at extending the novel adjectives when the target and the test objects differed in their basic category, such as finding '*another citron one*' when the word was initially introduced for a yellow spoon and was to be extended to a yellow key, choosing between it and a green key. They only succeeded when the test objects belonged to the same basic category as the target object, as in the condition when the same word *citron* was introduced by a yellow car, and in the test situation the child had to choose between a (different) yellow car and a green car as being '*another citron one*'. Similar results were achieved in the other studies for three-year-old children, while four-year-olds appear to have mostly outgrown the same-category requirement (e.g. Klibanoff & Waxman, 2000).

It seems that when both the target and the test-items belong to the same object-category, the situation resembles our two-picture choice situation, as it functionally reduces to a contrast only on a single dimension. In these circumstances, children do succeed in matching the adjective to the residual contrast among the items. When, however, the target and the test-items belong to different object-categories, the situation resembles our four-picture choice situation, as now there exists a contrast both in the objects and in the properties. In these conditions, correct comprehension of the syntax of the introductory sentence demands the more difficult integrative interpretation.

According to the findings of Klibanoff (2001), the same reducing effect can be achieved even when the object-categories involved are not basic-level ones but superordinate categories like 'tools', as long as the experimenter labels all the items in the task, target as well as test items, by the same label. This, apparently, allows the child to ignore the noun (and the specific

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identities of the objects) as irrelevant to the task. The label is enough to turn the task into a non-syntactic, single-element choice situation. As Mintz & Gleitman (2002) pointed out, these manipulations provide the children with a ready-made object-set, removing the need to compute it as part of the solution to the learning problem. In such facilitating conditions, even very young children are able to interpret a novel adjective as referring to properties and not to objects. According to the results of the present experiment, it is even possible that the facilitation comes from sparing the children the need to combine the adjective and the noun altogether.

The connections between the results of the present study exploring children's comprehension of attributive phrases and the findings of the experimental paradigm in which children are taught novel adjectives suggest that a large part of children's difficulties in learning adjectives could be syntactic. Our findings also imply that all kinds of adjunct relations and not only attributive adjective–noun combinations might pose a problem in acquisition. For instance, young children might find noun–noun attribution (such as 'baby carriage'), relative clauses, as well as adverbial adjuncts to verbs and adjectives difficult to learn. These possibilities merit further study.

REFERENCES

Allerton, D. J. (1982). *Valency and the English verb*. London: Academic Press.

Au, T. K. & Laframboise, D. E. (1990). Acquiring color names via linguistic contrast – the influence of contrasting terms. *Child Development* **61**, 1808–23.

Au, T. K. & Markman, E. M. (1987). Acquiring word meaning via linguistic contrast. *Cognitive Development* **2**, 217–36.

Braine, M. D. S. (1976). Children's first word combinations. *Monographs of the Society for Research in Child Development* **41** (1, Serial No. 164).

Dixon, R. M. W. (1977). Where have all the adjectives gone? *Studies in Language* **1.1**, 19–80.

Gelman, S. & Markman, E. (1985). Implicit contrast in adjectives vs. nouns: implications for word-learning in preschoolers. *Journal of Child Language* **12**, 125–43.

Hall, D. G., Waxman, S. R. & Hurwitz, W. M. (1993). How two- and four-year-old children interpret adjectives and count nouns. *Child Development* **64**, 1651–64.

Hasman, A. (1995). What came first – 'The egg is white' or 'The big hen'? Adjectives' acquisition by Hebrew native speaking toddlers – do predicative adjectives precede the appearance of attributive adjectives? Unpublished M.A. thesis, The Hebrew University, Jerusalem, Israel.

Heibeck, T. H. & Markman, E. M. (1987). Word learning in children: an examination of fast mapping. *Child Development* **58**, 1021–34.

Hudson, R. (1990). *English word grammar*. Oxford: Basil Blackwell.

Klibanoff, R. S. (2001). Shared category membership or perceptual similarity: what explains the foundational role of basic-level categories in children's acquisition of adjectives? Paper presented at the Biennial Meeting of the Society for Research in Child Development, Minneapolis, Minnesota, April 2001.

Klibanoff, R. S. & Waxman, S. R. (1999). Syntactic clues to word learning: initial expectations and the development of flexibility. In A. Greenhill, H. Littlefield & C. Tano (eds), *Proceedings of the 23rd Annual Boston University Conference on Language Development*. Somerville, MA: Cascadilla Press.

https://doi.org/10.1017/S0305000904006191 Published online by Cambridge University Press

Klibanoff, R. S. & Waxman, S. R. (2000). Basic level object categories support the acquisition of novel adjectives: evidence from preschool-aged children. *Child Development* **71**, 649–59.
Lehmann, C. (1984). *Der relativsatz*. Tubingen: Narr.
Markman, E. M. & Wachtel, G. F. (1988). Children's use of mutual exclusivity to constrain the meaning of words. *Cognitive Psychology* **20**, 121–57.
Mintz, T. H. & Gleitman, L. R. (2002). Adjectives do modify nouns: the incremental and restricted nature of early adjective acquisition. *Cognition* **84**, 267–93.
Montague, R. (1974). *Formal philosophy* (Edited by R. H. Thomason). London: Yale University Press.
Nelson, K. (1976). Some attributes of adjectives used by young children. *Cognition* **4**, 13–30.
Ninio, A. (1984). Functions of speech in mother-infant interaction. Final Science Report to the United States-Israel Binational Science Foundation (BSF), Jerusalem, Israel.
Ninio, A. (1995). Predicting a developmental lag of adjectival attribution in early word combinations on the basis of Dependency Theory. Paper presented at a symposium on Children's Early Word Combinations and Grammar, chaired by M. Tomasello. The Biennial Meeting of the Society for Research in Child Development, Indianapolis, Indiana, March, 1995.
Smith, L. B., Jones, S. S. & Landau, B. (1992). Count nouns, adjectives, and perceptual properties in children's novel word interpretations. *Developmental Psychology* **28**, 273–86.
Taylor, M. & Gelman, S. A. (1988). Adjectives and nouns: children's strategies for learning new words. *Child Development* **59**, 411–19.
Tomasello, M. (1992). *First verbs: a case study of early grammatical development*. Cambridge: CUP.
Vennemann, T. (1977). Konstituenz und Dependenz in einigen neueren Grammatiktheorien. *Sprachwissenschaft* **2**, 259–301.
Waxman, S. R. (1990). Linguistic biases and the establishment of conceptual hierarchies: evidence from preschool children. *Cognitive Development* **5**, 123–50.
Waxman, S. R. (1999). Specifying the scope of 13-month-olds' expectations for novel words. *Cognition* **70**, B35–B50.
Waxman, S. R. & Booth, A. E. (2001). Seeing pink elephants: fourteen-month-olds' interpretation of novel nouns and adjectives. *Cognitive Psychology* **43**, 217–42.
Waxman, S. R. & Booth, A. E. (in press). The origins and evolution of links between word learning and conceptual organization: new evidence from 11-month-olds. *Developmental Science*.
Waxman, S. R. & Klibanoff, R. S. (2000). The role of comparison in the extension of novel adjectives. *Developmental Psychology* **36**, 571–81.
Waxman, S. R. & Markow, D. B. (1998). Object properties and object kind: twenty-one-month-old infants' extension of novel adjectives. *Child Development* **69**, 1313–29.

https://doi.org/10.1017/S0305000904006191 Published online by Cambridge University Press