Object naming at multiple hierarchical levels: a comparison of preschoolers with and without word-finding deficits*

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ABSTRACT

According to the storage hypothesis (Kail & Leonard, 1986), word-finding deficits in young children are not the direct result of deficient retrieval strategies; they are a manifestation of a general delay in language development that affects lexical storage. In the current study, we explored one aspect of lexical storage, the hierarchical organization of the semantic system, in 13 preschoolers with word-finding deficits (WF) and 13 preschoolers with normal language abilities (ND), ranging in age from 3;3 to 6;7. The children named a series of objects at multiple levels of the noun hierarchy in response to contrast questions (e.g. for *rose* they were asked, 'Is this an animal?' to elicit *plant* [superordinate]; 'Is this a tree?' to elicit *flower* [basic]; 'Is this a dandelion?' to elicit *rose* [subordinate]). Both groups readily named at multiple levels, providing evidence of hierarchical organization of the lexicon. However, there were several differences between WF and ND groups that suggested that WF children did not have enough stored information to discriminate between similar semantic neighbours. We conclude (1) that hierarchical organization of the semantic lexicon is a robust developmental phenomenon, apparent in both ND and WF preschoolers and (2) that the word-finding deficits of preschoolers appear to reflect insufficient depth and breadth of storage elaboration rather than deficits in hierarchical semantic organization.

INTRODUCTION

Word-finding deficits are a poorly understood and little studied concomitant of developmental language impairment in young children. The deficit is manifested as significant difficulty in finding words accurately and quickly.

In the preschool years, these inaccuracies frequently take the form of semantic substitutions such as *pants* for *dress*. Often these semantic substitutions are visually similar to the intended targets (e.g. *lion* for *tiger*). Other behaviours symptomatic of the problem include comments on the word-finding difficulty (e.g. *I don't know*) as well as occasional errors of phonological form (e.g. *miracle ride* for *merry-go-round*), overuse of non-specific words (e.g. *thing*, *stuff*), novel compounds (e.g. *kinghat* for *crown*), and circumlocutions (e.g. *it's for horses* for *horseshoe*) (McGregor, 1997). Word-finding deficits are associated with poor skills in narrative construction (German, 1987, 1992), and reading (Perfetti, 1985; Catts, 1989, 1993; Wolf & Obregon, 1992) in school-aged children.

Recent research has supported the hypothesis that the word-finding deficits of these children reflect underdeveloped storage of words in the mental lexicon (Kail & Leonard, 1986; McGregor, 1997; McGregor & Leonard, 1989; McGregor & Windsor, 1996). Because of their delayed language development, these children may have fewer words in their lexicons, know less about the words in their lexicons, or have poorly organized lexical storage. Any of these could lead to difficulty finding words quickly and accurately.

In the current study, we explored one potential aspect of this storage deficit. We focused on a fundamental feature of semantic and conceptual organization: the ability to locate an individual object in multiple taxonomic classes at various hierarchical levels (e.g. *plant*, *flower*, *rose*). Our goal was to compare the flexibility and accuracy of object naming in children with word-finding deficits and their age-matched peers.

To elicit multiple labels for a given object, we used an experimental paradigm designed by Waxman & Hatch (1992). The examiner presented a series of object pictures and asked the children to teach a puppet 'all the different names for each picture'. The puppet then asked contrast questions to elicit naming. For example, while presenting a picture of a rose, the puppet asked, 'Is this an animal?' to elicit 'no, it's a plant', 'Is this a tree?' to elicit 'flower' and 'Is this a daisy?' to elicit 'rose'. The paradigm exploits children's sensitivity to the contrastive and hierarchical principles of hierarchical systems of organization (Miller & Johnson-Laird, 1976; Horton, 1983). According to the contrastive principle, a member of the class *sunflower* cannot also be a member of the class *cornflower*. According to the hierarchical principle, members of the class *sunflower* constitute a logical subset of the more inclusive class *flower*. If children are sensitive to these principles, they should match the hierarchical level modelled in the contrast question in their answers. In addition, Waxman & Hatch (1992) examined the effect of morphological form. For half of the targets, the subordinate labels modelled in the contrast questions consisted of compound or modifier+noun phrase (e.g. *cornflower*) for the other half, a simple noun was modelled (e.g. *daisy*).

Three results reported by Waxman & Hatch (1992) are of particular interest here. First, although normally developing preschoolers most frequently provided names at the basic level, they readily produced other labels as well. Second, the children supplied subordinate labels more readily than superordinate labels. Third, although the children matched the morphological form of their subordinate labels to the form of the model (whether simple noun or compound), their ability to name at the subordinate level did not vary with model type. Thus, although these normally-developing children were sensitive to the morphological form of a label, this transparency did not, in itself, lead them to produce more subordinate level names.

In the experiment reported here, we compared the performance of preschool-aged children with and without word-finding deficits on the Waxman & Hatch (1992) task in order to examine their organization of and access to stored information in the noun lexicon.

METHOD

Participants

Thirteen children with word-finding (WF) deficits and 13 normally developing (ND) children participated. All children were from white middle- to upper-middle-class families living in the northern suburbs of Chicago. In each group, there were three girls and 10 boys. The children ranged in age from 3;3 to 6;7 with a mean age of 5;0. Each participant in the ND group was matched by gender and by age ± 3 months to a participant in the WF group.

Although Waxman & Hatch (1992) chose three- to four-year-old subjects in order to document early hierarchical organization of the noun lexicon, we chose to extend the range to include five- and six-year-old subjects because (1) children with word-finding deficits are often not identified until the late preschool years, and (2) as a group, children with word-finding deficits present with varying degrees of delay in language development. Therefore, we felt that truest picture of multiple level naming abilities in children with word-finding deficits would be obtained in a sample that spanned this more inclusive age range.

Within the WF group, children presented with a variety of developmental communication disorders involving language, speech, and/or fluency. All children were receiving speech-language therapy at the time of their participation in this study. Each child in the WF group was initially selected because he or she had been diagnosed by a speech–language pathologist as having deficits in word finding. Pretests in our own lab, conducted prior to the experiment, confirmed the clinical judgments of the speech–language pathologists. The WF group was significantly less accurate in word retrieval

compared to their peers on the noun naming subtest of the *Test of Word Finding* (German, 1989) ($t = 3.801$, d.f. $= 24$, $p = 0.001$); the verb naming subtest of the *Test of Word Finding* ($t = 4.369$, d.f. $= 24$, $p < 0.001$) and in a story retell task ($t = 3.811$, d.f. $= 24$, $p = 0.001$). However, the children's difficulties with words did not extend to the receptive domain to any measurable extent. All children in the WF group achieved scores on the *Peabody Picture Vocabulary Test-Revised* (Dunn & Dunn, 1981) that were within normal limits.

Children in both the WF and ND groups passed pure tone audiometric tests administered at 500, 1000, 2000 and 4000 kHz at a level of 25 dB bilaterally. All children passed screenings of oral-motor structure and function. Also, the children showed no signs of frank neurological dysfunction and their emotional and physical development, as determined by parent report, was unremarkable. On the *Arthur Adaptation of the Leiter International Performance Scale* (Arthur, 1952) all children earned a standard score of 85 or above (test mean $= 100$, S.D. $= 15$).

Pictorial Stimuli

Twelve picture cards served as stimuli. (See Table 1). Objects depicted on the cards were chosen because each had a distinct name at three levels of the noun hierarchy and because the superordinate label of each is consistently produced by three- and four-year-old children (Waxman & Hatch, 1992).

Procedure

For the experiment itself, children were tested individually in a sound-treated laboratory room. The procedure lasted approximately 15 minutes. During that time, the children were asked to teach a puppet multiple names for 12 pictured objects. As a model, the experimenter presented a picture of a garbage truck and explained that it could be called a *garbage truck*, a *truck*, or a *vehicle*. To elicit multiple labels for each of the 12 objects, a puppet asked contrast questions. For each stimulus picture, contrast questions were presented in descending order across the noun hierarchy (e.g. for rose: 'Is this an animal?' [superordinate]; 'Is this a tree?' [basic]; and 'Is this a dandelion?' [subordinate]). For half the targets, the subordinate-level label was a simple noun (rose); for half it was a compound or modifier+noun phrase (sunflower). The contrast models and targets are presented in Table 1. Each of the 12 picture cards were presented one at a time, in random order.

Scoring

We scored the children's performance in two ways.

Contrastive names. The purpose of this analysis was to gauge children's

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TABLE 1. *Stimulus targets and models*

| Pictured target | Model contained within each contrast question | | |
	Superordinate	Basic	Subordinate
rose	animal	tree	dandelion
sunflower	animal	tree	cornflower
palm	animal	flower	oak
apple tree	animal	flower	pear tree
eagle	plant	dog	owl
blackbird	plant	dog	bluebird
collie	plant	bird	dachshund
firedog (Dalmatian)	plant	bird	bulldog
sandals	food	pants	boots
cowboy boots	food	pants	party shoes
jeans	food	shoes	shorts
sweat pants	food	shoes	dress pants

flexibility in providing names at multiple levels. Here we examined whether the children's responses matched the hierarchical level of the label used in the contrast question. No attention was paid to whether the naming response was a correct label for the object. Consider for example, the child's response to the subordinate level contrast question, 'Is this a dandelion?' for the target *rose*. In this analysis, the response, 'No, it's a clover' (incorrect) and the response, 'No, it's a rose' (correct) were accepted because they both revealed the child's sensitivity to the hierarchical level of the question.

Accurate and contrastive names. The purpose of the second analysis was to examine the accuracy of naming at multiple levels. The criterion here was more strict: a response was considered accurate if and only if it was contrastive and correct. In this case, only the latter response ('It's a rose') was accepted.

Two general types of responses were considered to be errors in this second analysis: (1) substitutions, which included phonological substitutions (e.g. *sandies* for *sandals*), semantic co-ordinate substitutions (e.g. *tulip* for *rose*), novel compounds (e.g. *Lassie dog* for *collie*), and circumlocutions (e.g. *a flower that's red and thorny* for *rose*); and (2) indeterminate responses which included 'I don't know' responses and acceptances of the contrastive model. The latter warrants explanation. For example, when shown the picture of a sunflower and asked, 'Is this a cornflower?', a child might accept our (contrastive) label, effectively blocking her opportunity to produce a correct subordinate label. In these cases, we did not ask for another response because we felt that this might discourage the children, especially those with word-finding deficits, and lead them to be more cautious in their production of

other targets. We scored this type of response as a correct level of response in the contrastive analysis but as an incorrect label in the accuracy analysis.

RESULTS

We compared the WF and ND group in flexibility and accuracy of contrastive naming.

Flexibility of contrastive naming

The children's flexibility of contrastive naming at multiple levels of the noun hierarchy is depicted in Fig. 1. To analyse the flexibility of contrastive
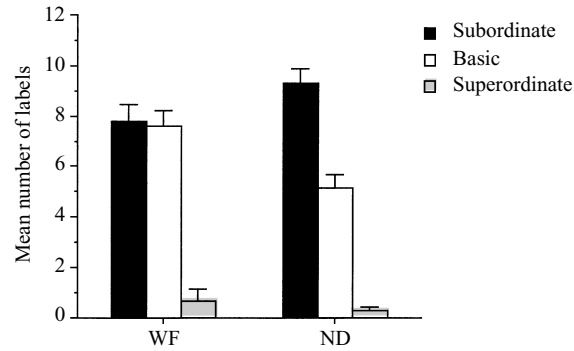

Fig. 1. Mean number of contrastive labels produced as a function of group and hierarchical level.

naming, we conducted a two-way ANOVA with group (WF, ND) as a between-subject factor and hierarchical level (subordinate, basic, super-ordinate) as a within-subject factor. The number of contrastive level labels provided by each child was the dependent variable.[1] There was a main effect for hierarchical level ($F(2, 48) = 133 \cdot 130$, $p < 0 \cdot 001$). The frequency of contrastive naming at each level was significantly different from the frequency of contrastive naming at all other levels (all p's $< 0 \cdot 001$). As can be seen in Fig. 1, contrastive naming was least frequent at the superordinate level.

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[1] Because, in this analysis, we were interested in flexibility rather than accuracy of naming, we counted acceptances of the puppet's model as contrastive level labels in this ANOVA. We also conducted a supplementary analysis excluding these; the results of this ANOVA were identical to the first.

Surprisingly, the children were more likely to provide contrastive names at the subordinate level than at the basic level. We suspect that this is related to the descending order of contrastive questions. The children seemed to 'catch on' to this design feature, and therefore, were quick to provide subordinate level names even in response to basic level models. This main effect of level is qualified by an interaction between group and level ($F(2, 48) = 7.693$, $p = 0.001$). As can be seen in Fig. 1, children in the ND group exhibited this pattern more dramatically than children in the WF group. A *post hoc* test of effects revealed that children in the ND group were less likely than their WF peers to provide basic level responses to the basic level contrast questions ($F(1, 24) = 9.198$, $p = 0.006$). Instead, the ND children frequently responded to basic level contrast questions with subordinates.

To evaluate the role of morphological transparency, we conducted a separate two-way ANOVA with group (WF, ND) as a between subjects factor and model type (compound, simple noun) as a within-subjects factors. The number of contrastive subordinate responses served as the dependent variable.[1] This analysis revealed a main effect for group ($F(1, 24) = 4.242$, $p = 0.05$) and a main effect for model type ($F(1, 24) = 10.901$, $p = 0.003$). As can be noted in Fig. 2, the ND children named more subordinates overall
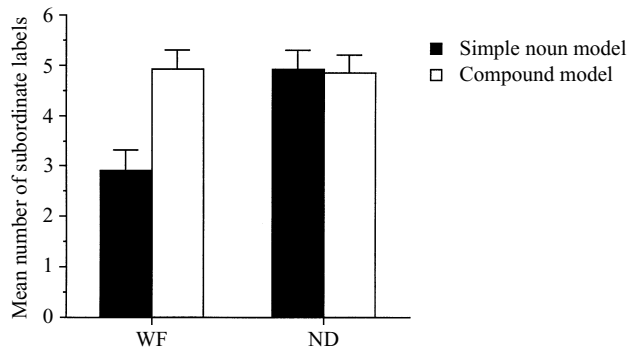

Fig. 2. Mean number of subordinate labels produced as a function of group and model type.

than the WF children. Also, more contrastive names were provided following compound than simple models. The main effects were qualified by an interaction between group and model type ($F(1, 24) = 12.715$, $p = 0.002$). Children in the WF group were more likely to name subordinates following compound models ($t = 3.766$, d.f. $= 12$, $p = 0.003$) but those in the ND group showed no effect of model type ($t = 0.322$, d.f. $= 12$, $p = 0.753$).

In a subsequent analysis, we examined the proportion of trials on which the child's response matched the morphological form of the experimenter's

contrast question. For each child, we computed the proportion of matching contrastive subordinate responses. This served as the dependent variable. A two-way ANOVA with group as a between-subject factor (WF, ND) and model type (compound, simple noun) as a within-subject factor revealed no significant effects. Children in both groups were equally likely to match the morphological form of the model. In the WF group, matching of forms occurred in 73 % and 75 % of all cases for compounds and simple nouns, respectively. In the ND groups the rate of matching was 66 % and 70 % for compounds and simple nouns, respectively.

Accuracy of contrastive names

The error rates at each hierarchical level of the naming hierarchy are presented in Table 2. We submitted the data to a two-way ANOVA with

TABLE 2. *Mean error rates for word-finding impaired and normally developing subject groups at each level of the noun hierarchy*

	Hierarchical level		
Group	Subordinate	Basic	Superordinate
Word-finding impaired			
Mean error rate	00·50	00·06	00·40
Standard deviation	00·29	00·08	00·55
Number of responses	112	104	11
Normally developing			
Mean error rate	00·34	00·05	00·00
Standard deviation	00·21	00·10	00·00
Number of responses	122	70	4

group (WF, ND) as a between-subject factor and hierarchical level (subordinate, basic, superordinate) as a within-subject factor. The proportion of responses in error was the dependent variable. Though the WF group made more errors than the ND group, this difference was not statistically significant. The main effect for hierarchical level ($F(2, 14) = 12·697$, $p = 0·001$) revealed that the subjects made more errors at subordinate than at basic levels ($p = 0·002$) and at superordinate than at basic levels ($p = 0·02$). Note, however, that the high superordinate-level error rate (40 %) is based on four errors out of 11 total superordinate-level naming attempts for the WF group.

We conducted a subsequent analysis to better characterize the types of errors produced. Because of the very small number of errors produced at the basic and superordinate levels, only error types at the subordinate level were examined. These errors were categorized by type according to whether they were substitutions (e.g. phonological substitutions, semantic co-ordinate

substitutions, novel compounds, or circumlocutions) or indeterminate (e.g. 'don't know' or acceptances of the contrastive model). The results of this error classification are presented in Table 3. It appeared that the WF group

TABLE 3. *Number of subordinate errors classified by group, model type and error type*

	Group					
	Word-finding impaired			Normally developing		
	Model type			Model type		
Error type	Simple	Compound	Combined	Simple	Compound	Combined
Substitution errors						
Phonological	2	0	2	1	0	1
Semantic co-ordinate	6	4	10	7	7	14
Novel compound	2	2	4	3	3	6
Circumlocution	3	2	5	2	1	3
Total substitutions	13	8	21	13	11	24
Proportion of total errors	—	—	00·36	—	—	00·67
Indeterminate errors						
Don't know	4	6	10	0	0	0
Accept	7	20	27	3	9	12
Total indeterminate	11	26	37	3	9	12
Proportion of total errors	—	—	00·64	—	—	00·33

produced a lower proportion of substitutions (and a higher proportion of indeterminate errors) than the ND group. To test this, we conducted a one-way ANOVA with group (WF, ND) as a between-subject factor and the proportion of subordinate errors that were categorized as substitutions as the dependent variable. There was a main effect for group ($F(1, 22) = 5·762$, $p = 0·025$).

Although the WF group produced proportionately fewer substitutions than the ND group, the two groups were quite similar in the types of substitution errors they made. Further examination of Table 3 reveals that, at the subordinate level, semantic co-ordinates (e.g. *hound* for *collie*) constituted the most frequent substitution errors followed by novel compounds (e.g. *Hawaiian tree* for *palm*) and circumlocutions (e.g. 'it's kind of like a regular dog with spots' for *firedog*) and, finally, errors of phonological form (e.g. ['sigəl'] for eagle). We also compared the profile of errors in the indeterminate category. As can be seen in Table 3, at the subordinate level, children in both groups were more likely to accept the experimenter's model than to reply, 'I don't know.'

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Finally, errors at the subordinate level were explored further to determine whether error type varied with model type (compound or simple noun). As can be seen in Table 3, error types were fairly equally distributed in response to compound and simple noun models. The one exception was acceptance errors. We conducted a two-way ANOVA with group (WF, ND) as the between-subject variable, model type (compound, simple noun) as the within-subject variable and the number of acceptances of the contrastive model as the dependent variable. There was a main effect for group ($F(1, 24) = 4\cdot239$, $p = 0\cdot05$). The WF group accepted both compound and simple models more often than their ND peers. Also, there was a main effect for model type ($F(1, 24) = 5\cdot133$, $p = 0\cdot03$). Acceptances of compound noun models were significantly more frequent than acceptances of simple nouns.

DISCUSSION

The results suggest that children with word-finding deficits have intact hierarchical organization of the semantic system. This conclusion is based on two strands of evidence. First, children in the WF group were as flexible in naming as their age-matched peers. Second, the children in the WF group were as accurate in their naming as their age-matched peers.

The ND and WF groups were also similar in the pattern of error rates at different hierarchical levels. For both groups, errors were more frequent at the subordinate than at the basic level. This differences may be attributable to the fact that subordinate terms are less familiar than basic level terms. Familiarity has been shown to influence speed of naming in both children with normally developing language and those with impaired language development (Leonard, Nippold, Kail & Hale, 1983).

Despite these similarities, there was evidence of deficiencies in lexical storage in the WF group. Error type profiles provided one strand of relevant evidence. The WF group demonstrated a significantly lower proportion of substitution errors and a higher proportion of indeterminate errors ('I don't know' and acceptances of the modelled noun) than their peers (see German, 1982; Fried-Oken, 1984; McGregor, 1997). In the case of 'don't know' responses, the children admit their uncertainty in deciding on the correct label ('Is this a dandelion?', 'I don't know'). In the case of acceptance responses, the children appear unaware that they are answering incorrectly (e.g. 'Is this a dandelion?', 'yes!'). That the ND group produced a higher ratio of substitution to indeterminate errors than did the WF group suggests a quality difference in the errors of ND and WF children. Because substitution responses bear some relation (usually a semantic relation) to the target, they demonstrate that the child has, in the very least, accessed the correct neighbourhood of the target word. Functionally, these substitutions provide the listener with some relevant information about the intended

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message. In contrast, the high rate of acceptance responses for the WF group suggests that they frequently did not have enough stored information to discriminate between similar semantic neighbours.

In addition, the WF group named subordinates less frequently than their ND peers. But even more interesting was the finding that subordinate naming in WF and ND groups was comparable following morphologically transparent compound models. The WF group was deficient in naming after simple noun models. In contrast, subordinate naming did not vary in response to model type for the ND group in the current study, nor for the younger ND group in Waxman & Hatch (1992). There are several explanations for the benefit derived by the WF group from compound/phrasal subordinates which accord with the view of word-finding deficits as part of a broader limitation in lexical storage. Possibly the WF children knew more subordinates that have compound forms. The morphological transparency of some subordinate-level terms may have facilitated their storage (Clark, Gelman & Lane, 1985; Gelman, Wilcox, & Clark 1989). Another possibility is that the storage strength of the phonological form of the target words was weak and the compounds, by directly providing part of the phonological form, facilitated the efforts of the WF group to name.

In conclusion, hierarchical organization of the semantic system is a robust developmental phenomenon evident in both children with normal language abilities and those with developmental language impairment. However, this conclusion is tempered by the fact that the WF group did indeed manifest some subtle differences in ability as compared to their ND peers. Their less frequent naming at the subordinate level, their greater dependence on morphologically transparent models to name at the subordinate level and their greater number of indeterminate errors at the subordinate level suggest that the breadth and depth of storage elaboration may be deficient.

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