DOCUMENT RESUME

ED 267 607 FL 015 550

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TITLE Preschoolers' Acquisition of Spatial Words in Mandarin Chinese.
PUB DATE Nov 85
NOTE 28p.; Paper presented at the annual meeting of the Chinese Language Teachers' Association (New York, NY, November 28-December 1, 1985).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Adjectives; Child Language; Comparative Analysis; English; Expressive Language; *Language Acquisition; Listening Comprehension; *Mandarin Chinese; *Preschool Children; *Spatial Ability

ABSTRACT

Two experiments investigated preschoolers' acquisition of spatial words in Mandarin Chinese. In one experiment, 5 groups of 10 children at 34, 39, 46, 52, and 57 months were tested for comprehension and production of 14 pairs of Chinese spatial words. In the comprehension test the children were asked to point to pictures corresponding to the words spoken; in the production test they were asked to say the opposite of the word spoken by the experimenter. Results indicated a high degree of consistency in the order of acquisition, which paralleled findings in English acquisition studies and was consistent with theory. However, the theory that unmarked words should be learned before the marked words was not supported. In the second experiment 3 groups of 10 children aged 34, 46, and 57 months were tested for their comprehension of two pairs of spatial terms. An object was placed in relation to another object having one or the other of the following characteristics: (1) inherent top, bottom, front, and back; (2) inherent front/back but not top/bottom; (3) inherent top/bottom but not front/back; and (4) neither top/bottom nor front/back. Results indicated that under all conditions even the youngest children had almost perfect comprehension of top and bottom but imperfect comprehension of front/back for objects without inherent front/back markings. (MSE)

ABSTRACT

The main objective of this study is to investigate preschoolers' comprehension and production of spatial wo Mandarin Chinese. The order of acquisition, relations between production omprehension, and cross linguistic comparisons between English and Ch ese are the main focuses of the present investigation.

In Experiment I, five groups of children with 10 children (half were boys) in each group at 34 month, 39 month, 46 month, 52 month and 57 month of age were tested for their comprehension and production of 14 pairs of Chinese spatial words. Comprehension was assessed by asking the child to point at pictures that correspond to the spatial words spoken by the experimenter. Production, on the other hand, was assessed by a game of opposition in which one puppet (played by the child) must always say the opposite of whatever was said by the other puppet (played by the experimenter). Results from the study showed that there was a high degree of consistency in the order of acquisition which paralleled colsely that was found for English. This order of acquisition was also consistent with predictions derived from Clark's theory of P-space and L-space. However, another of Clark's prediction that the unmarked word should be acquired before the marked word was not supported by our data.

In Experiment II, three groups of children with 10 children in each group were tested for thei. comprehension of two pairs of spatial terms above/ below and front/back. The average age of these children for each group was 34 month, 46 month and 57 month respectively. Comprehension was assessed by asking children to place a small object above, below, at the front or back of reference objects which were divided into four classes. They were: (1) objects with inherent top/bottom and front/back, (2) objects with inherent top bottom but without front/back, (3) objects with inherent front/back but without top/bottom, and (4) objects with neither top/bottom nor front/back. Results indicated that under all conditions, even the youngest children had almost per ct comprehension of top/bottom but comprehension was far from perfect for front/back for objects w thout inherent front/back markings.

Preschooler's Acquisition of Spatial Words in Mandarin Chinese

Words referring to spatial dimensions such as big/small, wide/narrow are found in most languages known to linguists. In terms of language development, some of these relational words (e.g. big, more) are among the earliest words acquired by children (Nelson, 1973; Mcshane, 1980). However, the conceptual complexity involved in many relational words made this acquisition quite extended, so that even by 6 or 7 years of age the full complexity of some words is still beyond many children's grasp.

Research into spatial relational words has been quite active. As pointed out by de Villiers (1978), reasons for this interest are : "first, these adjectives constitute an important way of describing and identifying objects; second, many studies have revealed a consistent ordering in their acquisition and in the difficulty children have with them; and third, children make interesting errors and substitutions in acquiring the full set of adjectives, errors that are suggestive of the way in which semantic development proceeds." (p. 136)

As far as the theoretical analysis of this acquisition process is concerned H. Clark (1973) has proposed the most comprehensive theory. Clark's analysis is based on the fundamental assumption that children's acquisition of spatial and temporal terms are guided by their prior cognitive-perceptual knowledge (the p-space) of space. He further argues that the consistent acquisition order for spatial terms (L-space) found among English speaking children reflects the close correlation between the L-space in English and the P-space in children's cognitive world, and the cognitive complexity involved in spatial terms. One may add that if one further assumes that the p-space is biologically constrained, then there should be high correlations in the acquisition order of spatial terms among all languages in which these terms are commonly used.

Clark believes that there are definite biological and physical constraints that lead the child to develop a p-space with very specific properties. For example for specification of object locations, one needs reference points and reference lines in one or two dimensional space and reference planes in 3-D space In addition, gravity defines the vertical direction quite independent of the specific locations on earth, and the terrestrial plane defines a natural reference plane. Given the asymmetrical nature of the gravitational force, there is a natural positive-negative distinction. On the other hand, the vertical plane separating left and right is quite symmetrical with respect to man's bilateral representation of our perceptual aparatus, so there is no natural positive-negative distinction here. In short

when man is in his typical upright position, the p-space has the following properties " (1) ground level is a reference plane and upward is positive, (2) the vertical left-right plane through the body is another reference plane and forward from the body is positive; and (3) the vertical front-to-back plane is the third reference plane and leftward and rightward are both positive directions." (p.35)

The L-space refers to the concept of space underlying the linguistic use of spatial terms. Clark (1973) wrote that " the most obvious properties of English adjectives and prepositions is that they require the notion "point of reference", following exactly ...(the) p-space" (p.36). In preposition, the object of the preposition is the point of reference for locating objects. In adjectives, both primary and secondary point of reference are found. The former is a zero point (e.g. the ground level) from which measures are made, the latter is an arbitrary reference point that depends on the specific standard implied (e.g."high","low" referring to mountain or houses) . Furthermore, certain adjectives can only apply to certain directions (e.g. "high","low" referring to vertical direction), or the notion of direction, is another property of the L-space. The third property of the L space is the notion of markedness well known to linguists. Generally, the more complex member of a pair of words is the marked member which corresponds to the less natural (or negative) direction of the p-space when there is asymmetry in the p-space.

In short, there is close correlation between the p-space and the L-space in terms of point of reference, markedness, and directionality.

When one considers the issue of acquisition order of these spatial terms, cognitive complexity should be the determining factor. Although there is no sure way to measure the absolute semantic (cognitive) complexity of words, Brown's (1973) notion of cumulative (relative) complexity can be relied on to make certain predictions. Following this strategy, Clark made the following predictions; (1) in antonymous pairs, the marked member should be acquired later, since the marked memeber is less natural in the p-space; (2) acquisition of spatial terms referring to secondary dimension (e.g. wide/narrow, broad/narrow) should occur after those words referring to primary dimensions (e.g. long/short, tall/short) while words requiring both primary and secondary dimension (e.g. thick/thin) should come the lattest.

One major weakness in H. Clark's theory has to do with the lack of specification of the mechanisms involved in applying the L-space terms to p-space knowledge during acquisition. E. Clark (1972, 1973) synthesized H. Clark's theory to her own semantic acquisition theory based on semantic feature hypothesis and presented a more detailed analysis on the actual acquisition process. The semantic feature hypothesis is based on the assumption that the semantic knowledge of a word can be analyzed into a set of semantic features, while E Clark's theory assumes that when a child learns the meaning of a word, he does it feature by feature, and the order of acquisition follows the principle that the more general features are acquired first. If one takes H. Clark's analysis on spatial terms and regards markedness, directionality, and point of reference as different semantic features of spatial words, then one can make more specific predictions on the acquisition order based on E. Clark's theory. For example, big/little would be the easiest to learn because their application is very general; they can be used to refer to any dimension of space. Long/short, high/low, tall/short all refer to one dimensional space, therefore, are less general than big/little and should be learned later than big/little. However, they are more general than wide/narrow and deep/shallow because the latter not only refer to one-dimensional space but also involves secondary point of reference which is more specific than primary point of reference. Following this analysis, Clarks' theories provide the following predictions on order of acquisition of some spatial terms.

big/little < tall/short, high/low, long/short < wide/narrow, deep/shallow < thick/thin

Research data have not been unanimous in either confirming or disconfirming Clarks' theories. One of the earliest study (Donaldson and Wales, 1970) had supported the prediction that marked member is learned later than the unmarked member of adjective pairs, however both methodological weakness (e.g. using comparatives and superlatives of adjectives as testing materials) and less than detailed analysis of data made this study [illegible] of many subsequent studies.

Two years later, E. Clark (1972) designed an opposition game to test children's production of spatial words. In this game, two hand-puppets were used to play a game in which one puppet (played by the child) always suppose to say the opposite of what the other puppet says (played by the experimenter). For example, if one puppet says "hot", the other would have to say "cold" and so forth. From this study, E. Clark was able to show that, as far as production goes, the order of acquisition of spatial words is exactly as predicted by her theory. But she did not find acquisition of unmarked member precedes the marked one. She explained this failure in terms of the nature of the opposition game which can be played only when the child understood the meaning of both members of a word-pair.

Several subsequent studies found conflicting results regarding the order of acquisition of marked vs unmarked spatial adjectives. Bartlett (1976) and Brewer and Stone(1975) found more errors in the comprehension of the negative pole but Carey (1977), like Clark, found no such discrepancy between negative and positive poles. Carey (1982) believed that the conflicting results can be understood by hypothsizing that children as well as adults encode spatial relation of two objects in terms of the positive member of the pair (e.g. taller, bigger . .etc.), so a comparative statement containing the negative member tends to result in longer verification time in adults (Clark, Carpenter and Just, 1973) and more errors in children. When the testing condition requires no comparison but a simple judgment (e.g. is this a long stick?) or production of a adjective word, the differential error rate between positive and negative words would disappear.

Acquisition order between different pairs of adjectives is much more robust and stable. Many studies (Bartlett, 1976; Brewer and Stone, 1975; Carey, 1977; E. Clark, 1972, Donaldson and Wales, 1970) found rather similar order of acquisition which is in general agreement with predictions based on the theories discussed earlier.

The present study is motivated by H. Clark's theory which explicitly stated that the acquisition order between different pairs of adjectives should be a language universal. If this is true, order of acquisition identical to English should be found in Chinese spatial adjectives.

EXPERIMENT I

In this experiment, 14 pairs of words commonly used in Mandarin Chinese to refer to spatial relations were used. They are : more/less (多少),big/little (大小), long/short (長短), far/near (遠近), tall/short (高矮), high/low (高低) , wide/narrow (寬窄), thick/fine (粗細), fat/thin (肥瘦), thick/thin (厚薄), deep/shallow (深淺), above/below (上下), front/back (前後), inside/outside (裏外). Order of acquisition of these words can be predicted on the basis of Clarks' theories.

多少	(n-space)	most general, for object description
大小	(n-space)	
長短	(1-space,-vertical)	less general, for object description
高矮	(1-space, +vertical)	
高低	(1-space, +vertical)	
遠近	(1-space, -vertical)	less general, for object location
上下	(1-space, +vertical)	
前後	(1-space, -vertical)	
裏外	(1-space, -vertical)	
粗細	(2-space, -vertical, secondary)	still less general, object description
肥瘦	(2-space, -vertical, secondary)	
寬窄	(1-space, -vertical, secondary)	least general , object description
厚薄	(1-space, -vertical, secondary)	least general, object description
深淺	(1-space, -vertical, secondary)	least general, object location

Production was tested through a game of opposition (Clark, 1972) while comprehension was assessed by asking children to point to pictures corresponding to words spoken by the experimenter. The main objectives of this experiment are (1) assessing the order of acquisition for both production and comprehension, (2) determine the acquisition relation between production and comprehension, (3) comparing Chinese acquisition order with that of English, and (4) to further delineate the nature of semantic acquisition through the analysis of error patterns.

Method

Subjects

Sixty five Mandarin speaking pre-schoolers were tested, of which 47 came from Taipei Da-An municipal kindergarten , 17 came from Taipei municipal Shin-Yi kindergarten and one from Chung-Chin (private) kindergarten. Fifteen children were excluded from the final sample for failure to coorperate or to meet the initial comprehension pre-test (explained below). Of the fifty children in the final sample, their age and sex distribution were given below.

Group	number	sex	age range (month)	average age (month)
1	10	half boys half girls	30-35	34
2	"	"	36-41	39
3	"	"	42-47	46
4	"	"	50-53	52
5	"	"	54-59	57

Materials

For the comprehension test, 18 set of pictures were drawn (see Appendix) of which 14 sets were used to test the 14 pair of words, 4 sets were used in a pre-test to make sure the subjects understood our instructions. Each set of pictures consisted two pictures depicting the two poles of a spatial word-pair.

For the production test, two puppets, a white rabbit and a gray bear, were used. The experimenter plays one puppet who says a word (e.g. long or short) and the subject who plays the other puppet must reply with a word that is the opposite of the spoken word.

Procedure

Each subject must complete both the comprehension and the production test for the data to be included in the final analysis. The two tests were given on separate occassions usually one to seven days apart. To balance testing effect, half of the subjects received the comprehension test first and the other half production first. Each subject was tested individually in a quite room on the premise of the kindergarten.

For the comprehension test, the experimenter first showed the child the pictures which usually engaged the child immediately. Then the experimenter turned to the first picture and said "show me the dog" . If the child made a mistake, E would correct her/him. For the next picture, the question was reduced to one word "ball?". Single word question was used in all subsequent pictures. There were 4 pre-test pictures of which the child must answer at least 2 correct to continue the study. After the pre-test, proper testing followed without any interruptions. This test normally took 20 minutes to complete.

The production test began with the introduction of the two puppets to the child. After allowing the child to play with the puppets for a few minutes, E said that these puppets were strange animals who always say something different from each other. For example, when one says "good" the other would "bad", when one says "fast" the other would say "slow" and so forth. Four examples (i.e. slow/fast bad/good, hot/cold, smile/cry) were used. Then the experimenter invited the child to play one puppet, and repeated the four pairs of words. If the child can play the game properly, the test words would follow immediately without interruption. This test normally took half an hour to complete.

Results and Discussion

Comprehension

Since each word was tested twice, a subject was regarded comprehending a word if he answered correctly on both occassions. For each word, the comprehension score was either 1 (i.e. showing comprehension) or 0 (i.e. failing comprehension) ; thus for each pair of words the maximum score was 2 and the minimum 0. Figure 1 presents the mean comprehsnion score of the 5 age groups as a function of spatial word-pairs. It is apparent that large differences exist between different word pairs, however there seems little difference in this trend between age groups. To check this observation, a two way analysis of variance (Anova) was performed on comprehension scores with Age (5 levels) and spatial word pairs (14 levels) as the independent variables. Both main effects were significant, (for age $F(4,45)= 5.88$, $p < 0.01$; for Word-pairs $F'(13, 585)=59.12$, $p < 0.01$) but their interaction was not significant ($F (52, 585) = 1.16$, $p > .05$). This result indicated that as the child became older, his comprehension improved. but the order of difficulty between different pairs of words remain uncahnged.

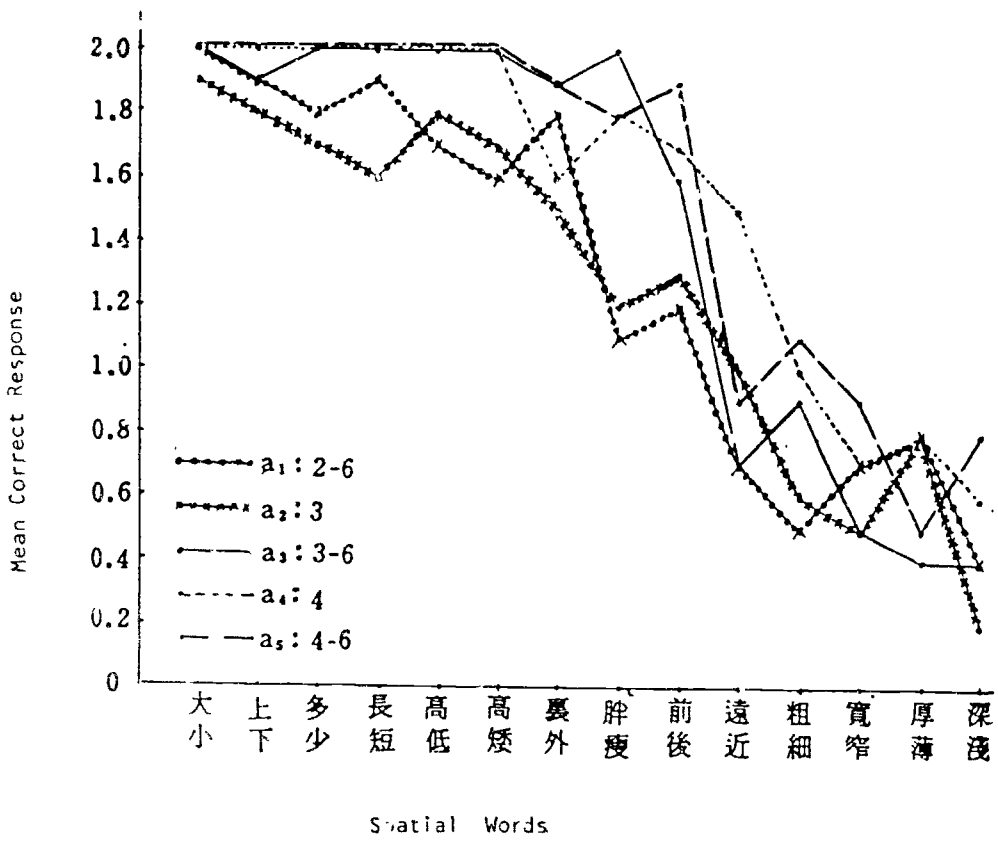

Figure 1. Mean correct response as a function of different spatial words

To determine which pairs of words are significantly different from which other pairs, a follow up pair-wise comparisons based on Newman-Keuls test was performed on all word pairs. From this analysis, the following results emerged

大 上 多 長 高 高 裏 肥 前 遠 粗 寛 厚 深
小 下 少 短 低 矮 外 痩 後 近 細 窄 薄 浅

Note words within parenthesis are not significantly different.

It seems that four groups of words may be ordered in terms of difficulty of

comprehension. The easiest words to comprehend are big/little, more/less, above/below, long/short, tall/short and high/low. The second group contains inside/outside fat/thin, front/back. Third group has far/near, thick/thin (粗細), and the hardest group contains wide/narrow, thick/thin (厚薄) and deep/shallow.

When one compares this order of difficulty with the predictions on page 5, one sees that except words of object location, the least difficult words are all n-space or 1-space words referring primary spatial dimension. However, words relating to spatial locations, except above/below all seem to be more difficult.

Two pairs of words deserved special attention. They are thick/thin (厚薄) refering to one dimensional secondary space (such as board, sheets of paper), and thick/thin (粗細) refering to two dimensional secondary space (e rope, wire, beam..etc.). There are no separate words in English to distinguish these usages. But in Chinese, these usages are clearly distinguished by different word pairs whose order of difficulty turned out exactly as predicted by Clark's theory.

To relate difficulty of comprehension to age, Guttman Scale was used to analyze these word pairs (Table 1) and a coefficient of reproducibility of 0.92 was obtained. Furthermore, from Table 1, one may tentatively conclude that, on the average, by the age of 3, Chinese children could comprehend big/little, more/less, above/below, long/short, tall/short, and high/low. Inside/outside, fat/thin, front/back, thick/thin (粗細), far/near were acquired bewteen 3 and 4. Acquisition of wide/narrow, thick/thin (厚薄) and deep/shallow occurs sometime after 4 years of age.

To determine whether the positive pole (unmarked member) of an adjective pair was acquired first, subjects who either understood or failed to understand both memebers of a word pair were eliminated for that word pair. From the remaining subjects who understood only one member, one can determine the proportion of subjects who understood the positive pole. Through binomial distribution, it is easy to determine whether this proportion is higher than expected by chance. Table 2 presents the result. If one uses the 10% chance level as the criterion, the 5 pairs of words showing asymmetric acquisition, 3 pairs favoured positive pole, 2 pairs favoured negative pole. If one adopts 5% level, then 2 pairs favoured positive pole and 2 pairs negative. In short there is no evidence supporting the contention that positive pole is acquired before negative pole.

年齢	多少	大小	長短	上下	高低	西東	裏外	前後	昨夜	甘細	遠近	厚薄	電車	深浅	平均年齢	人数
4.8														0		
4.4														0		
4.7											0		0			
4.4										0			0	0		
4.11												0	0	0	4.7	8
4.9										0		0	0	0		
4.5										0		0	0	0		
4.5										0		0	0	0		
4.6											0	0		0		
4.11											0	0	0	0		
4.3											0	0	0	0		
3.10											0	0	0	0	4.3	6
4.2							0	0			0	0	0			
3.10				0							0	0	0	0		
3.11										0	0	0	0			
4.10										0	0	0	0	0		
4.5										0	0	0	0	0		
4.2										0	0	0	0	0		
3.11										0	0	0	0	0	3.10	9
3.10										0	0	0	0	0		
3.8										0	0	0	0	0		
3.6										0	0	0	0	0		
2.10										0	0	0	0	0		
2.11									0	0	0		0	0		
4.10							0			0	0	0	0	0		
4.5							0			0	0	0	0	0		
2.11	0								0	0	0	0		0	3.8	7
4.7									0	0	0	0	0	0		
3.2									0	0	0	0	0	0		
2.8									0	0	0	0	0	0		
4.2								0	0	0		0	0	0		
4.8								0		0	0	0	0	0		
3.11								0		0	0	0	0	0		
3.8								0		0	0	0	0	0	3.9	7
3.1								0		0	0	0	0	0		
2.11								0	0	0	0	0	0	0		
2 10								0	0	0	0	0	0	0		
3.11							0	0		0		0	0	0		
3 0							0	0		0		0	0	0		
3.3	0								0	0	0	0	0	0		
3.3						0		0	0	0	0	0	0	0	3.4	6
3.5			0				0	0	0	0	0	0	0	0		
3.1	0		0					0	0	0	0	0	0	0		
2.11			0			0	0			0	0	0	0	0		
2.6					0		0	0	0	0	0			0		
2 9	0				0	0		0	0	0	0	0	0	0		
3 5				0	0		0			0	0		0	0	3 .	7
2 10				0	0	0		0	0	0	0		0			
3.4				0	0	0			0	0	0		0	0		
3 4	0	0	0			0		0	0	0	0	0	0	0		
不合数	4	0	3	2	1	3	10	5	10	4	4	5	2	4		50

note: empty cells represent correct comprehension, 0 means failure to comprehend.

Table 1. Guttman Scale for comprehension of 14 pairs of words.

關係詞	n	s	p	顯著水準				
				0.3	0.2	0.1	0.05	0.01
遠近	28	4	0.001	✓	✓	✓	✓	✓
寬窄	25	8	0.036	✓	✓	✓	✓	
胖瘦	13	10	0.971	✓	✓	✓	✓	
多少	5	5	0.984	✓	✓	✓	✓	
深淺	16	11	0.928		✓	✓		
高低	5	4	0.891	✓	✓			
粗細	21	9	0.256	✓				
厚薄	15	9	0.773	✓				
前後	11	5	0.387					
高矮	5	3	0.656					
裏外	5	2	0.344					
上下	4	1						
長短	3	2						
大小	1	0						

note: n = number of subjects understood one member of the word pair
s = number of subjects understood the positive pole.
p = binomial probability of s success given n trials with p= .5

Table 2. Binomial probability of comprehension of single member of word pairs

Comprehension

In order for the production of a word to be scored correct (a score of 1) the response word must be exactly as required by the experimenter. Any alternative response, regardless the semantic similarity to the correct response, would be scored wrong (a score of 0). The only exception concerns tall/high to which the same Chinese word is used, thus when tall or high was used as stimulus, either short or low would be accepted as correct. As in comprehension, for each pair of words the score would range from 2 to 0. A two way Anova involving Age (5) and Word-pair (14) was performed on subjects' scores, and both the main effects (Age $F(4,45)= 9.09$, $p < 0.01$

Word-pair $F(13,585) = 77.97$, $p < 0.01$) and the interaction ($F(52\ 585) = 1.91$, $p < 0.01$) were significant. A follow-up Newman-Keuls paired comparison test revealed the following order of difficulty of production.

前	上	裏	多	高	大	長	高	胖	遠	厚	粗	寬	深
後	下	外	少	矮	小	短	低	瘦	近	薄	細	窄	淺

When one compares the obtained order for production and comprehension the most striking change involves front/back which was one of the more difficult word-pair to comprehend, but the easiest in production. Other word-pairs also seemed to have changed somewhat their relative positions, but when one compares production and comprehension in terms of groups of words equivalent in difficulty, there was little significant change.

As before, one can present the data on a Guttman Scale (Table 3) and again the order of difficulty was well related to age. In other words, for all practical purposes, order of difficulty can be treated as order of acquisition.

One of the most interesting part of the production data was the errors made by children. Four categories were used to classify errors; they were (1) semantically appropriate errors (e.g. responding to "below" with 'high" or "heaven") (2) semantically inappropriate but related to correct response (e.g. responding to "above" with "front" or "inside"), (3) unrelated errors (e.g. responding to "big" with "shoes"), (4) no response. Two graduate students from our department made independent classification of 256 errors, they disagreed on only 19 errors which were classified by the present authors. There were some subjects responding to stimulus words by adding the negative marker "bu" (i.e. not) to the stimulus words. We classified these responses either as class (1) error, if the subject showed comprehension of the required response word in the previous test of comprehension, or class (2) error, if no evidence of comprehension was found. Figure 2. presents errors as a function of age. It seems apparent that as the child became older, unrelated response almost disappeared completely and the no response category also showed large decrement. Developmental changes in the other categories of error were not apparent. A more detailed analysis of semantically appropriate

年齢	前後	上下	裏外	多少	大小	長短	高矮	高低	胖瘦	遠近	厚薄	粗細	寛窄	深浅	平均年齢	人数
4 8			0							0	0			0		
4.9											0		0	0		
4 5								0				0	0	0		
4.4												0	0	0	4.6	6
4.4							0					0	0	0		
4.7				0						0		0	0	0		
4.11											0	0		0		
4.11											0	0	0	0		
3.10											0	0	0	0		
2.10											0	0	0	0		
4.6											0	0	0			
4.3					0		0	0			0	0		0	4.3	12
3 11									0		0	0	0	0		
3.5								0			0	0	0	0		
3 11						0					0	0	0	0		
4 7					0						0	0	0	0		
4.10					0				0		0	0	0	0		
4.8					0				0		0	0	0	0		
4.5			0							0	0	0	0	0		
4.5	0									0	0	0	0	0		
4 2			0							0	0	0	0	0		
4 5							0			0	0	0	0	0		
3 11										0	0	0	0	0		
3 10										0	0	0	0	0	3.10	10
3 8										0	0	0	0	0		
3.6										0	0	0	0	0		
3.2						0				0	0	0	0	0		
2.11					0	0				0	0	0	0	0		
2.8		0		0	0				0	0	0	0	0	0		
3.1								0	0	0	0	0	0	0		
4.10				0				0	0	0	0	0	0	0		
2.10		0			0			0	0	0	0	0	0	0		
2.11	0			0			0	0	0	0	0	0	0	0		
4.2							0	0	0	0	0	0	0	0		
3.10						0		0	0		0	0	0	0	3.4	12
3.4					0		0	0	0	0	0	0	0	0		
3.1				0	0	0			0	0	0	0	0	0		
3.3				0		0	0	0	0	0	0	0	0	0		
3.4				0	0	0	0	0	0	0	0	0	0	0		
2.11				0	0	0	0	0	0	0	0	0	0	0		
3.8			0		0		0	0		0	0	0	0	0		
3.5	0		0			0	0	0	0	0	0	0	0	0		
4.2			0	0	0	0	0	0	0	0	0	0	0	0		
2 6			0	0	0	0	0	0	0	0	0	0	0	0		
3.11		0	0			0	0	0		0	0	0	0	0		
2.11		0	0		0	0			0	0	0	0	0	0		
2.9		0	0	0	0	0	0	0	0	0	0	0	0	0	3.3	10
3.0	0		0	0		0	0	0	0	0	0	0	0	0		
2.10	0	0		0	0	0	0	0	0	0	0	0	0	0		
3 3	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
誤答数	3	3	4	8	11	5	6	5	5	3	2	0	2	1		

note: empty cells represent correct responses.

Table 3. Guttman Scale for Production data

errors is presented in Table 4. Words referring primary dimensions were the most frequent subsitution words representing 74% of the total substitution errors in the semantically appropriate category. Although when a semantically appropriate substitution occurs, usually a substitution word (e.g. little) is less specific than the target word (e.g. short, thin, low), there were cases of reverse relationship (i.e. using "short" to substitute "little"). Therefore these data do not provide unequivocal support for E. Clark's theory of semantic acquisition.

Table 5 is analogous to Table 2 but contains production data. Again, as in comprehension, there was no support for the contention that a child has the tendency to learn the positive member of a word pair before learning the negative word.

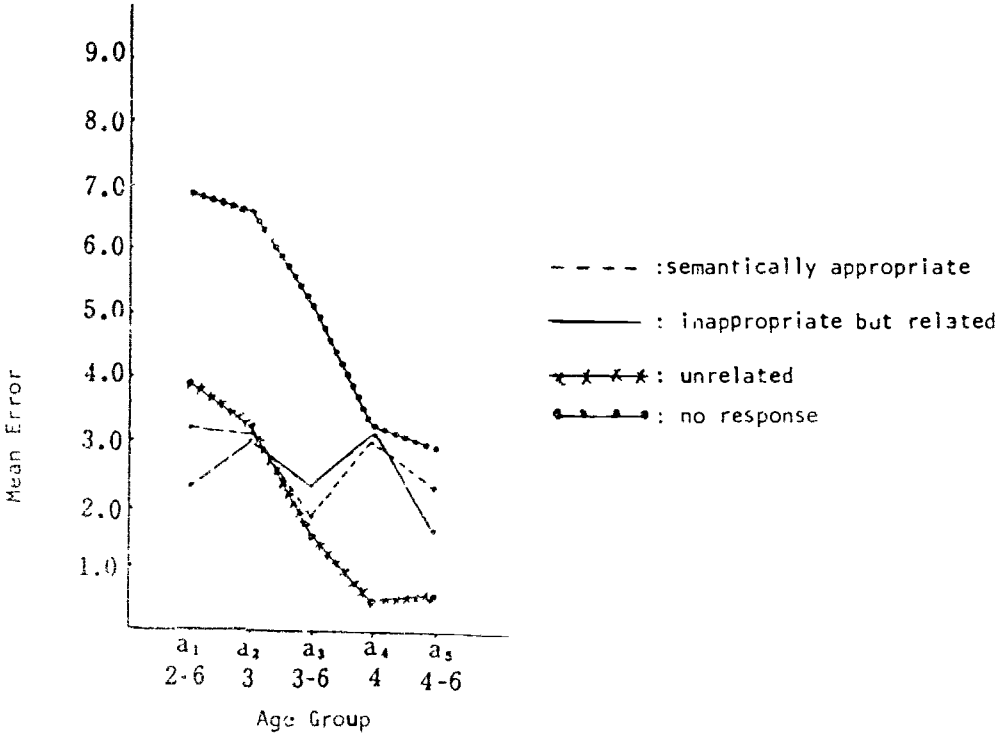

Figure 2. Mean error for each age group

The relation between Production and Comprehension

For the present analysis, word pairs were used as the basic unit of comparision, and a subject must show correct comprehension or production of both members of a word pair for his response to be included in the analysis. When one considers

替代字		正確反應
樓	下	下面(1)
	小	下面(1)，短(3)，低／矮(16)，瘦(5)，細(1)
	高	上面(2)；多(1)，長(2)，大(7)
天	堂	上面(1)
中	間	裏面(1)
	大	長(2)，高(5)，厚(1)，寬(1)，深(1)，多(1)
	矮	小(6)，薄(2)
	多	大(1)
	短	低／矮(3)
下	面	低／矮(3)
	長	高(1)，寬(1)，深(1)
上	面	高(2)
	寬	大(1)，厚(1)，粗(1)
	窄	薄(3)，細(3)
	淺	薄(2)
	胖	厚(1)，寬(1)，[illegible](2)
	細	窄(2)
	瘦	窄(1)
	粗	寬(1)
	厚	寬(1)，粗(2)，深(6)
	薄	細(2)
	近	淺(1)
	遠	深(2)

note figures in parenthesis represent number of cases

Table 4 Substition analysis for semantically appropriate responses

關係詞	n	s	P	顯著水準			
				0.3	0.2	0.1	0.05
粗細	8	1	0.020	✓	✓	✓	✓
高矮	13	9	0.910	✓	✓	✓	
長短	9	7	0.945	✓	✓	✓	
上下	6	1	0.063	✓	✓	✓	
裏外	11	4	0.194	✓	✓		
胖瘦	7	2	0.145	✓	✓		
大小	12	7	0.710	✓			
遠近	12	5	0.291	✓			
高低	12	6	0.500				
多少	9	5	0.623				
厚薄	7	3	0.363				
前後	6	3	0.500				
深淺	5	3	0.656				
寬窄	5	3	0.656				

n= number of cases
s= number of success
p= probability of s successes in n trials

Table 5. Binomial distribution of single member production of a word pair

the relationship between comprehension (C) and production (P) for a word pair, there are four possible combinations : (a) correct comprehension and production (CP), (b) correct comprehension but incorrect production ($C\bar{P}$), (c) correct production but incorrect comprehension ($\bar{C}P$), and (d) incorrect on both comprehension and production ($\bar{C}\bar{P}$). Table 6 presents the number of cases under these conditions for 14 pairs of word. Eventhough the total sum of cases for CP and $\bar{C}\bar{P}$ was fairly similar, there was a very clear split between word pairs that showed high CP but low $\bar{C}\bar{P}$ and word pairs showing the reverse relation. Counting from top, the first word pair (above/below) to the eighth word pair (high/low) in Table 6 all had a CP/ $\bar{C}\bar{P}$ ratio at 6.5 or above, while for the last five pairs of word the $\bar{C}\bar{P}$/ CP ratio was 5.6 or above. Word pairs showing high CP/$\bar{C}\bar{P}$ ratio were all

primary dimension words, except for far/near, words with high $\bar{C}\bar{P}/CP$ were all secondary dimension words, indicating that words refering to secondary dimension are more difficult to acquire.

關係詞 \ 組合	CP	C$\bar{P}$	$\bar{C}$P	$\bar{C}\bar{P}$
上下	40	6	4	0
前後	32	1	12	5
裏外	34	7	5	4
大小	32	17	0	1
多少	34	11	2	3
長短	32	14	1	3
高矮	31	13	2	4
高低	26	19	1	4
胖瘦	23	10	4	13
粗細	1	9	1	39
寬窄	1	3	2	44
遠近	5	5	12	28
厚薄	3	6	0	41
深淺	0	4	1	45
總計	294	125	47	234

note CP = correct comprehension correct production
C$\bar{P}$ = correct comprehension incorrect production
$\bar{C}$P = incorrect comprehension correct production
$\bar{C}\bar{P}$ = incorrect comprehension and production

Table 6 Comparison of comprehension and production

Turning attention to cases of $C\bar{P}$ and $\bar{C}P$, it is apparent that except for four word pairs (i.e. above/below, front/back, inside/outside, and far/near) all word pairs showed much higher comprehension without production instances than the reverse. This result obviously indicated that for most words, comprehension preceded production in acquisition. This is well in agreement with common expectation. But what about the exceptions found in Table 6? The exceptions involved four word pairs above/below, front/back, inside/outside and far/near, and all of them are locative words. Why are locative words more difficult to comprehend? One possible reason might be that locative words are more difficult to depict in pictures so that more errors were made in the comprehension test. Although this possibility can not be ruled out completely, close examination of our stimulus pictures did not show any undue vagueness for pictures on locative terms. In any event, it is not always true that comprehension precedes production. For example, some deitic terms such as "this", "that", "here", and "there" appeared quite early in children's vocabulary, but initially are used only in their attention-directing function. Only much later, can children comprehend their contrastive spatial functions (Wales, 1979). So it is quite possible that some children in our sample were able to produce the correct contrastive locative words but unable to comprehend the meaning of these same words as reflected in the picture comprehension task. Just how far can children comprehend these locative spatial terms is the focus of the next experiment.

Experiment II

Studies on spatial locative terms are numerous, and most of them are concerned with the word pair front/back (E. Clark, 1980, Harris and strommen, 1972, Johnston and slobin, 1979, Johnston, 1984, Kuczaj and Maratsos, 1975). Despite predictions that front should be easier to learn because of its perceptual prominence, most studies found no apparent lag between the acquisition of these words Regarding the vertical dimension, an earlier study by E. Clark (1973) found that children seemed to comprehend "on" before "in" which in turn preceded "under". Closer examination found that children at an earlier stage may have adopted a nonlinguistic strategy of placing everything on the top surface of a reference object thus giving the impression of understanding the meaning "on" before "in" and "under". Following this insight, E. Clark (1980) undertook another study in which she varied the nature of the reference objects which were from four categories: (1) objects with inherent top/bottom and front/back, (2) object with inherent top/bottom but not front/back, (3) objects with inherent front/back but not top/bottom, and (4) objects without inherent top/bottom nor front/back. Children were asked to show the experimenter the various positions of these objects. Her results showed that children understood top/bottom before front/back but no significant difference between different members of these word pairs.

The present study followed the essential design features of E. Clark's(1980) study to determine Chinese children's comprehension of locative words with respect to different reference objects.

Method

Subject

Three groups of children who participated in the previous study were chosen. They were group A1 (mean age 34 month), A2 (mean age 46 month) and A3 (mean age 57 month).

Materials

Two objects were selected for each of the four categories of objects. For category HV (i.e. objects with inherent horizontal and vertical positions) the chosen objects were a small toy truck and a toy chair, for category H (i.e. objects with inherent horizontal position but no vertical position) a model and a flate metal

design (0.7 cm thick and 8.7 cm in diameter) with picture on the front surface cork surface at the back, for category V (i.e. objects with inherent vertical position but not horizontal position) a small bottle (10 cm tall, 3 cm in diameter) and a small toy table lamp (13 cm tall, 6 cm in diameter) were used, and finally for category Un (i.e. objects with neither inherent vertical nor horizontal positions) a ping-pong ball and a cubic wooden block (2.4 cm each side) were chosen.

Procedure

Each child was tested individually in a quite room on the nursery school. After a few minutes of familiarizing the child with the surrounding and the testing materials, the experimenter picked a small cat (about 1 cm) and ask the child to place the cat in experimenter's hand , if the child made a mistake he/she would be corrected. Then the experimenter asked the child to place the cat on his/her own head. When the child had no difficulty following the instructions, the experiment would begin. The child would be asked to place the cat on various positions (reference objects. All reference objects described above were used for al our positions (top/bottom,front/back), thus each child would be questioned 32 times (8 objects x 4 positions). Appearance order of objects and order of questions were randomized for each child.

Six students at National Taiwan University were also questioned with respect to these objects and the four positions, and their response agreed in 96% of cases. The only descrepancies came from one of the subject in answering the question front/back with respect to objects without inherent front/back (Category V) and objects without front/back and top/bottom (Category Un). Majority answers were used as the correct response with respect to which children's responses were judged.

Results and Discussion

When a child responded to a question in a manner identical to adult response he/she would be given a score of 1, otherwise a score of 0 will be given. Since for each object category , each distinct position was questioned twice (i.e. two objects), a child can get a maximum score of 2 and minimum 0 for each distinct condition. This dependent measure was subjected to a 3-way Anova (Age (3) x Object Category (4) x Position (4)). Except age, the other two main effects were significant (for Object Category, $F(3,81) = 79.96, p < 0.01$, for position $F(3,81) = 170.81$, $p < 0.01$). The only significant interaction involved Position x Object Cate.

($F(9,243)=40.22$, $p < 0.01$), all other interactions were non-significant. Since neither Age nor any of its interaction were significant, for all practical purposes, this factor can be ignored. In Figure 3 data averaged over age were presented. Inspection of this figure made it quite clear where the significant effects in the Anova originated. As far as top/bottom is concerned, almost perfect comprehension was shown by children at all ages for every category of objects, but comprehension of front/back was drastically affected by the nature of the reference objects. Mean correct response for objects with inherent front/back was more than three times higher than that for objects without inherent features. Compared with English data (E. Clark, 1970) our data are in general agreement in that top/bottom was much easier than front/back and there was no apparent difference between different members within each word pair. However, for comparable age group, our data had a much higher correct-response level than English speaking children for front/back under category HV and H.

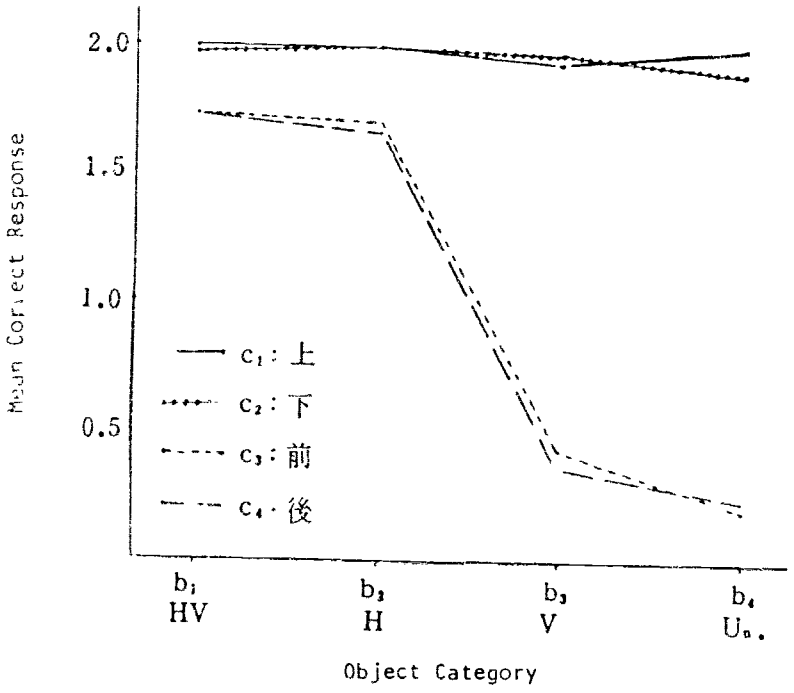

Figure 3. Mean correct response by object category and positions

Furthermore, Clark found strong tendency of non-linguistic strategy among children unable to comprehend front/back. Nearly half of total response were placing an object on the top surface of the reference object when the instruction "top" or "front" was given in Clark's data. When we analyzed misplacement in our data (see Table 7), there was no undue tendency of substituting top for front or back. To be sure, there were such substitutions, but other substituions were just as frequent. In fact the use of aduldt's back response for front instruction was slightly higher than the use of top for front. Thus there is no evidence in our data to support Clark's claim that the non-linguistic strategy of placing an object on top of another object is the underlying basis for children's acquisition of top/bottom before they acquire front/back.

在方位「前」之替代情形（「前」爲正確反應）

物品種類		上		下		（前）		後		遠		近	
		人次	%	人次	%	人次	%	人次	%	人次	%	人次	%
二歲半組	HV	0	0	0	0	16	80	1	5	2	10	1	5
	H	1	5	0	0	14	70	0	0	5	25	0	0
三歲半組	HV	1	5	1	5	17	85	1	5	0	0	0	0
	H	0	0	0	0	19	95	1	5	0	0	0	0
四歲半組	HV	0	0	0	0	19	95	1	5	0	0	0	0
	H	0	0	0	0	18	90	0	0	2	10	0	0

物品種類		上		下		（前）		後		左		右	
		人次	%	人次	%	人次	%	人次	%	人次	%	人次	%
二歲半組	V	4	20	0	0	6	30	4	20	4	20	2	10
	Un.	5	25	0	0	1	5	3	15	8	40	3	15
三歲半組	V	4	20	0	0	2	10	7	35	4	20	3	15
	Un.	5	25	0	0	1	5	6	30	3	15	5	25
四歲半組	V	2	10	0	0	5	25	6	30	7	35	4	20
	Un.	2	10	0	0	4	20	4	20	3	15	7	35

在方位「後」之替代情形（「後」爲正確反應）

物品種類		上		下		前		（後）		遠		近	
		人次	%	人次	%	人次	%	人次	%	人次	%	人次	%
二歲半組	HV	1	5	0	0	1	5	14	70	3	15	1	5
	H	0	0	0	0	1	5	14	70	2	10	3	15
三歲半組	HV	1	5	0	0	0	0	19	95	0	0	0	0
	H	0	0	1	5	1	5	18	90	0	0	0	0
四歲半組	HV	1	5	0	0	0	0	19	95	0	0	0	0
	H	0	0	0	0	0	0	18	90	0	0	2	10

物品種類		上		下		前		（後）		左		右	
		人次	%	人次	%	人次	%	人次	%	人次	%	人次	%
二歲半組	V	2	10	2	10	4	20	5	25	2	10	5	25
	Un.	1	5	2	10	1	5	3	15	5	25	8	40
三歲半組	V	0	0	1	5	7	35	3	15	6	30	3	15
	Un.	1	5	1	5	6	30	0	0	7	35	5	25
四歲半組	V	0	0	1	5	7	35	3	15	6	30	3	15
	Un.	0	0	2	10	5	25	4	20	5	25	4	20

Table 7. Substitution frequency

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