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ABSTRACT

To analyze the relationship of logical development and comprehension of syntax, 60 children aged 5-8 years were individually tested. Measures included class inclusion, conservation of substance and weight, a sorting test, and a test of comprehension of active and passive sentences. Class inclusion was not strongly related to syntactical comprehension, but conservation was. Syntax was more strongly correlated with conservation than with another language measure. Logic may be related in different ways to vocabulary, syntax, and verbal fluency. Syntax, the organization of elements in a sentence, seems to have an appreciable relationship with logic during this period of development. (Author)

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A STUDY OF THE RELATIONSHIP OF COGNITIVE DEVELOPMENT AND SYNTACTICAL COMPREHENSION

By

Barbara Hutson

The major approaches to the relationship of language and thought seem to fall into these categories: (1) Thought is dependent upon language, (2) Thought is language, (3) Language is dependent upon thought. James Jenkins (196) describes these and also the need for a fourth category which recognizes that each of the others has some value, but that none by itself can explain the full range of phenomena relevant to this point. He also notes that though one system may aid development of the other, the direction of this aid may change from time to time during development. To understand this interaction, it is necessary to study the development of both systems in the same children and to compare the relationships found at various ages.

Even where strong relationships exist, inappropriate measures will fail to show them. Some studies have used such a narrow or unrepresentative slice of language or thought that generalization to the relationships of the systems as a whole seems unsafe. Others have used measures, such as IQ or verbal ability, which are so broad that they may average out the very

I would like to thank Glenn Rediehs for administering the conservation tasks, Dorcie Edson, for administering the object sorting test, and the Research Service Center of the University of Florida for assistance in analysis of the data.

different effects that analysis of subskills within language and thinking might have revealed.

Perhaps a more fruitful approach to study of this problem lies in defining more precisely the areas within language and thinking whose relationship seems to deserve attention. The focus of this study is on cognitive development (the increasing ability to coordinate logical relationships) as a subset of thinking, and the development of syntactical comprehension (the increasing ability to understand the relationship of elements of a sentence as indicated by word order and markers) as a subset of language.

Three sources seem to support the belief that an examination of the relationship of cognitive development and syntactical comprehension is warranted. These are the general similarity of the operations which seem required for each, the similarity of the age range in which each develops, and recent research relevant to this question.

The development of syntactical production is generally considered to start about two years of age with the first 2-word sentences (though comprehension may well be present before production). Noting that much of syntax is in the child's repertoire (though perhaps not in stable or fully generalized form) before 4-1/2 years, and that it had earlier been assumed that all of syntax was acquired by this age, McNeill (1970) states that "it is now clear that some aspects of syntax are not acquired

until much later, and for some speakers certain details of grammar may never be acquired."

Cognition is considered to develop from reflexes present at birth through a period of sensorimotor development (birth to 1-1/2 or 2 years), a preoperational period (until about 7 or 8 years), a concrete operational period (from 7 or 8 until about 11 years), and a period of formal operations (from about 11 to 14 years). The children in this study would be expected to be in the preoperational period (characterized by lack of reversibility and conservation, but showing an ability to appreciate order and direction) and the concrete operational period (characterized by development of the ability to understand the coordination of order and direction in more than one dimension simultaneously). (Piaget, 1970)

Literate adults generally accept certain logical conventions about the relations of objects in the world and of actions upon them. Research on the cognitive development of children has found that children only gradually come to understand and apply these rules (Flavell and Hill, 1967). Similarly, adults understand the linguistic conventions by which the underlying meaning of a sentence is expressed in the surface structure (N. Chomsky, 1965) and that alternative surface structures or sentence forms may express the same underlying meaning. Recent research on children's comprehension of syntax has found that children come into this understanding over an extended period, and that some aspects may develop in stages (C. Chomsky, 1969) similar to those noted in cognitive development.

There has been speculation that comprehension of the later-developing syntactical constructions may require a certain level of logical development (Kessel, 1970). Studying awareness of underlying structural ambiguities, Kessel found that such awareness emerges rather abruptly after the age of 10, and suggests that this may be related to the development of formal operations, the most advanced stage of logical operation.

Carol Chomsky finds evidence of stages in the development of at least some syntactical constructions between the ages of 5 and 10. Particularly difficult to learn are those constructions in which the child must balance off the influence of an apparently familiar sentence pattern with that of a word whose meaning or usage assigns a different meaning to that pattern. She comments that the children "do not, as they see it, fail to understand our sentences. They understand them, but they understand them wrongly." This seems to parallel the observation in Piaget's studies of cognitive development that children who do not thoroughly understand the concept implied by a question seem to reformulate the question in a way consistent with their level of understanding and proceed to answer it (Inhelder and Piaget, 1964) according to their interpretation.

Inhelder and Sinclair (1969), studying children who vary in their grasp of concrete operations, observe a parallelism between the verbal patterns and the level of operativity of their subjects. They suggest that in both areas the source of difficulty is the young child's inability to decentrate and coordinate. The child who has not yet grasped concrete operations can

focus on a single aspect, such as length of an object, but cannot coordinate two dimensions in such a way as to recognize the effect that changing one dimension has upon the other.

The most pronounced differences between conservers and non-conservers were in the use of structural devices, comparative markers and sentence structure. There was a much closer link between syntactical structure and operativity than between vocabulary and operativity. Inhelder and Sinclair conclude that "an operational component is necessary before linguistic structures, acquired in isolated sentences, are ready to be generalized and correctly applied in all situations." Piaget, (1970) commerting on their work, states that "Chomsky's transformational structures are facilitated by the previous operation of the sensorimotor schemes, and thus their origin is neither in an innate neurophysiological program (as Chomsky himself would have it) nor in an operant or other conditioning 'learning' process [as Chomsky (1959) has shown conclusively]."

Although they have not been specifically related to cognitive development, the active-passive sentence forms studied by Fraser, Bellugi and Brown (1963), and Turner and Rommetveit (1967) seem likely (though one of many possible) syntactical developments to study in this context. Fraser et al., studying 3-year old children, found that in both comprehension and production these children made far more correct responses to active sentences than to passive sentences. They speculate that the young child may process the passive sentence as if it were

active, basing his interpretation on the usual rule of English word order in which the subject precedes the object. He thus fails to appreciate the rule by which the passive markers reverse this pattern. Turner and Rommetveit, studying older children with both reversible and nonreversible sentences, find a similar lag in the development of passive voice. There is reason to question whether the inability to coordinate two rules is related to the cognitive skill of coordinating dimensions.

Although there has been little research directed to this point, there seems reason to believe that there may be a relationship between development of syntactical comprehension and cognitive development, based on the child's increasing ability to coordinate relationships in each of these domains. The purpose of this study is to examine these relationships by individual testing on several measures of cognitive development and of linguistic development. The hypothesis tested was that there would be a stronger relationship between syntax and some of the logical measures than between other language measures and the logical measures.

METHOD

Procedures

Class Inclusion. The child was shown a picture, such as a group of flowers which included roses and daisies. He was asked whether there were more roses or more daisies. Ten cards were shown. No verbal justification was required. (See Appendix A)

Conservation. The tasks used were similar to those described by Smedslund (1961), except for pretraining on the terms "same," "more," and "less." The child was shown two equal balls of plasticine, and watched as one of them was changed in shape. He was then asked whether the pieces of plasticine had the same amount and whether they still weighed the same amount. The verbal justification was used to classify the child as conserver, nonconserver, or transitional.

Syntax. The sentence The cat chases the dog expresses the same message in the active voice that The dog was chased by the cat expresses in the passive voice. To test whether the child recognized this equivalence, he was asked to point to the picture that best fit the sentence read to him. Eight active and eight passive sentences were presented. No reading skill or verbal fluency was required for the child to express comprehension. (See Appendix A)

Object Sorting. This is similar to the Piagetian horizontal reclassification task as described by Kofsky (1966). The child

was told to select any one of 33 common objects and then asked to pick out all the objects that belonged with it. For the second sort, the child was asked to think of a different way that some things could go with the object chosen for the first sort. Scoring on a scale of 0 to 4 based on adequacy (Rapaport, 1968), using criteria of relevance and breadth-neither too narrow nor too inclusive.

Concept. The concept a child offers as the basis for his sort is analogous to the verbal justification for the conservation tasks, but in this test the verbal aspect is scored separately as failure, concrete, functional or abstract. Since it was possible for a child to change in level of concept from a score of 0 (failure) on the first concept up to level 3 (abstract) on the second sort or from level 3 to 0, a transformed scale of 6 points was used to measure amount and direction of change.

Data Analysis. The relationship of the test measures, interviews, classroom observations, and demographic information (from the larger study of which this formed a part) was assessed by means of a principal components analysis with orthogonal rotation and by one-way analysis of variance. Means for syntax and conservation tests were computed for subgroups by age and race. Means for the sorting test and concepts were computed for subgroups by age and sex. The relative strength of the correlations of certain language and logical measures was assessed by a Z-test of the difference of the correlation coefficients (Hays, 1963).

RESULTS

Class Inclusion. For the 10-item class inclusion test, the mean score for the group was 3.4. This included 2 non-inclusion items which almost every child passed. Very few children showed understanding of class inclusion. This measure neither correlates appreciably with nor loads on the same factors as syntax, conservation, or classification. The highest factor loading for class inclusion was on a factor which contained high negative loadings for 2 socialization measures of ability to express feelings and sensitivity to others.

Conservation. Age had a significant effect upon conservation of weight ($F = 4.10$, $df = 3,56$, $p < .05$), but not upon conservation of substance. Race had a significant effect upon conservation of substance ($F = 4.30$, $df = 1,58$, $p < .05$), but not upon conservation of weight. Correlation of the two conservation tasks was .68, and both loaded on the same factor, along with syntax and race. (See Appendix B, Table 1)

Syntax. Age and sex appear to have no significant effect in this group upon acquisition of syntactical comprehension. Race, however, seems to be a significant variable in the development of comprehension of syntax. It appears to have more effect upon comprehension of the passive voice than of the active voice during the age span tested.[1] The effect of race on comprehension

[1] This does not rule out the possibility that a test of children at age 3 or 4 might have shown an effect of race upon the earlier-developing active voice.

of passive voice was significant ($F = 7.07$, $df = 1,58$, $p < .05$), but the effect of race on comprehension of active voice was not significant. (See Appendix B, Table 1)

The correlation of syntax and conservation was not significantly different from that of the two conservation measures with one another, suggesting an appreciable overlap in the language and logical test responses. The correlation of syntax with Concept 1 (another language measure), was smaller than the correlation of syntax and conservation of substance. The difference in these correlations was significant ($t = 2.52$, $p < .05$).[1] (See Appendix B, Table 3) The patterns for conservation of weight were similar but less pronounced than those for conservation of substance. Active voice shows a stronger relationship than passive voice, but in general, syntax correlates more strongly with the logical tasks of conservation than with the other language measures.

Sort and Concept. Sort 1 and concept 1 clustered together in a different factor than sort 2 and concept 2. The factor in which sort 1 and concept 1 appear has a loading of -.53 on sex (favoring boys) and a loading of -.56 on ability to change from one conceptual level to a higher one. Sort 2 and concept 2 appear in a factor with a loading of -.07 for sex and a strong positive loading on change. (See Appendix B, Tables 2 and 4)

[1] Significance of the difference in correlations was tested by a t-test for dependent measures. (Blalock, H.M. Social Statistics, New York:McGraw-Hill 1960)

DISCUSSION

Although syntax does not seem strongly related to class inclusion for this group of children, a significant relationship between syntax and conservation was found. The syntax measures generally correlated more strongly with the conservation tasks than with the other language measure, concept for sort.

While it might have been expected that performance on the two sorts would have more in common with each other than with their respective verbal justifications, sort 1 and concept 1 cluster together in a factor separate from sort 2 and concept 2. The factor containing sort 1 and concept 1 seems to be a sex-related ability for simple classification, while the factor containing sort 2 and concept 2, which more nearly resembles the horizontal reclassification task, is better described as flexibility. It appears that the child's approach to making any grouping is quite different from his approach to making a different grouping based upon the same object.

Age, sex, and race seem to have, not an across-the-board effect upon language and cognitive development, but differential effects on various aspects of each. More information based on larger samples, greater age span, and more careful definition of race effects (to separate effects of social class, language exposure, etc. from possible genetic differences in sensitivity to language stimulation or ability to structure events) is needed.

The low relationships found between the various measures of language indicate that language cannot be viewed as one-dimensional, and that studies of relationships based on one aspect of language cannot be taken to represent the relationships of other aspects. Such aspects of language as syntax, vocabulary and verbal fluency may each be important in the development of some logical functions, but findings are likely to be clearer when these aspects are separated.

The findings in this study seem to point up the logical nature of syntax, but in themselves offer sparse clues as to the precise character of the similar operations which may be present in both syntactical and cognitive tasks. It is suggested that these operations involve the ability to keep simultaneously in mind various aspects of a situation and to coordinate them.

Further studies of this area will require use of a variety of tests of cognition and syntax to tap different areas of each. These tests should provide for a range of complexity within each area to allow assessment of growth in a continuous fashion over the age span of cognitive and syntactic development. The important issue of distinguishing between competence (understanding) and performance (the actual expression of this understanding) seems best approached by identifying and minimizing or systematically varying performance factors to determine their influence on the expression of competence.

The relationship of cognitive development and syntactic comprehension seems to offer a rich field for investigation.

Further research is required to determine whether this relationship changes appreciably over the developmental span and to determine whether certain levels of competence in one area are required or helpful for further progress in the other.

A within-subjects design and longitudinal study are desirable for studying this issue. If certain logical operations always precede or follow certain syntactical acquisitions, Flavell and Wohlwill's (1969) discussion of implicative and non-implicative mediation in concept formation may be extended to analyze the relationships between cognitive development and syntactical comprehension.

Cross cultural studies would make it possible to analyze which of the relationships found were stable across languages and which were affected by the form of a particular language. This approach may also be useful in assessing the effects of the cognitive development of children of various subcultural groups. Such investigations may add to our understanding of the processes by which children learn.

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Appendix A

Class Inclusion Items:

Are there more apple trees or more trees?
more fruit or more bananas?
more chocolate chip cookies or more cookies?
* more canoes or more of other boats?
more flowers or more tulips?
more squares or more shapes?
* more pickup trucks or more tank trucks?
more balls or more footballs?
more sports cars or more cars?
more candy or more candy canes?

*Non-inclusion items, which require only comparison of 2 subclasses.

See Inhelder and Piaget

Syntax (Active-Passive) Items

1. The snake eats the bird.
2. The bird is eaten by the snake.

3. The boy carries the horse.
4. The boy is carried by the horse.

5. The cat is chased by the dog.
6. The dog chases the cat.

7. The car is pushed by the truck.
8. The truck is pushed by the car.

9. The bird eats the snake.
10. The snake is eaten by the bird.

11. The horse carries the boy.
12. The horse is carried by the boy.

13. The dog is chased by the cat.
14. The cat chases the dog.

15. The truck pushes the car.
16. The car pushes the truck.

See Turner and Rommetveit

Appendix B

Table 1
Means by Race and Age
for Class Inclusion, Conservation, and Syntax

Test	Maximum Score	Race:	Negro		White		Group Mean	SD
		Age :	5&6	7&8	5&6	7&8		
Class Inclusion	10		2.40	3.63	3.23	3.72	3.42	1.86
Global Syntax	16		11.40	13.00	13.32	14.80	13.42	2.39
Active	8		6.60	7.25	7.05	7.60	7.27	1.06
Passive	8		4.80	5.75	6.27	7.20	6.47	1.74
Conservation of Substance	3		1.40	2.00	2.09	2.56	2.22	0.90
Conservation of Weight	3		1.00	2.00	1.73	2.44	2.00	0.88
			n=5	n=8	n=22	n=25	n=60	

Table 2
Means by Sex and Age for Sort and Concept

Test	Maximum Score	Sex:	Male		Female		Group Mean	SD
		Age:	5&6	7&8	5&6	7&8		
Sort 1	4		2.36	2.75	1.54	2.18	2.23	1.14
Sort 2	4		1.57	1.69	1.46	1.70	1.62	1.18
Concept 1	3		1.64	1.69	1.31	1.47	1.53	0.93
Concept 2	3		1.07	1.25	1.07	1.12	1.13	1.14
Change	6		2.43	2.56	2.77	2.65	2.60	2.35
			n=14	n=16	n=13	n=17	n=60	

Table 3
T-Tests for Difference of Correlation Coefficients

	Correlations	t	
Substance/Weight Substance/Global Syntax	.6796 .5069	1.8094	NS
Substance/Global Syntax Concept 1/Global Syntax	.5069 .1341	2.5223	$p < .05$
Weight/Global Syntax Concept 1/Global Syntax	.4748 .1341	2.2408	$p < .05$

Table 4
Means by Age and Race for Sort and Concept

Race:	Negro		White	
Age:	5&6	7&8	5&6	7&8
Sort 1	1.20	2.63	2.14	2.40
Sort 2	.60	1.25	1.73	1.84
Concept 1	1.00	1.25	1.59	1.68
Concept 2	.80	.75	1.14	1.32
Change	2.80	2.50	2.55	2.64
	n=14	n=16	n=13	n=17

A Study of the Relationship of Cognitive Development and Syntactical Comprehension

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