DOCUMENT RESUME

ED 074 186 UD 013 390

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TITLE	The Effects of Culture and Education on the Acquisition of Formal Operational Thinking.
SPONS AGENCY	Rutgers, The State Univ., New Brunswick, N.J.
PUB DATE	Feb 73
NOTE	14p.; Paper presented at the American Educational Research Association annual meeting, New Orleans, La., February 1973
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	*Cognitive Development; Cognitive Processes; Cultural Factors; Educational Background; Educational Diagnosis; Logical Thinking; *Migrant Youth; Problem Solving; *Puerto Ricans; Sex Differences; Spanish Speaking; *Suburban Youth; Testing Problems; *Thought Processes; Verbal Development

ABSTRACT

This study was designed to investigate the role of culture and education in the development of formal operational thought, by comparing the results achieved by suburban American youths, American educated youths who were recent migrants, and youths who had been educated in Puerto Rico. It was hypothesized that the suburban youths and Puerto Rican youths would develop formal thought before the American educated Puerto Ricans. Three groups of subjects were selected on the basis of culture and education. Their ages ranged from 12 to 18 years, five males and five females being tested at each age level. Subjects performed four Piagetian tasks: the balance bar, the pendulum the floating objects task, and interpretation of proverbs. Subjects were tested individually and interviews were recorded on tape. Each subject had opportunity to use Spanish if he preferred to do so. When considering the three manipulative tasks together, the ability to give two out of three answers at formal level placed subjects in the formal category. The age at which 60 percent of a group were operating at formal level was considered the age of onset of formal operations for that group. Suburban youths achieved full formal thought by age 12-13. The same level was achieved by age 14-15 for the American educated Puerto Rican group. The Puerto Rican educated group reached this level at age 16-17. (Author/JM)

ABSTRACT

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on the Acquisition of Formal Operational Thinking

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Performances on four Piagetian tasks (balance bar, pendulum task, floating bodies, and interpretation of proverbs) were used to assess the effects of culture and education on the acquisition of formal operational thinking for three groups: American educated suburban youths, American educated Puerto Ricans, and Puerto Rican educated Puerto Ricans. Results showed that, in general, the criterion for formal operations was met by ages 12-13, 14-15, and 16-17 for the three groups respectively. There were no appreciable sex differences. Cultural and educational variables and certain factors thought to retard the development of Puerto Rican students were discussed.

The Effects of Culture and Education on the Acquisition of Formal Operational Thinking

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One of the implications of Piaget's developmental theory of cognitive growth is that the transition from one stage to another is indicative of the development of progressively higher levels of thought. The stages, as defined by Piaget, are (1) sensorimotor, (2) preoperational, (3) concrete operational, and (4) formal operational. They are qualitatively different, and each embodies some unique characteristics which make it distinctive.

Of particular interest to this paper is the development of the fourth and final stage, that of formal operational thinking. At this stage an individual develops the ability to reason abstractly. He is no longer bound by concrete objects and present conditions. Finally able to free himself from such activities, he becomes objective, and appreciates many other points of view. He sees future possibilities and can form hypotheses with regard to propositions which are abstract. These formal operations take several years to develop, beginning about the age of twelve and continuing until about age fifteen.

The transition from concrete operational thinking to that of formal thinking is marked by the appearance of several new abilities unavailable at previous levels. These abilities are: (1) the combinatorial system, (2) the group of four transformations, or the INRC group, (3) the sixteen binary operations, (4) proportions, (5) probabilities, and (6) dissociation of factors. At the same time there is the development of an experimental spirit accompanying the arrival of formal operations.

A number of interesting factors are responsible for this development. Maturation requires physical experience, which, in turn, requires social interaction. Underlying these is the child's own ability for self-regulation, or equilibration, without which the other factors are ineffective. No clear evidence has emerged to date as to which types of physical or social environments arouse or retard the process of equilibration, and subsequently affect the rate at which children progress through the Piagetian stages of development.

It has been observed in certain individuals that formal thought has been developed in one area but not in another. It has also been observed that one subsection of the population has developed more slowly than another. These phenomena are referred to as a décalage, or time lag.

To explain the individual time lag, Lovell (1971) reasoned that familiarity with the content of a task and prior beliefs may facilitate or hinder the use of formal thought in the task solution. In the case of individuals the décalage does not seem to pose much of a problem for interpretation. Inhelder states that "both adolescent and adult are far from reasoning formally all the time. The attainment of a cognitive stage merely means that the individual becomes capable of behaving in a certain way which was impossible before" (Tanner and Inhelder, 1960).

The phenomenon of group décalage, however, is less readily accepted and more difficult to explain. Suggestions have been made as to why group décalages occur, but we are not yet able to say which child rearing practices, teaching methods, or cultural differences are most conducive to the development of formal operational thought (Lovell, 1969).

This study was designed to investigate the role of culture and education in the development of formal operational thought, by comparing the results achieved by suburban American youths, American educated youths who were recent migrants, and youths who had been educated in Puerto Rico. It was hypothesized that the suburban youths and Puerto Rican youths would develop formal thought

before the American educated Puerto Ricans. It was also hypothesized that females would lag behind males in development.

METHOD

Subjects

Three groups of Ss were tested: (1) suburban youths attending their local public school; (2) Puerto Ricans who attended American public schools since first grade; and (3) Puerto Rican youths in the same cities who had recently arrived from the islands and who had attended Puerto Rican schools.

Tasks

Ss performed four Piagetian tasks: (1) the balance bar, (2) the pendulum, (3) the floating objects task, and (4) interpretation of proverbs. The first three tasks required manipulation of apparatus. The fourth task was verbal. In the fourth task there was an option of either English or Spanish proverbs.

Design

Three groups of S were selected on the basis of culture and education. Ages ranged from 12-18. Five males and five females were tested at each age level.

Procedure

Ss were tested individually and interviews were recorded on tape. Each S had opportunity to use Spanish if he preferred to do so. Testing was begun with the youngest group first. When four (40%) were found who were below formal level for two out of three manipulative tasks, testing was stopped and continued at the next level.

Scoring

Protocols were assessed by the examiner and by an independent assessor and scored according to the procedure outlined by Piaget (1958). Assessment at concrete level, level IIB, was assigned a score of 1, beginning formal level, level IIIA, was assigned a score of 2, and full development of formal level, level IIIB, was assigned a score of 3.

Analysis

Results were compared by groups for individual tasks and for the three amnipulative tasks together. Males and females were compared in groups for individual tasks and the group of manipulative tasks. When considering the three manipulative tasks together, the ability to give two out of three answers at formal level placed S in the formal category. The age at which 60% of a group were operating at formal level was considered the age of onset of formal operations for that group. Individual scores were viewed across tasks to determine individual décalages.

RESULTS

When examining performance on the three manipulative tasks together it was found that suburban youths had achieved full formal level thought on at least two out of three tasks by age 12-13. This same level was achieved by age 14-15 for the American educated Puerto Rican group. The Puerto Rican educated group did not reach this level until age 16-17. As predicted, the suburban youths developed more rapidly than did the American educated Puerto Ricans. Contrary to prediction, the American educated Puerto Ricans developed more rapidly than did the Puerto Rican educated group.

TABLE 1

Percent of Ss Achieving Full Formal Operational Thinking by Task, Age, Group, and Sex.

	Suburban Americans			American Ed. P.R.			P.R. Ed. Puerto Ricans		
Ages	M	F	Total	M	F	Total	M	F	Total
12-13	80	100	90	-	-	-	-	-	-
14-15	-	-	-	100	70	85	-	-	-
16-17	100	60	80	-	-	-	70	90	80
12-13	100	80	90	-	-	-	-	-	-
14-15	-	-	-	70	70	70	-	-	-
16-17	100	80	90	-	-	-	80	70	75
12-13	0	0	0	-	-	-	-	-	-
14-15	-	-	-	0	10	5	-	-	-
16-17	90	30	60	-	-	-	10	20	15
12-13	100	100	100	-	-	-	-	-	-
14-15	-	-	-	20	0	10	-	-	-
16-17	100	100	100	-	-	-	80	70	75

When performance on individual tasks was examined, it was found that, on the balance and pendulum tasks, formal level thinking was fully developed by age 12-13 for suburban youths, age 14-15 for American educated Puerto Ricans, and age 16-17 for Puerto Rican educated youths.

TABLE 2

Level of Thinking on Manipulative Tasks for Individual Subjects

	Suburban American Ages 12-13			American Ed. P.R. Ages 14-15			P.R. Ed. Puerto Ricans Ages 16-17		
Sex	Bal.	Pend.	Fl. Obj.	Bal.	Pend.	Fl. Obj.	Bal.	Pend.	Fl. Obj.
	3	3	1	3	2	1	3	3	1
	3	3	1	3	3	1	3	3	1
	1	3	2	3	2	1	2	3	1
	3	3	1	3	3	1	1	1	1
	3	3	1	3	3	1	3	3	1
Males	3	3	1	3	1	1	3	3	1
	3	3	1	3	3	1	3	3	2
	2	3	2	3	2	1	3	3	1
	3	3	1	3	3	1	1	3	1
	3	3	2	3	3	1	3	3	3
	3	1	1	3	3	1	3	1	1
	3	3	2	1	1	1	3	3	3
	3	3	1	3	3	1	3	3	1
	3	1	2	1	1	1	3	3	1
	3	3	1	3	3	1	1	3	1
Females	3	3	1	3	3	3	3	3	1
	3	3	1	3	3	1	3	1	1
	3	3	1	1	2	1	3	3	1
	3	3	1	3	3	1	3	3	3
	3	3	1	3	3	1	3	1	1

1 concrete level (IIB)

2 beginning formal level (IIIA)

3 full formal level (IIIB)

The floating objects task, however, produced quite different results. It was not until age 16-17 that suburban youths were able to solve this problem. Only 5% of 14-15 year old American educated Puerto Ricans and 15% of Puerto Rican educated youths answered at formal level.

Formal level thinking was achieved by age 12-13 for suburban youths when interpreting proverbs. Only 10% of American educated Puerto Ricans had reached this level by age 14-15, a greater lag than for manipulative tasks. For the Puerto Rican educated group 75% achieved formal level thinking at age 16-17, a time lag of three to four years. This is comparable to the time lag in manipulative tasks.

These results were true for both male and female subgroups, with few exceptions. The only large male-female difference was for the 16-17 year old suburban youths. Ninety percent of the males had reached level IIIB but only 30% of the females.

Individual décalages were found among the manipulative tasks. The most striking was that produced by the floating objects task. In many instances it was a lag of two substages, i.e. from formal level to concrete.

DISCUSSION

The unexpected lag of the Puerto Rican educated youth may be partly an artifact of the test procedure. Although each had the opportunity to communicate with E in either English or Spanish, the E was not a native Puerto Rican, and being tested as a newly arrived immigrant may have affected performance. An examination of performance among different age groups in Puerto Rico is needed to investigate further the effect of educational differences.

It was also hypothesized that females would lag behind males, but only one major difference appeared. It may be that at age 16-17 social and peer pressures are more effective than at previous ages, where only minor differences occurred.

An unexpected result was the individual décalage between the balance and pendulum tasks and the floating objects task. It may be due to the higher level of complex reasoning required for this task. The balance required only two

comparisons; the pendulum had four variables three of which had to be eliminated; but the floating objects task had a complexity of interacting variables, none of which could be eliminated. Only older suburban males were able to control all these variables and come to the correct conclusions.

Contrary to Piaget's findings, all Ss had to be urged to manipulate the apparatus. There was no sign of spontaneous experimentation except among the suburban 12-13 year olds. None of the Ss had taken science courses other than the required courses in the upper elementary school. Therefore, they were probably unaccustomed to handling experimental apparatus.

These results indicate that realization of one's full potential is apparently affected by cultural and educational factors. In fact the suburban youths had a two to four year advantage over both Puerto Rican groups. This suggests that a suburban cultural background promotes development of formal operations. The lag in development demonstrated by Puerto Rican educated youths relative to American educated Puerto Ricans suggests that American education may provide richer experiences for stimulating abstract thinking and reasoning.

Piaget's work and the related research indicate that it is important for the student to be taught at his appropriate level of development. If the student is still at concrete level he must be provided with plenty of manipulative materials even though he may be in high school. If there is a lag between one type of activity and another, as, for example, the American educated Puerto Rican's lag in the verbal task, then this must be taken into account during instruction.

Knowledge of the direction development may take in various cultures is important to the teaching situation and should be considered in curriculum planning. Further investigation may provide a valuable method of assessment of a child's cognitive level including diagnosis of retardation. The teacher may then slant his

instruction in the desired direction. In addition, the teachers themselves must be able to operate at formal level themselves, a situation which the literature suggests is not common.

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Appendix A

Objects used in the floating objects task:

Floating objects	Non-floating objects
Large candle	Large stone
Birthday candle	Small stone
Plastic sponge	Metal attachment for the ornament
Glass Christmas tree ornament	Glass ash tray
Wooden spool	Metal scarf clasp
Pumice stone	Piece of jewelry
Plastic box	

Appendix B

Proverbs presented to Ss in task 4

English proverbs:

Every cloud has a silver lining.

The new broom sweeps clean.

A stitch in time saves nine.

The grass is always greener on the other side of the fence.

His bark is worse than his bite.

Don't look a gift horse in the mouth.

Don't count your chickens before they hatch.

Look before you leap.

You can't teach an old dog new tricks.

All that glistens is not gold.

Spanish proverbs:

Gallina vieja da buen caldo.

Todo lo que sube - baja.

Perro que ladra, no muerde.

A caballo regalado no se le miro el colmillo.

Al que no quiere caldo, se le dan dos tazas.

Estas matando a cuchillo de palo.

Al que madruga dios lo ayuda.

Camaron que se duerme se lo lleva la corriente.

Mas vale pajaro en mano que ciento volando.

Footnotes

1. Paper presented at the annual meeting of the American Educational Research Association, New Orleans, February 1973.

2. This project was facilitated, in part, by a grant to the second author from the Rutgers Research Council, Rutgers University.

3. We thank Gloria Cohen for her generous assistance in reading the protocols.