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Conservation is a term used to describe the situation when an attribute (such as weight) of an object remains invariant through certain changes in other attributes (such as height or width) of that object. According to Piaget's theory of equilibration, children construct notions of conservation at the same time that they are developing concrete operations. These notions, according to both Piaget and Smedslund (1961, 1968), are experienced by children as logically necessary and are viewed as independent of external reinforcement. According to reinforcement theory, however, acquisition of conservation is explained in terms of a set of learned concepts which are subsequently extinguishable. The learning explanation is more dependent on empirical regularities than on logical implications.

A recent series of descriptive weight conservation studies (Brekke, et al, 1977) with teenage populations in North Dakota led to the surprising identification of a large number of nonconserving subjects among relatively normal groups who would have been expected to be weight conservers. This finding appeared to contradict both developmental and learning explanations of conservation. For if the developmental explanation were correct, adult weight conservation behavior should have been intact and should have resisted extinction even if confronted with visual evidence at variance with former conserving notions. If the reinforcement theory explanation were correct, adult weight conservation behavior should have been sufficiently reinforced by this age to be intact and should have been extinguishable only if confronted with sufficient conflicting visual evidence. Neither of these

explanations accounted for the results with the North Dakota teenagers, particularly since conservation extinction was not part of the research paradigm.

Interestingly, the past research has reported a remarkably high incidence of apparent extinction of weight conservation responses in adults. For example, Hall and Kingsley (1968) tested 64 college students on weight conservation after first confronting them with a single demonstration of contrived nonconservation. Only 19 of their students resisted extinction of their conserving responses. This finding is rather difficult to explain by equilibration theorists. In contrast, Miller, Schwartz and Steward (1973) found that 22 out of 36 college students persisted in their conservation responses even after three extinction trials and post tests. The large difference in direction of results between these two studies appears to be related to procedural differences, but the finding of the second study is difficult for the reinforcement theorists to explain.

Chiseri (1975) tested 54 college students on a weight conservation paradigm, 25 of whom had been given a pretest survey on the concept of conservation. The pretested group was significantly more likely to accept a contrived nonconservation demonstration as factual and extinguish their conserving responses. Chiseri concluded that his study as well as the former studies which had shown high rates of extinction of conservation of weight had been affected by the influence of pretest activities focusing subjects' attention on their conservation notions.

Thus it appears from these studies that not only do adults fail to conserve correctly in many cases, but a large number also extinguish when faced with empirical evidence contrary to their expectations. There is, however, need to suggest caution in making inferences from extinction of conserving behaviors in adults to the development of conservation in children. There may be developmental changes in the certainty with which a concept such as conservation of weight is held, changes which extend well beyond the point at which a child is usually considered to have become a

conserver.

But whether concepts of conservation are logically necessary or are learned through empirical observations, presumably the strength and stability of concepts like conservation increase with the length of time that they have been in the cognitive system. Hence, in spite of the experiences with the North Dakota teenagers, the unpretested Chiseri group, and the Hall and Kingsley adult sample, it seemed reasonable to predict that a typical adult, when given an opportunity to conserve on a weight task without prejudice of preceding suggestions or observations of contradicting conservation evidence, would make a conserving judgment without any difficulty. Therefore, it was determined to administer weight conservation tasks to several groups of students including college students in North Dakota to learn whether adolescents and adults, unhindered by an extinction design, would be characterized by a large precentage of nonconserving behaviors.

METHOD

The conservation of weight tasks were individually administered to a total of 314 normal students (163 males, 151 females). The subjects were classified into three groups on the basis of chronological age. The first group consisted of a total of 112 children (62 males, 50 females) from elementary schools in North Dakota and Minnesota. The chronological ages of these subjects ranged from 5 years 6 months to 14 years 11 months. This first group of subjects ranged in intelligence scores from 81 to 160 with a mean of 110. The scores were derived from either the Lorge-Thorndike, Kuhlman-Anderson or Slosson tests; most subjects had taken one of the first two tests previously in the school testing program. The Slosson was administered to those students who had no recorded intelligence test score. The second group was drawn from two high schools in Minnesota and included 101 subjects (49 males, 52 females) with a chronological age range of 15 years 10 months to 19 years 9 months. This second group of subjects ranged in intelligence

scores from 84 to 143 with a mean of 108.46, using the same measures as were available with the first group. The third group was comprised of 101 university undergraduate students (52 males, 49 females) in North Dakota. The chronological ages of these subjects was 17 years 10 months or older. The American College Test (ACT) Composite scores for 64 of the university subjects ranged from 15 to 31; the mean ACT score was 22.3 (the national mean for those taking the test is 19). The university students were enrolled in an introductory psychology course, which included an overview of Piaget as well as a test on Piagetian Theory prior to the experiment on conservation of weight testing.

The conservation of weight tasks in the study were modifications of the series of thirteen steps formulated by Furth (1964) in his investigation of the thinking processes of deaf children. The sequence of steps was retained, but the nonverbal presentation was adapted to a verbal procedure in a study of conservation of weight with blind children by Brekke, Williams and Tait (1974). The thirteen steps were:

Step 1	Two similar balls.
Step 2	One ball - one snake.
Step 3	One snake - half a ball.
Step 4	Two similar balls.
Step 5	One whole ball - two halves of the other ball.
Step 6	One whole ball - one half ball.
Step 7	Two similar balls.
Step 8	One ball - one ring.
Step 9	One disc - one ring.
Step 10	Half ring - half disc.
Step 11	Half ring - half disc in one hand and the same in the other.
Step 12	One ball - half ring.
Step 13	Two similar balls.

The crucial tests for the acquisition of conservation were steps 2, 8 and 9 according to the criteria established by Furth. For each of these steps, one of two equal-sized balls was transformed into the shapes of a snake, a ring and a pancake. Conservation of weight was tested by questioning, "Do they have the same weights or different weights?" All subjects were asked, "How do you know?" for the transformation steps 2, 8 and 9. The justifications contributed to the classification of the responses as conservers or non-conservers. Equal-weight balls were used in steps 4, 5, 7, 10, 11 and 13. Steps 3, 6 and 12 were designated as control measures to check on a consistent "same weight" response being correct. These procedures were given to the subjects on an individual basis. A subject was considered to be a conserver if he was successful on all three critical steps (steps 2, 8 and 9). The same procedures were followed with the control group of normal subjects.

RESULTS

Results in Table 1 show the number of conservers and non-conservers at various age levels in the three groups. The proportion of conservers in each group is remarkably similar: for the youngest (elementary and junior high school) group, 51.79% were conservers; for the high school group, 58.42% were conservers; and, for the university group, 60.40% were conservers.

It can be seen from Table 1 that above 108 months (9 years), the majority of subjects in all groups are conservers (with exception of high school and university subjects in the 204-215 month age range wherein exactly 50% were conservers). The interesting point is that while conservation became more probable above age 9, it clearly did not become a universal (that is, acquired by all, or almost all subjects) at any age range.

TABLE 1

Number of Conservers and Nonconservers

In Each Age Range

Chronological Age (in months)	Elementary and Junior High (N=112)		High School (N=101)		University (N=101)	
	Conserver	Nonconserver	Conserver	Nonconserver	Conserver	Nonconserver
60-71	0	1				
72-83	2	2				
84-95	5	12				
96-107	7	13				
108-119	7	6				
120-131	7	4				
132-143	9	3				
144-155	5	5				
156-167	7	4				
168-179	9	4				
180-191			2	1		
192-203			28	14		
204-215			22	22	1	1
216-227			6	5	16	11
228-239			1	0	18	10
240-251					10	6
252-263					2	2
264-275					4	3
276-287					3	1
288-up					7	6
	58	54	59	42	61	40

Tables 2 and 3 contain a further investigation of the data using a three-way X^2 analysis (Stokey and Williams, 1976). The classifications are made on the basis of group (elementary-junior high, high school, university), sex and conserver-nonconserver status.

TABLE 2

Group, Sex and Conserver-Nonconserver Status

	Elementary-Junior High	
	Conserver	Nonconserver
Male	36	26
Female	22	28

	High School	
	Conserver	Nonconserver
Male	30	19
Female	29	23

	University	
	Conserver	Nonconserver
Male	33	19
Female	28	21

TABLE 3

Three-way X^2 Analysis For Group, Sex

And Conserver-Nonconserver Status

Source of Variation	df	X^2
Sex and Conservation	1	2.262
Groups and Conservation	2	1.785
Sex and Groups	2	1.007
Sex, Conservation and Groups	2	.418
TOTAL	7	5.472

From Table 3 it can be seen that for only the first source of variation does the X^2 value exceed the degrees of freedom; while nonsignificant (p=.10), it shows the mild relationship with sex and conservation; males tend to conserve slightly more often than females.

DISCUSSION

Since the conservation of weight concept has been reported by Piaget and Inhelder (1940) as being attained by over 70% of their children between 9-10 years of age, an even higher incidence of conservation beyond that age might logically be expected. Clearly, this was not true with the subjects in the present study.

Can the relationship between intelligence and conservation explain this unexpected finding? Logically, the incidence of conservation might have been expected to be higher because all three groups were higher than normal in intelligence. Each group's intelligence test mean was above the national average:

elementary group ten IQ points above, secondary group eight IQ points above and the college freshmen group three ACT points above. However, the correlation between conservation and IQ scores in groups one and two was r=.05. The correlation between ACT scores and conservation in group three was r=.07. As a matter of fact, the person with the highest ACT score (31) was a nonconserver. Thus the selectivity of subjects did not seem to provide a sufficient explanation. It may be aruged that the ACT data represented only 64 of the university subjects (ACT scores were not available for 37 students). However, conservation-nonconservation ratios were almost identical for the two groups (60.94% of those who had taken the ACT test were conservers while 59.46% of those who had not taken the ACT test were conservers).

Can the age and maturity of the subjects explain the large number of nonconservers? There was a possibility that older subjects might have taken the testing situation less seriously than their younger counterparts. However, little or no evidence was available to support this suggestion. The only feedback from the examiners hinting at this possibility was that several college students felt the test had some "trick" to it. The percentages of conservers from each group were remarkably similar.

Would an inherent developmental ceiling on acquisition of conservation explain the failure of many teenagers and adults to conserve? The simplest explanation for the present set of results might be that conservation is not attained by previous nonconservers in a normal population beyond a given age, i.e., the results are sound and do report a real phenomena. Projecting these horizontal samples into one longitudinal population, it might appear that the same 50 to 60 percent of the people conserved from middle childhood on and the same 30 to 40 percent did not learn weight conservation at any point in their development. If that interpretation is correct, it would appear that people can compete successfully in intellectual activities without necessarily having established a cognitive operation of an earlier stage. Thus, they might be seen as able to function effectively even

though they have a cognitive deficit. For example, almost 40% of the university subjects failed the conservation of weight tasks and yet were still able to graduate from high school and be admitted to a university. This hypothesis needs further investigation. The relationship is undoubtedly far more complex and interactive.

Can learning theory and the extinction model explain the failure of some young adults to conserve? Based upon reinforcement principles, it was possible that within any age group some subjects might have extinguished lower levels of conservation as they grew through their cognitive stages to a more abstract and logical thought process. The present research effort was not directed to test this hypothesis, but current research is underway to test several stages of conservation within a single group of college students as one way of beginning to examine this theory.

Other legitimate questions to be raised in regard to the data might include the following: Were the assessment procedures an adequate measure of conservation behavior at any or all three group ages? Was adult conservation behavior a different phenomena from child conservation behavior and, therefore, was the comparison between groups valid? Were the higher levels of egocentric development in adolescence affecting the expression of the structure and function of cognitive levels attained at any earlier age (Elkind, 1970)?

In conclusion, these data raise some questions in interpreting Piagetian theory. It would appear that a less absolutistic approach might be made in assessing cognitive functioning until more research has been completed. Failure at one level of cognition might not portend failure at a higher level.

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