SOCIAL-CLASS DIFFERENCES AND TASK VARIABLES IN THE DEVELOPMENT OF MULTIPLICATIVE CLASSIFICATION

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OVERTON, WILLIS F.; WAGNER, JANIS; and DOLINSKY, HARRIET. Social-Class Differences and Task Variables in the Development of Multiplicative Classification. CHILD DEVELOPMENT, 1971, 42, 1951–1958. *Lower-class Negro and middle-class white children at 4–5, 6–7, and 8–9 years of age were administered 2 forms of a matrix-completion task. 1 form contained 3-dimensional objects; the second form contained 2-dimensional pictorial representations of the same objects. The study was conducted to explore the role of this task variable, socioeconomic class, and age in the development of multiplicative classificatory skills. Although no differences were found for the 2 matrix forms, the results indicated significant age and age by social class effects. Lower-class and middle-class groups performed equally at ages 4–5 years and 6–7 years. At age 8–9 years, however, the lower-class group performed more poorly than the middle-class group. There was no improvement for the lower-class group between ages 6–7 and 8–9. These results are discussed in terms of the development and activation of cognitive structures.*

This study investigated the development of multiplicative classificatory skills in lower-class Negro and middle-class white children on tasks which

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contain either three-dimensional objects or two-dimensional pictorial representations of the same objects.

Multiplicative classification refers to the *simultaneous* classification of objects into two or more categories—for example, a bat is both a flying animal and a mammal. Stated differently, multiplicative classification involves the ordering of objects at the intersection of two or more classes. Thus, given the class of all mammals and all flying animals, the bat is an exemplar of the intersection of these classes.

Within Piaget's theory (Flavell 1963), the ability to grasp dual- and multiple-class membership is dependent upon the development of logical structures which become functional at approximately the sixth or seventh year of life. Specifically, this skill is based upon the logical grouping termed "bi-univocal multiplication of classes."

Multiplicative classification differs from what has traditionally been termed "free classification," in that it involves an understanding of logical relationships among two or more classes—specifically, a recognition of class intersection. In free classification, the child is required to construct categories by grouping together all items which are alike or which "go together." Thus, he must determine the categories of classification himself; but once the categories are formed, he need not be concerned about their interrelationships. In multiplicative classification, the categories of classification are given (e.g., within the structure of a matrix-completion task) and the child is required to make inferences about class relationships to determine the class intersection.

In several studies which focused on the problem of free classification, Sigel found that lower-class children performed more poorly than middle-class children when the stimulus material consisted of two-dimensional pictorial representations of objects rather than the actual three-dimensional objects (Sigel, Anderson, & Shapiro 1966; Sigel & McBane 1967). Sigel attributes this difference to a deficiency in representational competence among lower-class children.

The present study explores whether Sigel's findings generalize to multiplicative classification. This study also explores the performance of lower-class Negro children and middle-class white children on multiplicative classification at several age levels.

METHOD

Subjects.—A total of 96 subjects were employed, 32 from each of the following age levels: 4–5 years (mean age = 5 years, 1 month; range = 4-2 to 5-11); 6–7 years (mean age = 6 years, 9 months; range = 6-2 to 7-8); 8–9 years (mean age = 8 years, 9 months; range = 8-4 to 9-10). Males and females were evenly distributed within each group. Half of the Ss at each age level were lower-class Negro children and half were middle-class white children. Ages between the socioeconomic groups were matched to within 1 month. The lower-class group was drawn from an inner-city core area. The younger Ss in this group were participants in the Early Push program; the older Ss attended a public school in this area. The middle-class group attended nursery and elementary schools in a middle-class section of the suburban Buffalo area. Information on socioeconomic class was provided by principals, teachers, and census data.

Procedure.—A matrix-completion task was employed for the assessment of multiplicative classification (Inhelder & Piaget 1964). In this task, the *S* is presented with stimulus objects in the form of a 2 × 2 matrix with the bottom right cell being empty. The problem for the *S* is to choose the stimulus object from a choice set that completes the matrix—that is, that simultaneously classifies the object as a member of both the class formed by the horizontal dimension and the class formed by the vertical dimension. The Raven Progressive Matrices are typical examples of this problem.

Two practice and five test matrices were employed. The matrix cells and choice cards were composed of familiar objects—for example, crayons, spoons, forks, etc. Each matrix varied along three category dimensions. The category dimensions employed included size, color, number, and form. There were four choice cards for each matrix. Of these four cards, one correctly completed the matrix, one was totally redundant with one cell of the matrix, one was partially redundant with one cell of the matrix, and one was irrelevant to any of the matrix cells.

Two forms of each matrix cell and each choice card were constructed. One form consisted of the three-dimensional objects pasted on 4½ × 4½-inch pieces of heavy construction paper. The second form consisted of color photographs of the objects pasted on the same size construction paper. The photographs maintained size, color, and perspective relationships of the original objects.

Each *S* was tested individually on both forms of the matrices. Half of the Ss at each age and social class received the five object matrices, followed 2 days later by the five pictorial matrices. The other half of the Ss received the reverse order. Order of presentation of the matrices was randomized between Ss. The spatial arrangement of the choice sets was randomized within Ss.

RESULTS

Table 1 presents the mean scores for the three-dimensional object and two-dimensional pictorial forms of the matrices at each age and social-class level. No differences were found between the matrix forms (Wilcoxin matched pairs test: $Z = 1.92$, $p > .05$), nor were there differences between pictures and objects for any of the ages or social-class groups. There were also no significant order effects for groups presented with pictures followed

TABLE 1

MEAN CORRECT MATRIX SOLUTIONS FOR PICTORIAL AND OBJECT MATRIX FORMS AT EACH AGE AND SOCIAL-CLASS LEVEL

	4–5 YEARS		6–7 YEARS		8–9 YEARS	
	Middle Class	Middle Class	Lower Class	Lower Class	Middle Class	Lower Class
Pictorial form	2.19	2.00	3.63	3.81	4.81	4.00
Object form	1.63	2.00	3.69	3.38	4.50	3.63

by objects versus groups which received objects followed by pictures ($\chi^2 = .02$, $df = 1$, N.S.). For further analysis, data from the pictorial and object forms were combined.

There was a significant increase with age in the number of correct matrix solutions ($\chi^2 = 157.86$, $df = 2$, $p < .001$). Furthermore, although there was no general social-class effect ($\chi^2 = 3.11$, $df = 1$, $p > .05$), a significant age × social-class interaction ($\chi^2 = 7.15$, $df = 2$, $p < .05$) indicates the presence of social-class differences at specific age levels. Figure 1 graphically presents the means of this interaction.

Social-class comparisons at each age level showed no significant differences between social class at either the 4–5 or 6–7 year age levels. However, there was a significant effect at the 8–9 year level, indicating that the lower-class Ss performed significantly more poorly than the middle-class Ss ($\chi^2 = 17.57$, $df = 1$, $p < .001$).

Comparisons across age levels for each social class showed that there was significant improvement between the 4–5 and 6–7 year age level for both the middle-class Ss ($\chi^2 = 39.70$, $df = 1$, $p < .001$) and the lower-class Ss ($\chi^2 = 32.98$, $df = 1$, $p < .001$). Between the 6–7 and 8–9 year age level, however, there was a significant improvement for the middle-class group ($\chi^2 = 22.81$, $df = 1$, $p < .001$), but no reliable differences were present for the lower-class group ($\chi^2 = .80$, $df = 1$, $p > .30$) (see fig. 1).

Analyses of these results separately for the pictorial form and object form of the matrices contributed nothing new to these findings.

CONCLUSIONS AND IMPLICATIONS

The absence of differences between pictorial and object forms of the matrix indicates that Sigel's findings for free classification do not generalize to multiplicative classification. One possible reason for this may reside in the differential employment of cues necessary for matrix completion versus free classification tasks. The matrix-completion task is more highly structured, in that the categories are already provided, giving the child a framework within which to make inferences about class relationships.

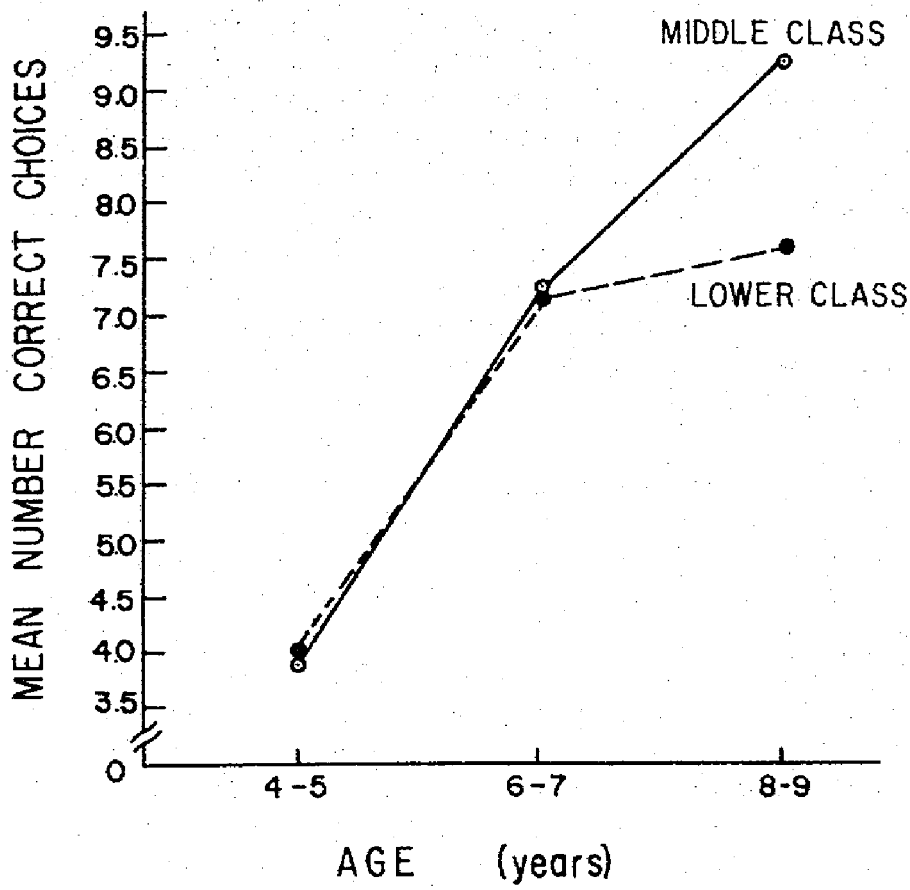

FIG. 1.—Mean correct matrix solutions at each age and social-class level

It seems quite probable that fewer cues are required in this situation than in the free classification task, where the child is required to construct his own categories on the basis of a disordered array of objects. Thus, we believe that two-dimensional objects provide sufficient cues for the inferences made in solving matrix-completion problems, but that these cues are insufficient for free classification. Free classification requires enriched cues provided by three-dimensional objects.

In a study currently being conducted, the performance of lower-class and middle-class children is being compared on matrix-completion and spontaneous cross-classification tasks. These two forms of multiplicative classification vary in amount of structure inherent in the task, with spontaneous cross-classification being more similar to free classification, in that the child must construct his own categories initially and then arrange them in the form of a matrix with recognition of class intersection. This study should provide additional insight into the kinds of operations utilized by children of differing social classes in classifying according to matrix-completion and free classification paradigms.

The positive findings of the study indicate that, although both the middle-class and lower-class children exhibit no differences in multiplicative classification at the 4–5 and 6–7 year levels, at the 8–9 year level the lower-class group performs significantly more poorly than the middle-class group. Furthermore, the lower-class group exhibits virtually no improvement in performance between the 6–7 and 8–9 year levels.

These findings may be explained on the basis of one of two alternative theoretical principles. The first explanation concerns the activation of already present cognitive structures while the second involves the actual development of cognitive structures. These alternatives may be approached within the context of a consideration of the normal stage development of cognitive structures.

Within Piaget's system, the structures required for a logical mode of approach to problems of multiple classification, as well as other types of classificatory and relational problems, emerge at approximately the sixth or seventh year of life. Prior to this period, which is referred to as the stage of *concrete operations*, the child's approach to classificatory problems is *preoperational*, in that it is generally characterized by an inability to coordinate systematically several stimulus categories and by a tendency to rely and act upon salient perceptual features of the task. The emergence of cognitive structures implies the development of the ability to coordinate categories, but it does not imply that this change will immediately and universally be reflected in performance. The problem of the reliance upon perceptual and possibly other task and situational features still remains. As Flavell and Wohlwill (1969) point out in their proposed elaboration and extension of Piaget's system, the transition period from the stage of preoperations to the stage of concrete operations extends from the point at which structures are "first-in-competence" to the point at which they are "always-in-performance." During this period, already emerged structures are in the process of becoming consolidated; as a consequence, they are not always reflected in actual performance. Although the child *can* at this time operate in a logical manner, task and situational variables play a major role in determining his approach. The significance of this within the context of the present discussion lies in the implication that during this period the introduction of relevant task and situational variables should result in the *activation* of already present structures and hence in their reflection in performance. Prior to this period, the same variables would be ineffective since presumably the structures are not present to be activated. Following this period, such variables would also be of minor importance since the structures are then always-in-performance.

Overton has provided some empirical support for this conceptualization of the activation of cognitive structures during the transition from preoperations to concrete operations by demonstrating that reduction of the perceptual features in the matrix task results in significantly enhanced performance at the 6–7 year level, whereas this variable is not effective at either the 4–5 or the 8–9 year levels (Overton & Brodzinsky 1969).

In the results of the present study, these considerations of the transition between preoperations and concrete operations form the basis for two alternative explanations of the poor performance of the lower-class group at the 8–9 year age level and of the failure of this group to exhibit improved performance between 6–7 and 8–9 years. First, both lower- and middle-class groups may develop the necessary cognitive structures simultaneously, but activation may occur later for lower-class children. This suggests that, although the environment of the lower-class child presents sufficient opportunities for the development of cognitive structures, it fails to provide the relevant techniques necessary to orient him away from the perceptual world and toward reflective strategies at the appropriate time. As a consequence, he remains locked into an earlier strategy until at least his ninth year.

The second alternative is that cognitive structures do not in fact develop simultaneously in both groups, but rather that there is a retardation in the cognitive development of lower-class children. As distinguished from the first alternative, this explanation suggests that the environment does not provide the lower-class child with sufficient opportunities for the normal rate of structural development. Experimentally, the retardation of the emergence of cognitive structures in lower-class children means that activation techniques would be ineffective in enhancing performance over longer developmental time spans for these children than would be the case with middle-class children. Thus, for example, while activation techniques for middle-class children are not successful at the 4–5 year level, but are effective at the 6–7 year level, this interpretation predicts that activation techniques would not result in enhanced performance for lower-class children until possibly the 8–9 or 10–11 year levels.

In an attempt to explore these two hypotheses, research which employs the activation techniques introduced by Overton and Brodzinsky is currently being conducted with lower- and middle-class children.

Whether one or even possibly a combination of these two alternative explanations receives empirical support from further research, it should be noted that a focus on techniques which activate available cognitive structures—as distinguished from conditions which lead to the development of these structures—provides an important approach to the assessment of individual differences in cognitive development. In addition, this approach opens a new avenue for the exploration of factors influential in increasing the rate of cognitive development, since activation of structures should necessarily result in a decrease in the time between the point when structures are first-in-competence and when they are always-in-performance. Finally, it should be recognized that determination of whether a specific task or situational variable is an activation variable does not depend merely upon whether its introduction enhances performance. Rather, it requires evidence that the variable enhances performance following and prior to periods of no effect—that is, following the period of structures "not-in-competence" and prior to the period of structures "always-in-performance."

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