TRANSFER ABILITY AS INTELLIGENCE:

ITS RELATION TO AGE IN DIFFERENT ENVIRONMENTS

by

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ABSTRACT

The transfer ability of different aged children from different environments was investigated for two practice conditions. Hypotheses derived primarily from Ferguson's transfer theory of intelligence were generally substantiated. Indications were that while there may be environmental differences in transfer which increase with age, the environmental groups need not differ in transfer ability. The results also imply that an experience-independent measure of transfer ability is invariant with age and has little relation with I.Q. Suggestions for further research and practical applications are made.

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INTRODUCTION

The present study deals with transfer ability and its relation to age in different environments. The emphasis on transfer ability in this investigation derives from Ferguson's (1954, 1956) premise that transfer is the process best accounting for intellectual functioning and development. Though most psychologists working in the area of human abilities have concentrated on the structure of intelligence, Ferguson has placed the intellectual process at the hub of his theory. Also, Ferguson's transfer theory of intelligence offers a number of testable propositions regarding the way in which experience affects one's intellectual capacity as he grows. Research aimed at verifying Ferguson's ideas is only in the beginning stage and the present study is an attempt to add further support. The general plan involves comparing the transfer ability of children of three ages from two different socioeconomic environments. Specific hypotheses will be presented following a discussion of transfer and intelligence and a review of research pertinent to the environment and age variables.

Transfer is a topic which has received especial attention from psychologists for almost a century; thus the massive literature will not be reviewed here. However, it is necessary to underscore the importance of the concept as it relates to the investigation at hand. Simply stated, transfer is the process of carrying over to another situation behavior involved in an earlier situation (Woodworth and Schlosberg, 1958). Or, as expressed by McGeogh and Irion (1958, p. 299), transfer occurs ". . . whenever the existence of a previously established habit has an influence upon the acquisition, performance, or relearning of a second habit." Except for initial learning in infancy or learning highly specific to a task, all changes in behavior may be considered cases of transfer (Ferguson, 1954). It is another question whether or not learning in which experience cannot operate follows the same laws as transfer. In other words, is capacity for initial learning parallel with capacity for utilizing experience? At any rate, if not all learning is properly transfer, at least a large part of it is recognized to be so (Hebb, 1949).

Transfer and Intelligence

It was recognized many years ago that an important relationship holds between transfer and intelligence (James, 1930). Several contemporary psychologists continue to maintain that transfer is important to the concept of intelligence. For example, Townsend and Burke (1962) and Stephens (1963) share the view that the more intelligent are those who are more able to transfer general principles to new situations and discriminate among principles involved in different situations. If abilities develop by means of transfer and in turn provide further transfer (Ferguson, 1954), the transfer mechanism plays an increasingly more important role as the individual grows and deals with more complex tasks.

The intercorrelation of ability tests, giving rise to ability factors, is seen by Ferguson as evidence of transfer. It follows that, while it refers to a single process, transfer depends on those abilities developed. Hence, in order to assess individual differences in transfer, a psychologist must first account for differences in environmental influence which produce various ability patterns. The failure of researchers to achieve accord concerning the relationship between learning (transfer) and intelligence may be due largely to the use of measures which confound transfer ability and achievement, i.e., measures which confuse the process and the experience upon which the process operates.

Typically, both early and recent investigations of the relationship between transfer (or learning) and ability have involved comparing scores on conventional intelligence tests of the Stanford-Binet type with gains from pre-test to post-test on some task when activity aiding transfer intervened.

In a classic study by Thorndike (1924), the brightest one percent of the subjects showed a mean 20 point gain and the dullest one percent showed a mean 1.5 point gain on the IER Test of Selective and Relational Thinking after one year of high school. In contrast, Brooks (1924) found only small correlations (ranging between 0.06 and 0.11) between Otis

I.Q. scores and gain scores in arithmetical tasks. The arithmetic tests were separated by mental multiplication practice. Kuenne (1946), using a transposition task and pairs of stimuli varying in similarity, found percentage of correct transposition in children to increase with mental age. Bialer (1961), using children classified by I.Q. as normal, middle-grade retardate, and mongoloid, found differences favoring the more intelligent after training toward a one-trial transfer task. With more difficult tasks, it has been shown that younger, brighter subjects display greater gains over initial scores but the reverse is true for adult subjects (Barlow, 1937).

Studies considered under the rubric of learning and intelligence have been more abundant. In a review of these, Woodrow (1946) concluded that no relationship had been established between the realms of learning and mental ability. He admitted, however, that this conclusion might have been attributable to the use of difference scores. Harris (1963) and Gagné, Foster and Crowley (1961) have described the inefficacies of directly comparing pre-test to post-test gains. These authors have pointed out that direct difference scores can be unreliable and dependent on initial level of performance. It appears then, that studies of learning and intelligence have been plagued by both inadequate gain measures and inadequate criteria for mental ability.

In the latest survey of research in abilities and learning, Fleishman and Bartlett (1969) have stated, "The general misconception of defining intelligence as 'the ability to learn' dies hard, but the evidence against this notion continues to accumulate." After reviewing the work of approximately the same period, Wallen (1962) has asserted in direct contradiction, "In spite of the not uncommon statement that intelligence tests do not predict ability to learn, the evidence that they do continues to accumulate." However, Carver and Dubois (1967) observed that none of the studies considered by Wallen controlled for initial individual differences. On the other hand, the studies cited by Fleishman and Bartlett do not appear to support their claim.

There has been a recent trend toward the use of sophisticated multivariate techniques and of complex and varied tasks more appropriate to the investigation of the relationship between human abilities and learning. In general, when learning is more broadly defined, the earlier somewhat inconclusive findings become less important. McKay and Vernon (1963) have found a strong enough association among measures of various kinds of learning to suggest a general learning factor. Allison (1960), using inter-battery factor analysis, obtained seven factors common to 28 learning measures and 39 ability measures. Canonical regression of Allison's factor correlations by the present writer revealed that a composite of the intellectual ability factor and the numerical ability factor was the best predictor of the combined conceptual and rote learning factors. The canonical variates generated with these factors accounted for the 92.3 percent of the variance common to the ability and learning domains in Allison's data.

The results of these studies suggest that, like mental ability, learning is not a unitary trait, but can be factored into several dimensions. Jensen, in Gagné (1967) suggests that the description of complex learning situations would be best attacked by looking at the ". . . network of already-learned subabilities which form the basis for the acquisition of more complex behaviors higher up in the transfer hierarchy." The hierarchical view of transfer fits in well with the Burt (1949) or Vernon (1950) hierarchical structures of intelligence. Jensen's statement also indicates the direction of another recent trend in the search for communality in learning and intelligence: the investigation of the relationship between abilities and aspects of learning functions other than static points on learning curves. Ferguson (1965) observes that one such aspect is transfer from one task to another.

In all the aforementioned studies, including those reviewed by Fleishman and Bartlett (1969), the assumption has been that the various ability tests employed measure intelligence. Validation for these tests has characteristically consisted of correlation with previously standardized tests, item analysis for discrimination among ages, or, more recently, obtaining factor loadings for tests. Construct validity achieved by these techniques can be of little value when test construction has not been based on any common theory of intellectual processes. Furthermore, since test administrators are warned that deviation I.Q.'s obtained with different tests are not interchangeable (Anastasi, 1961), it can be inferred that the intellectual criteria for different tests are not the same.

The Environmental Factor

When environmental differences are introduced into investigations of intelligence and learning, the findings are less equivocal. Most of the research in the context of socioeconomic, racial or regional differences implies that these environmental differences are powerful influences in the development of mental abilities, in both degree and configuration.

A vast body of studies pertains to negro-white differences in intelligence. The general finding is that whites' performance on intelligence tests is superior (Dreger and Miller, 1960). Osborne (1960), in a longitudinal study, found an increasing difference in I.Q. between whites and Negros from ages 11 to 15 with Negros performing more poorly. When the two races were tested at age five, however, Anastasi and D'Angelo (1952) found no contrast in performance on the Goodenough Draw-a-man Test. Pioneer research by Klineberg (1935) produced a significant relation between intelligence scores of Negros and their length of residence in the city of New York. Lee (1951) found a similar increase in I.Q. with the amount of time Negros spent in northern American schools.

For some time investigators have attempted to equalize white and Negro groups on socioeconomic factors before comparison of I.Q.'s (Tanser, 1939; Bruce, 1940). A recent attempt was made by McQueen and Browning (1960) who matched subjects on age, grade, residential area, and father's occupation. As in other studies, a consistent Negro handicap is noted. On the other hand, McCord and Demerath (1958) found high status blacks to perform on a par with whites when the two groups were matched socioeconomically. In another study, the two races were matched on overall I.Q. but differed significantly in subtest score patterns (Woods and Toal, 1957). Whites performed better on culturally "loaded" and spatial visualization items whereas Negros were superior on items requiring perceptual speed and accuracy.

Groups differing in race and I.Q. apparently do not have different learning ability. Semler and Iscoe (1963) and Haggard (1954) have shown final performance on a learning task to be the same in racial and social class groups differing in I.Q. European and African children in Natal exhibited significant gains with Africans showing a greater increase after practice on a set of non-verbal learning tasks biased in favor of the European group (Lloyd and Pidgeon, 1961).

Other race differences have been investigated. In a study by Lesser, Fifer and Clark (1965), four special ability tests given to each of four ethnic and racial groups of lower and middle class background produced striking profile comparisons. Lower status groups' ability profiles were all lower than their middle status counterparts but both socioeconomic levels of each ethnic group displayed almost identical patterns. Ethnic and socioeconomic variables evidently contribute to ability development in different ways. The reliability of such ability profiles requires investigation.

MacArthur (1967) noted differences between Eskimo and white school class-mates on culturally "loaded" (verbal: educational) material, whites being superior. Striking is the fact that only two factors were required to describe Eskimo children's abilities whereas three were obtained for white children. Jensen (1961) compared Mexican-American and Anglo-American children on I.Q. and three learning tasks: immediate recall, serial learning, and paired associates. He found no ethnic differences in learning at higher I.Q.'s but reported that Mexican-Americans of lower I.Q. were superior in learning ability to the Anglo-American children of the same I.Q.

Where children have been stratified by socioeconomic status, intelligence tests have favored the upper part of the hierarchy. In such an investigation, Eels, Davis, Havighurst, Herrick, and Tyler (1951) found significant differences in intelligence among seven socioeconomic classes in a large urban sample. Three related studies (Havighurst and Janke, 1944; Janke and Havighurst, 1945; and Havighurst and Breese, 1947) give similar findings. It was found in these studies that rural ten year old boys performed better on the Minnesota Mechanical Assembly Test than did their urban counterparts, though the latter were superior in overall ability. Also, the Stanford-Binet correlation with the Mechanical Assembly Test decreased from 0.66 to 0.13 for boys aged ten and sixteen respectively, indicating a greater differentiation of abilities with age. Sixteen year old higher status boys lost their superiority in mechanical ability but retained superiority in general mental ability. Some sex differences were noted for ten year olds: girls excelled on the more verbal tasks while boys were superior on spatial tasks. However, these differences were not evident for sixteen year olds. Mitchell (1956) found a simpler ability factor structure for a lower status group in comparison with a higher status group of children. The low status group's factors were less mutually independent and more dependent on verbal components. This was supposedly because of the low status children's relative verbal incompetence resulting in even "non-verbal" tasks being affected.

Urban children perform better on intelligence tests than do rural children. This is particularly true when the rural population is relatively isolated from the mainstream of the culture. For example, Sherman and Key (1932) carried out a comparative study of children's intelligence in four Blue Ridge Mountain areas and one relatively literate community in the same area. The average I.Q. of the four isolated areas was significantly lower and decreased with age at a more rapid rate than in the literate community. Schooling was more adequate in the literate community, this perhaps explaining the smaller variance in scores on all measures for these children. It is significant that all subjects were Anglo-Saxon in origin and all descended from the same group of settlers. Retesting after a ten year lapse in a Tennessee Mountain region, Wheeler (1942) observed a significant increase in I.Q. (74% of the earlier group fell below median of group tested later) and a lower mean chronological age for each school grade. During the time between testings, roads and transportation had been markedly improved, well-equipped schools had been built and staffed by college graduates, industry had grown rapidly and modern housing and farm equipment had been introduced.

Most other studies concerned with regional differences report deficiency in general ability in rural children (McNemar, 1942; Burnett, Beach and Sullivan, 1963). Burnett, et al. found a difference between Newfoundland city and outport children in performance on the Raven Progressive Matrices Test only when the testing was timed. The authors suggested that the time factor was influenced by difference in life styles between the groups.

Generally, it has been observed that environmental change is associated with alteration of I.Q. and that environment may act as a limiting factor on the level of development of general mental ability. Jensen (1968) has suggested that the threshold for environmental depression of ability is very high. In other words, extremely poor environmental conditions must exist before severe intellectual impairment is evident. Most evidence obtained from studies of abilities, learning and the environmental variable implies that intellectual functioning is not irreversibly weakened by cultural deprivation. Moreover, whether level of general ability is the same or otherwise in two different environmental groups, it is apparent that such groups may have different ability patterns. Ferguson's transfer theory of intelligence attempts to bring together the studies of human ability and the learning process which allows for change in abilities. In terms of this theory, environmental or sub-cultural differences in ability patterns are related to sub-cultural differences in interests, values, and life styles. Also, different ability patterns result in group differential ability to transfer with respect to those abilities in which the groups differ. This difference in transfer should increase in proportion to the duration of the groups' exposure to their respective environments. According to Ferguson's theory, the general intelligence potential or overall transfer capacity would be the same in the two groups. Equality of the different groups' transfer ability could be demonstrated experimentally by equalizing the experience needed for a particular ability in which the groups initially differed. The present experiment is concerned in part, with the hypothesized, environmentally induced difference in transfer and its elimination.

There is little doubt that socioeconomic and regional factors contribute to differences in patterns and levels of ability. Whether or not racial differences are mostly environmentally induced remains, from a scientific point of view, an open question. The flames of polemic between nativist and environmentalist are being fanned anew by the recent unpopular statement by Jensen (1969) that racial differences in intelligence are likely genetically produced. While there seems to be enough evidence on both sides of the nature-nurture ledger to continue the controversy, most contemporary psychologists take a position perhaps best termed interactionism. That is, though not denying individual differences in the physiological limit of ability, they emphasize the dynamic role of experience in the emergence of ability patterns.

In the face of results showing apparent racial factors in intelligence, the persistence of the environmentalists' bias is aided by other considerations suggested by Klineberg (1963) and Dreger and Miller (1960); not only might intelligence tests be biased toward the white population, but also some depressing motivational influence may operate on the mental growth of black children. A propos of this, Vernon (1965) has said of North American Indian children that they seem to ". . . show fairly normal intellectual development till adolescence, but then, when they realize the depressed status of their minority culture - the absence of opportunity for progress and advancement - apathy sets in." The role of motivational determinants in intellectual growth is largely unexplored.

Some attempts have been made to construct tests of mental ability which would be free of culturally biased material. Again, Jensen (1968) has pointed out that validation is taxed by lack of an adequate criterion. Moreover, it is probably futile to expect that any test can be free of cultural parameters since, as Ferguson (1956) puts it, "The concept of a culture-free test is a misconception because the abilities of man are themselves not culture free." Thus, as Wesman (1968) offers, it might be more profitable in the future to search out the intellectual process than to isolate <u>the</u> structure of intelligence.

The Age Factor

Group mean raw scores on intelligence tests increase with age according to a negatively accelerated curve. The shape of individual growth curves can be vastly more variable than curves drawn from group data. (Goodenough and Maurer, 1942; Honzik, Macfarlane and Allen, 1948). The former investigators attribute such changes in I.Q. to inherited growth patterns and errors of measurement. Hunt (1961) suggests that fluctuations in these curves may be explicable in terms of case histories. In the Berkeley Growth Study (Bayley, 1949) and the Berkeley Guidance Study (Honzik, Macfarlane and Allen, 1948) longitudinal testing yielded coefficients for predicting I.Q. at age 18. These coefficients were in the order of 0.8 to 0.9 at age 17 but dropped continuously to about zero by age one. The Berkeley studies indicate that after one or two years of schooling, growth curves tend to become more stable with predictive validity usually better than 0.7. Changes in I.Q. might better be predicted by extrapolation along a growth curve from two or more spaced testings. At any rate, it is evident that growth functions must be taken into account in the accurate prediction of future performance. A problem with using successive I.Q. test scores to predict future ability is that inasmuch as individuals are not matched on experience, differences in I.Q. will not reflect differences in potential learning. That is, practically speaking it would seem more beneficial to obtain a measure of educability (transfer ability) rather than a static measure of present achievement.

Cattell (1963) has isolated two oblique second order factors which indicate two separate sets of intellectual abilities: Crystallized General Ability (G_c) which is loaded by primaries heavily influenced by acculturation and formal education, and Fluid General Ability (G_f) which involves tasks which Cattell believes to be relatively free from these influences. Spearman's (1927) definition of the "g" factor--the ability to perceive relations and educe correlates--is applied to G_f. Both G_f and G_c rely on transfer for development, but Cattell sees the former more as a measure of genetically determined capacity. In a cross-sectional experiment, Horn and Cattell (1966b) observed a rapid increase in G_f to about age 18 and a subsequent moderate decline. The view that G_c depends more on education and experience was supported by the finding that it follows a growth curve which continues to rise past age 18. Though G_f factor tests may partially solve the problem of assessing genotypic ability, they do not account for individual differences in experience which enter into performance on all test items.

Similar increases and decreases in abilities with age were reported in a longitudinal study by Owens (1966) which took into account gains due to cultural change over 42 years.

Fluid General Ability, according to Cattell, is tapped most efficiently if the test content is either equally familiar or novel to all testees. In the case of familiar content, the test items would require unfamiliar principles for solution.

If an ability measure is to reflect innate capacity rather than acquisition level, it should not vary with age. Use of the Intelligence Quotient, relating raw score to age, is one solution. However, this practice assumes rates of development constant for all individuals and still relies on achievement-oriented rather than process-oriented tools of assessment. Given the same ability-relevant experience through equal training in the ability, individuals of different backgrounds should show comparable ability to transfer regardless of age. Similarly, a single individual should show the same capacity for transfer at all ages throughout his life. The transfer measure employed to assess mental ability must, of course, be independent of achievement. Another aspect of the present thesis is the investigation of the constancy of transfer ability when such a measure unrelated to pre-test ability is used.

Some Interactionist Views

Diverse theoretical sources have both stimulated and integrated research into the nature of intellectual processes. Those theorists who stress the interaction of the organism and its environment all include transfer-like concepts in their formulations.

Information processing strategies arising from work with electronic computers have been used as analogues of intellectual functioning (Newell, Shaw and Simon, 1958). The postulated information processing system contains a large storage of complex strategies which are programmed through experience. These complex "programs" are engaged by stimuli, not in a passive reflexive fashion, but according to the active organization of the system. Pribram (1960) and his associates have found a large amount of neurological evidence to have its counterparts in computer simulation. As a result, Miller, Galanter, and Pribram (1960) postulate an intrinsic and an extrinsic system which can be thought of as program memory and data (stimuli) input respectively. The two systems function as a comparator, the storage being "searched" to manage incoming stimuli. When experience, represented in the storage, cannot deal with the input, control shifts to the extrinsic system and its feedback mechanism. In this manner, utilization of past experience and revision of existing strategies take place.

Through his neurological speculations, Hebb (1949) has provided one possible framework for brain programming on the cytological level. By repetitious experience, neural cell assemblies in the brain become "structuralized". Also through experience, any number of these assemblies become linked to form phase sequence. Intelligent behavior is autonomous central processes (thought) which result from cell assemblies operating in a sequence. The extent of an individual's physiological capacity is termed Intelligence A. Intelligence B is the produce of Intelligence A and experience, representing the degree of development of phase sequences.

Piaget's cognitive development theory provides another major interactionist framework. His ethological observations of children have led to concepts paralleling some from information-processing theory and consistent with Hebb's "physiologizing" (Hunt, 1961). The organism is in continuous interaction with the environment. Adaptive interaction involves inner organization or assimilation which occurs if the organism responds to new situations in terms of past experience. Past experience determines the individual's schemata (programs) for responding. Accommodation is the altering of these schemata by feedback from the environment. As the developing child acts upon and in turn is acted upon by his environment, his schemata evolve from simple reflexive schemata to the autonomous central processes or logical operations of the adult. A more or less asymptotic level of abilities is reached at the stage of formal operations. This period commences when the child is eleven or twelve years old and has mastered concrete operations. Concrete operations are the logical building blocks forming the foundation of adult abilities which develop through assimilation and accommodation.

It should be emphasized here that only in special cases of transfer for example Harlow's (1949) learning sets, does the organism rely almost solely on experience. At least some accommodation in terms of the new situation must play a part in effective transfer.

The notion that transfer is the mechanism central to the development of abilities has been advanced by Ferguson (1954, 1956). According to this theory, the level of an ability is represented by a point on a learning curve. The relatively stable abilities of the adult are represented by the "crude" asymptotes of learning curves. Differences in crude limits arise from differential interaction of biological propensities and environmental stimulation. Critical stage(s) of development may exist, resulting in a depressed adult crude limit if cultural deprivation has occurred. A corollary is that environments offering different kinds of stimulation may produce dissimilar patterns of abilities. As Ferguson states, development of abilities relies on transfer from what is learned in a particular culture. Also, that which provides greatest transfer is the relatively invariant pattern of fully-developed abilities of the adult. As the individual grows in a changing environment, his ability pattern and its accompanying transfer effects may also change, preventing prediction of future performance from measures of earlier performance. Different abilities with attendant transfer effects may be employed at different ages. A similar point is made by Garrett (1946), who believes that abilities become more differentiated with age, the emerging pattern depending on changing experience and interests.

The concept of a "g" factor in intelligence results from the fact that abilities are correlated. This overlap in abilities is seen by Ferguson as evidence of transfer. In the course of learning a task, those abilities which produce greater transfer should be more highly correlated with the task. As learning plateaus are reached, reorganization and integration involving other abilities occurs. Thus transfer ability, or "g", utilizes different abilities at different stages of learning. Empirical grounds for this are given by Fleishman and Hempel (1954, 1955) and Fleishman (1955), who found changes in the ability factor structure of a learning task as practice proceeded. Bunderson (1967) has verified that abilities transfer differentially at different stages of practice in conceptual learning. Ferguson's idea of transfer involving different abilities at different stages of practice is similar to the concept of learning set hierarchies emanating from work by Gagné (1962) and his colleagues on programmed learning and its relation to abilities.

To summarize Ferguson's ideas--general mental ability manifests itself through transfer which acts reciprocally on the achieved ability pattern which in turn depends on the individual's environment and age.

The first study addressed to Ferguson's theory was carried out by Sullivan (1964), who wished to demonstrate that transfer tasks of varying difficulty to a large sample of elementary school children. Rather than giving a pre-test, Sullivan used I.Q. as a blocking factor and found experimental (practice) group performance to increase progressively over controls (no practice) proceeding from lower to higher I.Q. groups. He also observed that younger subjects transferred more than older subjects who had the same mental age. This observation has been confirmed by Shannon (1968) in a more extensive investigation concerned also with determining optimal conditions for transfer in bright and dull children.

Sullivan's subjects showed decreasing amounts of transfer with increase in I.Q. when the task was very easy, whereas a difficult task produced negative transfer for those of low I.Q., no evident transfer effect in the middle I.Q. range, and positive transfer only for the high I.Q. blocks.

Shannon (1965) illustrated the effect on the I.Q.-transfer relation of the environmental factor. Using a task involving transfer of principles from a number series task to a letter series task, she discovered greater transfer effect in a group of children of lower socioeconomic status (assumed free with respect to environmental stimulation). The "restricted" environment group was significantly lower in two intelligence measures than the "free" group. No difference in test performance was obtained between groups after transfer took place when Raven Progressive matrices score was used as a covariate, but the free group's performance remained superior when the Dominion Test of Learning was the concomitant variable. The use of intelligence tests as covariates, replacing a pre-test, assumes that these are properly measures of "initial" ability. In Shannon's experiment, letter series performance both before and after practice was more highly associated with Raven score for the restricted group and with Dominion I.Q. for the free group. The difference between environmental groups in letter series test criterion for the two intelligence measures was large enough to make doubtful the propriety of using either intelligence measure as substitute for a pre-test.

Hypotheses

In the present attempt to provide further support for Ferguson's transfer theory, the following ideas were pursued.

If the principles of reasoning involved in a task have not been educed in a formal learning situation, (e.g. in school) one would expect to find a difference in transfer of these principles favoring those individuals whose informal learning environment (e.g. at home) fosters thinking relevant to the task. Such individuals, according to Ferguson's theory, should show an increasing ability to transfer as they grow older, while those from a less advantaged environment should become relatively more retarded in transferring the principles in question. This condition might exist between two groups of children dichotomized by social class, a variable well-known to be related to abilities.

The transfer theory suggests that lower status children would show less transfer ability in a traditional reasoning problem than children of higher status possibly because less value is placed on this kind of task in the lower socioeconomic stratum. The lower status individual's intelligence is, instead, manifested through other types of tasks in keeping with the values of his subculture. The learning which occurs in an environment common to both groups, for example, in a school system attempting to maintain homogeneity of educational quality, should tend to prevent group differential performance at least in school subjects. In other words, formal training of both groups, in material otherwise biased toward one of the groups, should eliminate the bias. This may not be true in the case of children living in severely deprived circumstances. It has been offered that in such instances motivational handicaps may mask an individual's intellectual potential. For example, Deutsch (1965) believes that motivational factors may be indirectly responsible for a cumulative deficit apparent in the language-dependent abilities of slum children.

The purpose of the present experiment is to investigate differences in transfer ability between groups whose environmental backgrounds supposedly engender different ability patterns but not different motivity. Similar achievement levels in the groups will be taken as indication of similar motivity. Groups of children of different ages are to be chosen from two socioeconomically dissimilar regions in a large urban area, but with care taken that the lower status region could not be designated a serious "problem area". Subjects will be presented with two transfer tasks. The first task will require transfer of principles relying on informal learning, i.e., the subjects will not have formal guidance but must depend on experience brought to the experimental situation. The second task will include a period of formal instruction by means of guided discovery of the task-relevant principles. Eight hypotheses were derived. In the following statements the operational definition of transfer is a gain measure independent of performance preceding transfer.

1 The higher status (H) group will show greater transfer under the informal transfer condition than will the lower status (L) group.

2 All groups will show an increase in transfer with age under the informal condition.

3 The L group will show a smaller transfer increase with age than the H group under the informal condition.

The reasoning for the last two hypotheses is that increasing age is coextensive with increasing exposure to both school and home environment.

4 Under the formal transfer condition, L and H groups will show the same amount of transfer.

5 Task performance before transfer will show an age increment in both L and H groups.

This performance corresponds to static points at each age level on a group growth curve related more to present achievement and I.Q. than to transfer. Thus:

6 The correlation between I.Q. and task performance before transfer will be greater than the correlation between I.Q. and transfer.

The point has been discussed earlier that when the environmental element is introduced, I.Q. may vary in its utility when transfer is the criterion. It is therefore submitted that:

7 The correlation between I.Q. and transfer would be greater for the H group than for the L group.

Since transfer is deemed the mechanism of intelligence, it is to be expected that transfer ability, independent of level of achievement, would be constant across ages provided that facilitation of transfer is maximized. Therefore:

8 Under the formal condition, there would be no difference in transfer among age groups.

Subjects

One school, representative of a lower socioeconomic status (L) area, and one of an area of higher status (H) were chosen with the help of school officials and a sociological census by Bartlett *et al.* (1964) in the city of Vancouver. In the selection of the schools, care was taken to avoid confounding racial, ethnic and environmental depression factors.

Three age groups were chosen within the range normally expected to be found in each of elementary school grades five, six and seven. Subjects too young or too old for each grade were not used. To avoid comparison of overly-skewed sample distributions, age ranges within grades were separated by four month gaps between grades. As Table 1 shows, the mean ages range from ten to twelve years approximately. This is the period during which the alleged Piagetian transformation from concrete to formal operations occurs. It is a time of relatively stable growth in ability. The choice of age groups not widely spaced also allows direct comparison of performance using a single test requiring the same resoning for all. School classes were provided in accordance with their availability and subjects within classes were obtained from class lists with the aid of a random number table. Altogether 12 classes were used, each representing a particular combination of environment, grade and transfer condition. There were 19 subjects in each of the 12 groups, making a total of 228.

Informal

		Lower Status			Higher Status		
	Grade:	5	6	7	5	6	7
Age	Mean	125.8	136.3	148.5	125.6	135.6	150.7
	S.D.	3.6	4.4	3.1	3.6	5.8	2.7
I.Q.	Mean	109.8	117.4	118.1	121.6	119.2	121.4
	S.D.	11.4	11.7	9.2	10.8	9.2	9.3

Formal

		Lower Status			Higher Status		
	Grade:	5	6	7	5	6	7
Age	Mean	123.2	136.6	149.4	124.7	135.4	147.4
	S.D.	3.5	4.1	3.4	3.5	4.0	2.9
I.Q.	Mean	117.5	113.6	117.3	113.5	117.1	114.0
	S.D.	7.7	11.8	9.7	7.5	8.6	8.5

Table 1. Means and Standard Deviations of Ages in Months and I.Q.'s for all Groups.

Design

A traditional transfer paradigm was employed. The experimental groups were given alternate forms of a test interpolated with practice on material different in content from the tests but identical in principles needed for solving the items. The control groups were given these equivalent tests but irrelevant activity separated pre-test and post-test.

The experimental and control conditions are of interest in their own right in this experiment, representing the formal and informal transfer conditions respectively.

Transfer Tasks

The transfer tests used consisted of twenty series of letters selected from the Nufferno Speed and Level Tests (Furneau, 1956). Sullivan (1964) constructed these tests with items of varying difficulty which he found to allow for good discrimination among individuals and to lack ceiling effect in the late elementary school ages when a ten minute time limit was imposed. The task involved completion of a sequence of letters according to one or more of six general principles. A series of forty number sequences also collected by Sullivan provided practice of different content but the same principles as those required by the letter series tests. Numbers and letters supply the type of content which is assumed to be over-learned in all strata of our society. The test and practice series are included in Appendix A.

Intelligence Tests

All subjects had been tested with the Henmon-Nelson Test of Mental Ability (Lamke and Nelson, 1957). Lefever (1959b) reports that this instrument has undergone meticulous standardization and correlates well with scholastic success. Though it attempts to obtain a measure of general mental ability equatable to the Stanford-Binet, the Henmon-Nelson has a strongly verbal bias (Tyler, 1959). This particular group test of mental ability was deemed representative of conventional intelligence tests in common use. Table 1 contains mean I.Q. and standard deviation for each of the groups.

Procedure

All groups in one school were given the first form (A3) of the letter series test during one morning. Standardized instructions were used (see Appendix A) and a ten minute time limit was rigidly imposed. The three formal transfer groups in the school were then presented with the number series practice. Subjects attempted each item first, then guidance was given by the administrator. The classroom teacher cooperated by ensuring that the subjects attempted each sequence, but gave no individual prompting. After the guided practice session, the second form (B3) of the letter series test was administered. Informal transfer groups carried on with normal classroom work irrelevant to the experimental tests before being given the second form of the letter series test. Approximately forty minutes elapsed between pre-test and post-test for all groups. Two days later, the same procedure was followed with the groups in the second school.

For each item of the practice or test, subjects were required to indicate the two letters or numbers which would logically come next in the series.

RESULTS

Age, Environment and Transfer Condition

The means and standard deviations for all groups' initial and final letter series tests (T1 and T2 respectively) are listed in Table 2. Figure 1 illustrates the change in letter series test performance with age (grade) for both L and H groups under the informal transfer condition. As expected, all these groups showed an improvement in test performance with age. Table 2 shows the mean transfer effect for the groups in terms of raw differences between post-test and pre-test. From these differences it is apparent that H subjects displayed greater transfer at each age level than did L subjects in the informal condition and the difference in transfer between environmental groups increased with age. Performance on T2 was consistently better for H than for L groups, though initial performance was best in the grade seven L group.

Figure 2, showing test performance under the formal transfer condition, demonstrates improvement with age in both environmental groups on T1 and T2. Table 2 reveals, for the formal condition, difference scores which show little variability either across age levels or between environments.

Analysis of variance for T1 scores yielded significant age effects within informal and formal conditions ($F=28.16$, $p<0.01$, $F=17.60$, $p<0.01$) but no environmental differences in initial test performance. No significant difference in

Informal

	Lower Status			Higher Status		
Grade:	5	6	7	5	6	7
T1	1.37	1.89	6.42	1.53	2.16	5.00
S.D.	1.74	2.28	3.95	2.06	2.73	2.79
T2	1.95	3.37	10.37	2.68	4.21	10.79
S.D.	2.76	3.92	4.80	3.06	5.14	3.92

Formal

	Lower Status			Higher Status		
Grade:	5	6	7	5	6	7
T1	2.21	2.79	6.05	1.26	4.05	5.63
S.D.	3.10	3.22	3.12	1.97	4.21	3.11
T2	5.84	6.79	10.00	4.68	7.74	8.84
S.D.	5.11	4.93	3.99	3.50	6.19	4.18

Table 2. Initial and Final Letter Series Test Means and Standard Deviations for all Groups.

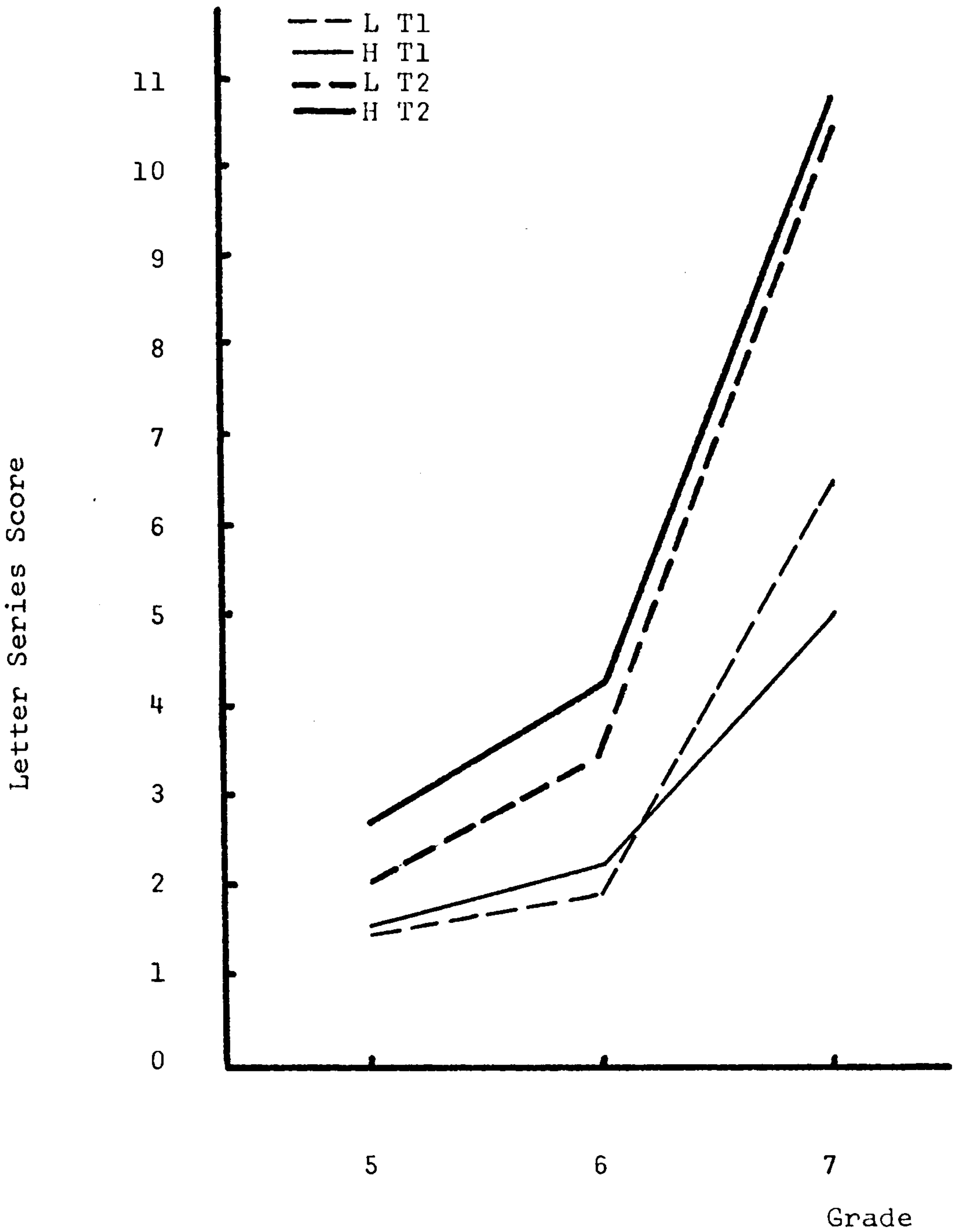

Figure 1. Mean Letter Series Pre-test and Post-test Score as a Function of Grade for Informal Condition Groups

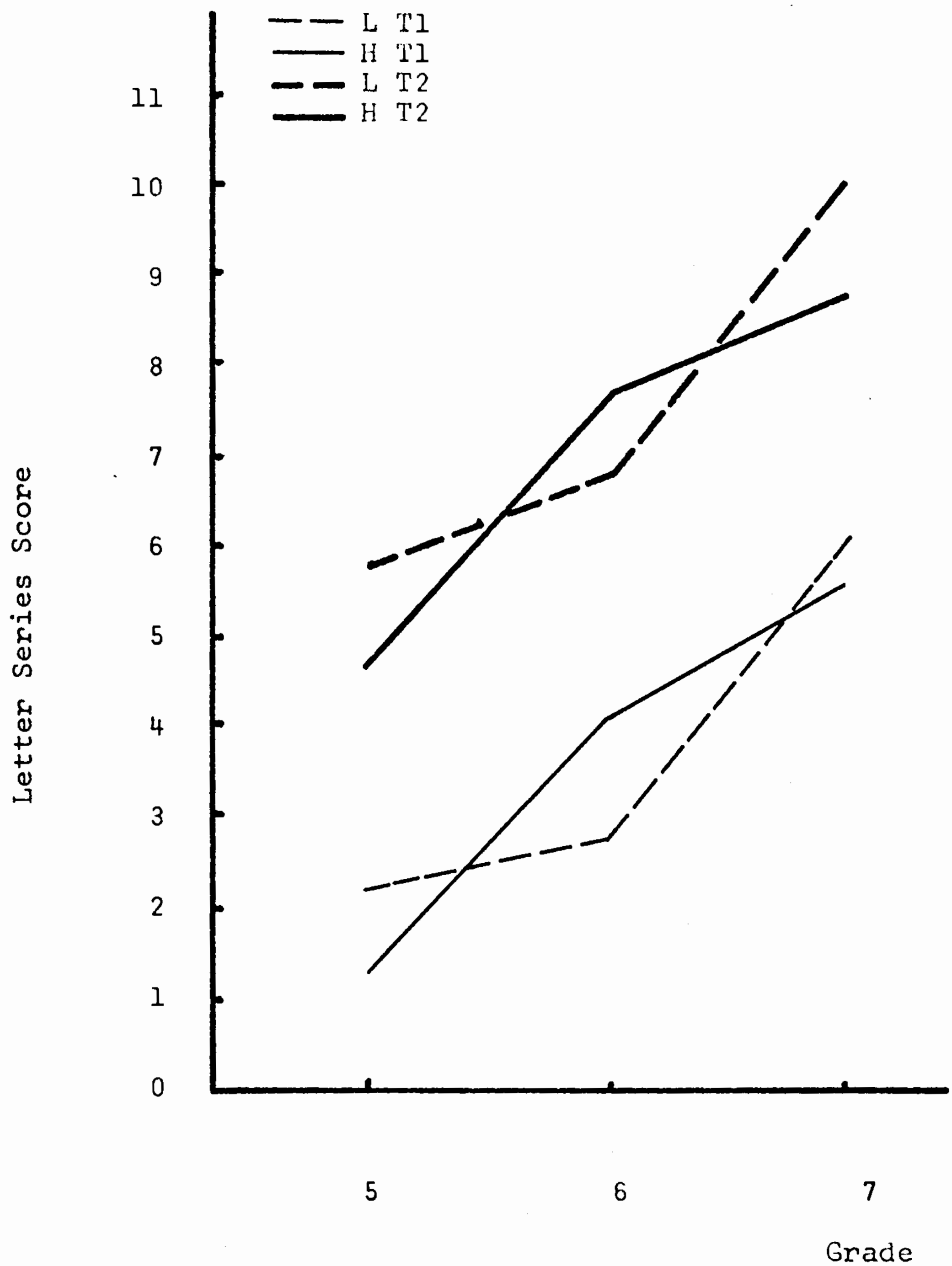

Figure 2. Mean Letter Series Pre-test and Post-test Score as a Function of Grade for Formal Condition Groups

pre-test scores was obtained between transfer conditions.

When individual and group differences exist in pre-test performance, it is inappropriate to make direct comparisons of post-test gains. To avoid this problem, residual gains were examined using T1 as the concomitant variable. For each transfer condition, a two factor analysis of covariance was performed to determine transfer effects due to age and environment, independent of initial performance.

Cochran's test for homogeneity of variance was carried out for T1 and T2 variances and the assumption of homogeneity of variance was found tenable. Data summarily underwent arc sine transformation prior to statistical analysis. Homogeneity of regression of T2 on T1 was tested and found tenable.

Table 3 summarizes the results of the analyses for both transfer conditions. In the informal condition transfer significantly increased with age but the apparent interaction with environment was not significant. The H groups of all three age levels demonstrated greater transfer than their L counterparts ($p=0.076$). Though the intra-class correlation for this environmental effect was not large ($\omega^2=0.105$), an estimate from the obtained F value of the probability of occurrence of a type II error ($\beta \simeq 0.4$) suggested that the effect should be considered significant.

With T1 performance controlled for the formal groups, no significant differences in transfer were detected either between environments or across age levels.

Informal

Source	MS	df	F	p
Environment	0.1180	1	3.22	0.076
Age	0.3552	2	9.68	0.000
Interaction	0.0134	2	0.36	0.695
Error	0.0367	107		

Formal

Source	MS	df	F	p
Environment	0.0123	1	0.25	0.621
Age	0.0208	2	0.42	0.660
Interaction	0.0107	2	0.21	0.807
Error	0.0500	107		

Table 3. Summary of Analyses of Covariance for Informal and Formal Conditions of Transfer. Mean squares calculated from arc sine transformed data.

In order to compare transfer effects between formal and informal conditions, a three factor analysis of covariance was carried out. The independent variables were age, environment and transfer condition. Again the covariate was T1 and the dependent variable was T2. Group means adjusted by T1 are plotted in Figure 3 and listed in Table 4. Of interest in this analysis are the transfer condition main effect ($F=15.34$, $p<0.001$) and the transfer condition by age level interaction ($F=11.21$, $p<0.001$). Other terms involving comparison of formal and informal conditions were not significant. The advantage of the formal groups over the informal decreased with age. In fact, at the grade seven level the two L groups showed identical transfer and the formal H group performed much below the informal H group. The apparent result is that, at the grade seven level, practice either made no difference in transfer or even hindered it. To understand this unexpected effect, a closer examination of the grade seven groups was made. Analysis of covariance for these groups showed a significant difference in transfer between environment and transfer condition ($F=3.91$, $p=0.052$; $F=3.71$, $p=0.058$). These apparent negative and zero effects of practice might be explained in terms of differences in ability between groups. Though predictions have been made concerning the unsuitability of I.Q. as general ability measures across environments, if I.Q. accounts for some of the variability in T2 scores it may be worth scrutinizing

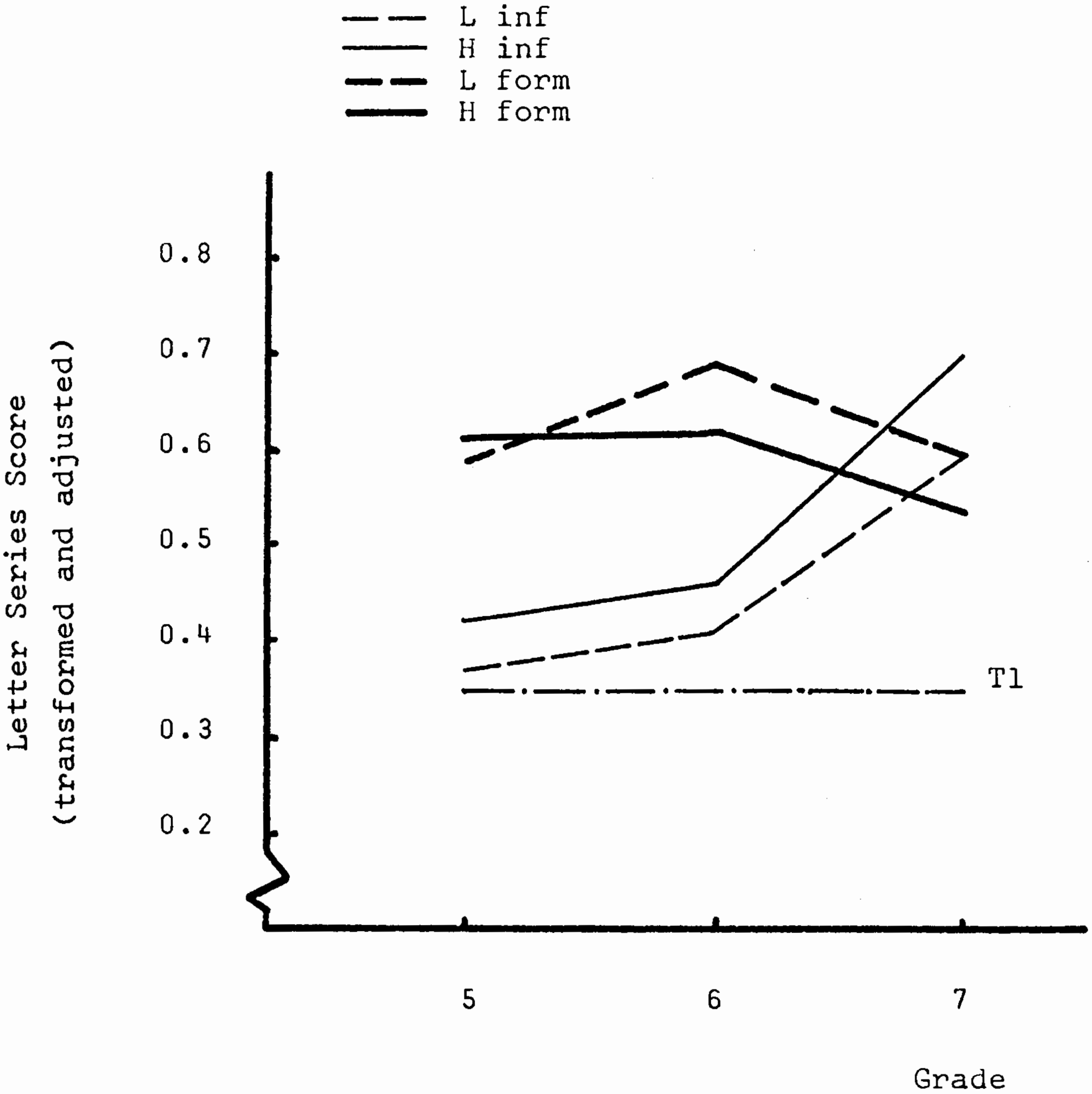

Figure 3. Mean Adjusted Post-Test Scores for Informal and Formal Conditions as a Function of Grade. T1 is mean pre-test score for all groups. Scores are arc sine transformed.

Informal

Grade:	5	6	7
Lower Status	368	414	595
Higher Status	414	457	695

Formal

Grade:	5	6	7
Lower Status	591	641	594
Higher Status	610	614	542

Table 4. Mean Letter Series Post-Test Performance Adjusted by Regression on Pre-test. Scores are arc sine transformations with decimals omitted.

group differences in this measure. If the within grade and environment I.Q. differences are examined (see Table 1) it is evident that only the separation in T2 of the formal and informal grade seven H groups might be significantly affected by I.Q. differences. For reasons discussed later, inter-environmental differences in I.Q. cannot be justifiably compared. Using both T1 and I.Q. as covariates, the grade seven groups were further analyzed. The addition of I.Q. as a covariate eliminated the environment by transfer condition interaction ($F=2.64$, not significant) and reduced the disparity between the two H groups ($F=2.85$, $p<0.1$).

It has been stated that comparative transfer among groups or individuals is most meaningful when they are matched on initial performance. Although covarying T1 in this experiment does not exactly match groups, the T2 means adjusted by this procedure provide an adequate means of comparing transfer among the groups. The relative transfer displayed by these different groups is readily observed by noting the difference between adjusted T2 means and the common T1 baseline displayed in Figure 3.

Transfer and I.Q.

Under both formal and informal transfer conditions there was a fairly consistent decrease in I.Q. correlation with letter series test from T1 to T2 in the L groups and a consistent increase in the H groups in I.Q.-T1 to I.Q.-T2 correlation. The mean I.Q.-T1 correlation for L groups was

0.443 and the mean I.Q.-T2 correlation for these groups was 0.333. The corresponding mean correlations for the H groups were 0.365 and 0.428. To obtain correlations of I.Q. with transfer (i.e. that part of T2 score independent of T1), the effects of T1-T2 correlations on the I.Q.-T2 correlations were partialled out. This procedure resulted in an I.Q.-transfer correlation of -0.004(n.s.) for the combined L groups and a value of 0.276 ($p<0.1$) for H groups. The T1-T2 correlations for all groups were much higher than the corresponding I.Q.-T1 and I.Q.-T2 correlations, having a mean of 0.719.

Supplementary Data - Transfer and I.Q.

To help establish the generality of the obtained I.Q.-transfer relation, a third group of subjects were administered the number and letter series task. These subjects, numbering 65, were in grade five of an elementary school in an area considered to be approximately mid-way in socioeconomic status between the L and H areas. All subjects had been tested with form As of the Otis Alpha (non-verbal) and with form Fm of the Otis Beta (verbal) Quick-Scoring Test of Mental Ability (Otis, 1954). The Otis tests are commonly used measures of general mental ability similar to the Henmon-Nelson test ($r=0.78$) and rely on school achievement for validation (Lefever, 1959a). Achievement measures in the form of grade point averages (scale of 1 to 6) for six school subjects were computed for the children. I.Q.'s from

Cattell's (1957) I.P.A.T. Culture-Fair Test of "g" were also included in this testing. The I.P.A.T. test is assumed by Cattell to be relatively free from the influences of differential experience and to tap the individual's native capacity (G_F). Means and standard deviations for all variables are listed in Table 5.

Correlations among the measures are displayed in Table 6. Intercorrelations among the Otis tests, G.P.A., and T1 were moderately high and significant (all r's 0.6, $p<0.01$). The I.P.A.T. test correlations with these measures were significant but slightly smaller. All measures showed smaller correlations with T2 than with T1.

After partialling out the T1-T2 correlation, both Otis tests and G.P.A. showed insignificant association with T2. Only the I.P.A.T. test correlated significantly with transfer.

Individual Differences

Transfer scores in the form of standardized residual gains (Manning and Dubois, 1962) were computed for all L and H subjects who underwent the formal transfer treatment. These standard scores, being independent of T1, were considered relatively "pure" measures of the individuals' transfer ability in the task. A histogram illustrating the distribution of these transfer scores in the experimental sample is shown in Figure 4. The distribution is also unaffected by age differences since these transfer scores are not influenced

	MEAN	S.D.
AGE (months)	121.6	4.9
OTIS ALPHA	112.6	12.5
OTIS BETA	109.8	15.2
I.P.A.T.	106.4	25.6
GRADE POINT	3.28	0.82
EXPERIMENTAL		
PRE-TEST	5.02	3.44
POST-TEST	8.85	4.24
CONTROL		
PRE-TEST	4.79	3.88
POST-TEST	7.42	4.56

Table 5. Means and Standard Deviations for Measures Taken on Supplementary (Middle Status) Group.

	T2	OTIS ALPHA	OTIS BETA	I.P.A.T.	G.P.A.
T1	686	615	669	588	612
T2		540	578	493	490
OTIS ALPHA			754	571	661
OTIS BETA				486	772
I.P.A.T.					603
TRANSFER		140	040	337	-016

Table 6. Correlations among Measures obtained for Middle Status Group. Decimals omitted. Correlations with transfer are partials resulting from removal of $r_{T1.T2}$.

(For $r=0.325$, $p<0.01$).

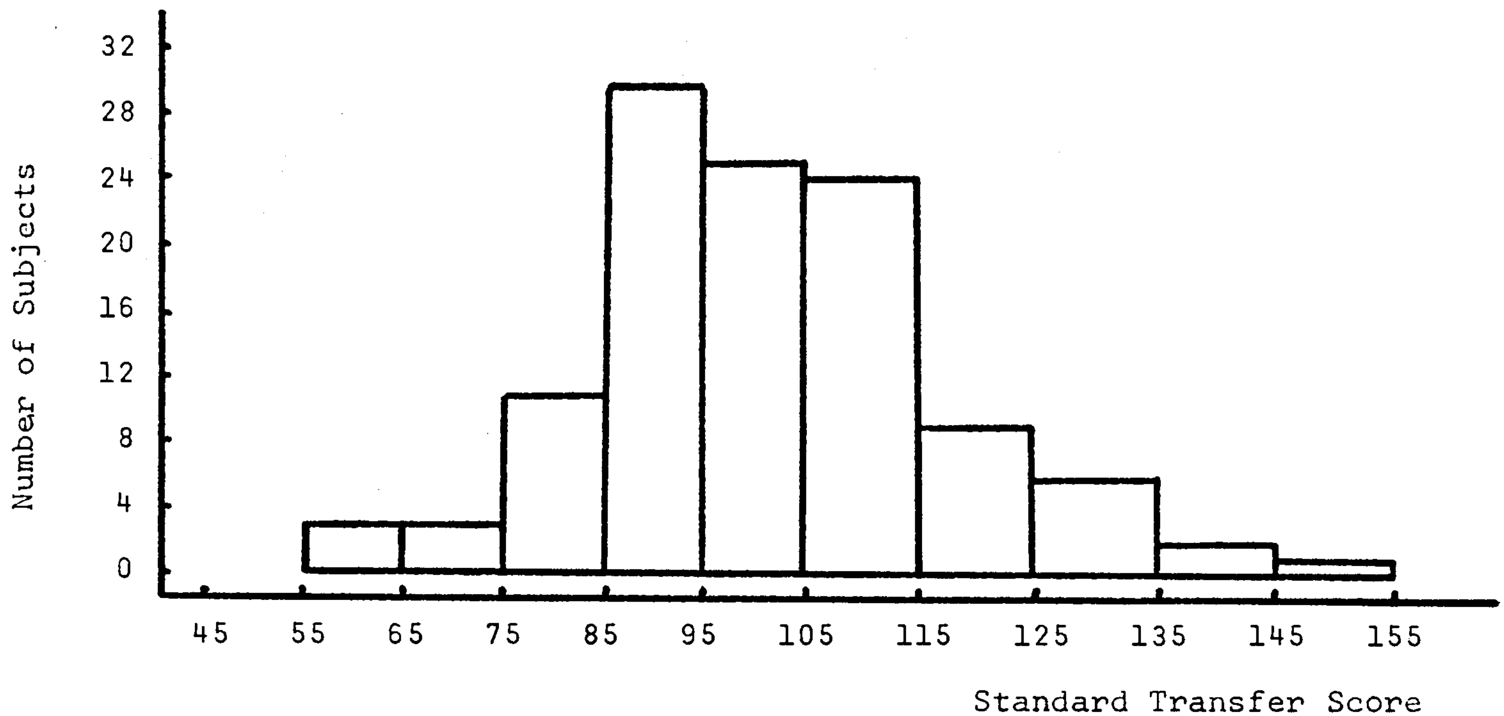

Figure 4. Distribution of Standard Transfer Scores for Formal Condition Subjects (N=114). (Standard Transfer score = $100\ (Z_{T2} - r_{T1.T2}\ Z_{T1}) + 100$).

by experience. Comparative transfer ability of individuals measured in this way is justified, however, only to the extent that the task used is within the maturational limits of the subjects. A scatter plot of T2 against T1 indicated that, at least for a few individuals, the present task was too difficult. However, the suggestion of a "floor" effect in the task was neither strong nor peculiar to any one group. There was, at the same time, no evidence for a "ceiling" effect since there was increase in group performance in every case accompanied by increase in variance from T1 to T2. Good discrimination in the upper score region was confirmed by examination of individual scores on the scatter diagram.

DISCUSSION

Environment

In general, the hypotheses of this experiment were confirmed. The reasoning underlying the hypotheses was derived primarily from Ferguson's transfer theory of intelligence.

Briefly, the present study showed that transfer of principles involved in even a relatively simple task can increase with age at different rates depending on differences in task-relevant experience, but that with training appropriate to the task, groups of different experience can show equal transfer ability. It was demonstrated that groups from different environments can show different ability to transfer principles of logic from one situation to another. This difference is believed to result from extra-experimental conditions peculiar to each environmental group, which produce superior performance in those of higher social status. It has been suggested earlier that the nature of these conditions may be related to motivational or learning factors associated with the informal or home environment. The fact that transfer but not pre-test performance differed for the two environmental groups, emphasizes the importance of controlling experience in the testing situation in order to obtain valid measures of transfer ability. In this experiment this control was accomplished when guided practice of the task-relevant principles was given. The advantage of the higher status group was then eliminated--all performed at the same level. In other words, formal training removed the bias favoring the H group, in a sense equalizing experience for everyone. If the environmental groups had been more markedly different, a greater margin of transfer in the informal H group over the informal L group might have been found. Shannon's (1965) environmental groups appeared to be more widely separated than those of the present experiment. Nonetheless, even her experimental (formal condition) groups did not differ significantly in transfer.

The H groups' transfer improved with age slightly more than transfer for the L groups under the informal condition. Though this effect was consistent, it was not statistically significant, most likely again because the environmental difference was not extreme. The use of more difficult and less specific transfer tasks over a wider range of ages would hopefully reveal the reliability of this effect. It would be helpful also to obtain information beyond that supplied by Shannon (1968) about the optimum training conditions and by Bunderson (1967) concerning differential transfer components applied at various stages of a task. The information could be used to discover the best ways of maximizing transfer in formal training for complex mental tasks.

In this experiment it was relatively easy for the two environmental groups to "overlearn" the principles taught. The utility of this kind of experiment, oversimplifying the parameters of transfer ability in humans, should be its pilot function in pointing the way to multivariate studies. Such studies would be concerned, for example, not only with training conditions and stages of transfer but also with individuals' transfer strategies determined by experience.

<u>Age</u>

After practice, when T1 was controlled, all three age groups displayed the same transfer ability. The T2 scores increased with age, of course, but this age effect in the formal case was found to be entirely attributable to the increase with age of T1 (increased achievement with age). The transfer task employed in this experiment was selected deliberately to allow these age groups to be directly compared. Since transfer ability was postulated to correspond to innate potential when base level is controlled, it was expected that all age groups would show equivalent transfer on a comparable test. This is interpreted as hypothesized, <u>viz</u>., genetically-determined intellectual ability is independent of age. This does not mean that a younger person of transfer ability equal to that of an older person can perform the same intellectual feats. The older individual presumably has attained a greater level of achievement, the experiential base upon which the transfer ability operates. Also, experience alters the nature of the transfer. Multivariate approaches are needed here, too, to determine if transfer functions differentiate into more complex hierarchical forms with age. In any event, the "g" factor of transfer is held to be constant with age.

Since there may be relative leaps or lags in development among people with the same transfer capacity, the practice of chronological age-norming by developmental psychologists may prove to be a descriptive tool at best. At worst, age norms are used for prediction of future achievement on the basis of present I.Q. Previous discussion has illustrated that without knowledge of future experience, such predictions may be very poor. A measure of transfer "g" would at least predict trainability or perhaps, combined with measures of motivation and interest, would give a better indication of future achievement. Increase with age in ability and achievement test scores can be represented by acquisition functions which are analogous to curves of pre-test scores in a transfer experiment.

At present it is not possible to say how general is the phenomenon of transfer constancy with age. Perhaps the maturational variable must be taken into account. Future research, for example, might attempt to compare transfer ability of children at various Piagetian stages of development. Also, a look at patterns of maturation might be fruitful.

<u>Transfer Condition</u>

This experiment demonstrated that transfer for all formal groups was approximately the same, but for the informal groups it increased with age. This is equivalent to saying that the benefit of practice decreased with age. Since L groups had shown less transfer under the informal condition, they were helped more by the practice afforded by the formal training condition. Both L and H formal groups in grade seven performed less well than expected. To be congruent with the hypotheses, these groups should have shown transfer equal to or greater than that shown by the grade seven informal condition H group, which displayed the best transfer performance. If the expected result had occurred, it would have been interpreted as showing that the letter series test was a "grade seven" task with all formal condition groups but the grade seven H group being assisted by practice. Instead, practice seems to have depressed both the grade seven formal condition groups, with the H group more affected. Could it still have been the case that the test used was a task most suitable to the grade seven H groups, in the sense that their experience obviated the need for practice to achieve maximum transfer? Perhaps the additional "experience" provided by guided practice somehow interfered, producing only an apparent lower transfer ability in the formal condition H group compared with its informal condition counterpart. This explanation is plausible because the informal L group showed less transfer than did the informal H, but the formal L was not as adversely affected as was the formal H group. Evidence to support the explanation of the discrepancy between hypothesis and results is drawn from several sources.

Shannon (1968) discovered that pretesting before giving practice can produce interference in transferring to the post-test. Also, Sullivan (1964) has alluded to possible distortion of transfer effect when pre-tests are given. If the task used in the present study were in fact a "grade seven" task, as it appears to have been, might interference have arisen from rigidity of the grade seven groups resulting from their increased experience? That is, did the interpolated practice, involving different material, confuse these children and make them look for something more difficult or different in the task? The rigidity of approach to problems would be greater for H subjects than for L subjects, since the former supposedly had the environmental "advantage". Less experienced subjects should be more receptive to training in tasks less familiar to them. Luchins (1942) and others have investigated the phenomenon of fixation in thinking strategies by inducing problem solving sets in their subjects. Analogously, perhaps an individual may be rendered less flexible in accommodating material with which he is partially familiar. In Ferguson's terms, transfer becomes more dependent on what is learned as this approaches the overlearning stage. Further training at an age when task-relevant principles are well established may lead to confusion and submaximal performance. Thus, in the construction of instruments to assess transfer ability and in the education of individuals to realize their maximum transfer potential, both achievement level and method of presentation of material must be taken into account. Both of these factors may have been responsible for the unexpected poorer performance of the formal condition groups in grade seven.

Cattell avers that innate mental ability declines in early adulthood. If transfer ability is synonymous with Cattell's G_F factor, perhaps it would be reasonable to look for a "critical" stage in intellectual development near the onset of senescence rather than around the very early years of growth. Since one reaches the "crude" limits of his separate abilities and begins to decline in G_F more or less contemporaneously, common maturational changes may be responsible for both. The inference is that the decline in genetically determined mental ability may manifest itself as decreasing ability to transfer, seen as more rigid adherence to a now relatively invariant set of strategies acquired through experience.

Shannon has suggested that children are possibly trained in a way which hinders transfer. As transfer research progresses and becomes more sophisticated, hopefully the results will have practical application in the field of education. If experience does give rise to "fixation" in reasoning habits, then educating for transfer appears to be a partial antidote.

Individual Differences

The trend in differential psychology is rightly in the direction of multivariate studies of the individual. The general transfer ability of an individual relative to the rest of the population, even obtained by using a large number and variety of tasks, has some value for understanding his intellectual functioning. However, neither such a unidimensional nomothetic nor the non-quantitative idiographic method of describing the individual provides a truly individual psychological picture with predictive power at the same time. Future study might attempt to develop an approach which would create equations for individual intellectual styles.

In the meantime, if an appraisal of the individual's transfer "g" factor is needed, the present experiment has suggested a tack--standardized residual gain scores could be used. These measurements might, for example, be derived from pre-test and post-test scores on a test using two similar sets of tasks interpolated by practice on the task-relevant principles, which had been built into the test. To ensure equal training in principles for all, regardless of experience before testing, the test could be programmed and untimed. Standard residual gains are independent of pre-test performance and of the metric. Consequently, these measurements would allow direct comparison of transfer ability among individuals across all ages.

Transfer and I.Q.

This study showed for both the original groups tested and the replication that conventional measures of general mental ability have little in common with transfer. Only in the case of subjects of higher social status was a relationship between conventional I.Q. and transfer obtained. The conventional intelligence measures used in the study, the Otis Alpha, the Otis Beta and the Henmon-Nelson tests are considered good examples of group ability tests in widespread use and give results closely allied to those of individual measures such as the Stanford-Binet and Wechsler tests (Tyler, 1959). School achievement was found to be highly related to conventional I.Q. and also showed no significant relationship to transfer. Pre-test performance on the transfer task, another achievement measure, was related to I.Q. and school achievement as expected. The I.P.A.T. test's communality with transfer was the interesting exception. Though the significant association was not high, it suggests that the culture-fair claim for the I.P.A.T. test has some credibility. Cattell's removal from his test of items which discriminate between different environmental groups possibly help put all subjects on a more equal experiential footing. Thus the I.P.A.T. test may restrict much transfer to within the test itself.

SUMMARY

Ferguson's transfer theory of intelligence, integrating many ideas coming out of previous investigation of the nature of human abilities and learning, has in turn stimulated work concerned with parameters of transfer ability. Recent studies have given some support for Ferguson's predicted relationship between transfer and intelligence and one study has found that individuals from a "restricted" environment were not necessarily inferior in transfer ability.

In addition to the problem of the transfer-I.Q. relationship and the environmental variable, the present study also concerned itself with the age factor and the condition under which transfer took place.

Three age groups representing two socioeconomic classifications were divided into "informal" and "formal" experimental transfer situations. A more direct comparison of transfer ability was permitted by controlling transfer task pre-test level over all groups, a procedure which has not been generally followed in similar past experiments.

Several hypotheses derived from the transfer theory of intelligence were generally supported. The results indicated that environmental differences may produce differential transfer ability and that this ability difference may increase with age. Formal training or changes in experience seem to eliminate the advantage of one environmental group over another in the three ages tested.

The results also indicate that a "pure" measure of transfer ability is independent of age. Such a measure was found not to be related to conventional I.Q. except for higher status subjects. Decremental effects of practice on the most experienced groups suggested that proaction may be the function of overlearning and perhaps the decline of innate ability with aging.

Suggestions for future research into the transfer theory of intelligence and for practical application of results were discussed.

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APPENDIX A

Instructions to subjects

Letter series pre-test (form A3)

Letter series post-test (form B3)

Number series practice

INSTRUCTIONS TO SUBJECTS

Letter Series Tests

Please do not open the test booklet until you are told.

Please put your name in the space at the top of the first page.

The problems in this test contain letters which are arranged in a certain order. You have to find out what the order is and print the two letters that come next on the right. You will have ten minutes to do the test.

Are there any questions?

You may start now.

Number Series Practice

Please do not open the test booklet until you are told.

Please put your name in the space at the top of the first page.

The problems in this test contain numbers which are arranged in a certain order. You have to find out what the order is and print the two numbers that come next on the right. For example, (demonstrate solution of examples A and B). After you try each problem, I will do it also to make sure you know how.

Are there any questions?

LETTER SERIES TEST - FORM A3

1. A T U B U V C V W D ___ ___
2. E T E F S F G R G H Q H I ___ ___
3. R S T Q R S T P Q R S T ___ ___
4. V X Z B D F H ___ ___
5. A M N C N O E O P G P Q ___ ___
6. E F E F C D G H G H C D ___ ___
7. C D F G I J L M O P ___ ___
8. A B D G K P ___ ___
9. D E E F F F G G G ___ ___
10. X Y Z X X Y Z Y X Y Z ___ ___
11. P A O P A N O P A M N O P A ___ ___
12. Z Y X W V U Y X W V U X W V U ___ ___
13. L M O R V Z C ___ ___
14. T T T T T S S S S R R R Q ___ ___
15. G H I R S T J K L R S T M N O ___ ___
16. R Z R S Z R S T Z R S T U Z ___ ___
17. L M N N M L O P Q Q P O R S T ___ ___
18. W X V W X U V W X ___ ___
19. D E F D G H I G J K L J M N O ___ ___
20. T R P P N L J J H ___ ___

LETTER SERIES TEST - FORM B3

1. G A B H B C I C D J ___ ___
2. C Q C D P D E O E F N F G ___ ___
3. H I J G H I J F G H I J ___ ___
4. R T V X Z B D ___ ___
5. H A B J B C L C D N D E ___ ___
6. A B A B X Y C D C D X Y ___ ___
7. G H J K M N P Q S T ___ ___
8. B C E H L Q ___ ___
9. P Q Q R R R S S S ___ ___
10. A B C A A B C B A B C ___ ___
11. H Z G H Z F G H Z E F G H Z ___ ___
12. F E D C B A E D C B A D C B A ___ ___
13. Z A C F J N Q ___ ___
14. L L L L L K K K K J J J I ___ ___
15. R S T C D E U V W C D E X Y Z ___ ___
16. A X A B X A B C X A B C D X ___ ___
17. D E F F E D G H I I H G J K L ___ ___
18. N O M N O L M N O ___ ___
19. L M N L O P Q O R S T R U V W ___ ___
20. S Q O O M K I I G ___ ___

NUMBER SERIES PRACTICE

A. 1 2 3 4 5 6 7 __ __

B. 9 8 7 6 5 4 __ __

1. 1 3 5 7 9 11 __ __
2. 2 4 6 8 10 12 __ __
3. 14 12 10 8 6 __ __
4. 15 13 11 9 7 __ __
5. 1 2 2 3 4 4 5 6 6 7 __ __
6. 1 2 2 3 3 4 5 5 6 6 7 8 8 __ __
7. 1 2 3 3 4 5 6 6 7 8 9 __ __
8. 1 2 3 4 4 5 6 7 8 8 9 10 11 __ __
9. 1 2 2 3 3 3 4 4 4 4 5 5 5 5 __ __
10. 5 6 6 7 7 7 8 8 8 8 9 9 9 9 __ __
11. 9 8 8 7 7 7 6 6 6 6 __ __
12. 8 7 7 6 6 6 5 5 5 __ __
13. 1 2 4 5 7 8 10 11 13 14 __ __
14. 5 6 8 9 11 12 14 15 17 18 __ __
15. 1 2 3 5 6 7 9 10 11 13 14 __ __
16. 6 7 8 10 11 12 14 15 16 18 19 __ __
17. 7 8 9 6 7 8 9 5 6 7 8 9 __ __
18. 4 5 6 3 4 5 6 2 3 4 5 6 __ __
19. 1 9 2 1 8 2 1 7 2 1 6 2 __ __
20. 1 8 3 1 7 3 1 6 3 1 5 3 __ __

21. 1 100 2 100 3 100 4 100 ___ ___

22. 1 50 2 50 3 50 4 50 ___ ___

23. 1 101 2 102 3 103 4 104 ___ ___

24. 1 51 2 52 3 53 4 54 ___ ___

25. 4 5 1 6 7 1 8 9 1 10 ___ ___

26. 7 8 2 9 10 2 11 12 2 13 ___ ___

27. 1 2 3 3 2 1 4 5 6 6 5 4 7 8 9 ___ ___

28. 3 2 1 1 2 3 6 5 4 4 5 6 9 8 7 ___ ___

29. 1 2 1 3 4 3 5 6 5 7 8 ___ ___

30. 4 5 4 6 7 8 9 8 10 11 ___ ___

31. 1 2 3 1 4 5 6 7 8 9 ___ ___

32. 3 4 5 3 6 7 8 6 9 10 11 ___ ___

33. 1 100 1 2 100 1 2 3 100 1 2 3 4 100 ___ ___

34. 5 100 5 6 100 5 6 7 100 5 6 7 8 100 ___ ___

35. 9 50 8 9 50 7 8 9 50 6 7 8 9 50 ___ ___

36. 9 100 8 9 100 7 8 9 100 ___ ___

37. 20 1 19 2 18 3 17 4 16 5 ___ ___

38. 100 1 95 2 90 3 85 4 80 5 ___ ___

39. 90 1 85 3 80 5 75 7 70 ___ ___

40. 20 2 19 4 18 6 17 8 16 ___ ___