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CONTENTS

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A Discussion of Piaget's Concept of Conservation of Number and Quantity

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The present paper is a review of research findings concerning "conservation studies with children" of Jean Piaget and his associates in Geneva and their replication by other investigators in Great Britain, the United States, Africa and a few other countries. The main findings of all the early works of Piaget regarding quantity concepts (matter, weight and volume) showed the same developmental trends in children from no conservation to almost assertain of conservation. The studis on conversation of quantity and numbers also had the obvious bearing on the validity of Piaget's stage-sequence approach—an initial stage in which children respond to numbers wholly on perceptual basis; an intermediary one in which individual numbers are responded to in conceptual terms; and a final-phase in which relationship among the individual number is conceptualized. All the research studies carried out in the United States, Canada Great Britain and Norway, except for one support Piaget's assertation of developmental sequence of children in the acquisition of conservation of quantity and number. However, the experiments on training on conservation in children are inconsistant in their results and need more follow-ups before coming to any conclusion. Though the studies done with non-western children also confirm Piaget's hypotheses, there is difference in age at which conservation is achieved among western and non-western childern. The cross-cultural literature discussed, however, bears ample testimony to the viability of Piaget's system and its potential for generating research. The research findings were more supportive of the sequence of conservation skills but have not confirmed the particular age period specified by Piaget. Certain problems inherent in the methodology which might give rise to descrepency have also been discussed.

The major source of impetus for the research on development of cognitive skills in children, during the last twenty years, has been the work of Jean Piaget and his colleagues at the Centre International d' Epistemologie Gênëtique in Geneva. The significance of Piaget's work lies in the fact that he has provided a comprehensive and conceptual framework within which cognitive functioning has been intensively studied.

No other investigator has produced as encompassing and specific an exposition within a developmental framework of the acquisition of cognitive structures. The present paper will review the "conservation studies" done by Piaget and his assistants in Geneva and their replications by other investigators in Great Britain, the United States, Africa and a few other countries. In addition a review of experimental studies dealing with inducing conservation in children through training procedure will also be presented. Background material includes a brief discussion of Piaget's theoretical framwork and his usual experimental paradigm in conservation studies.

Piaget (1950, 1957) and his co-workers assert that logical structure is not originally persent in the child's thinking, but that it develops as a function of an internal process, "equilibration", which is heavily dependent on activity and experience. According to Smedslund (1961) this point of view differs radically from that of learning theory since practice is not assumed to act through external reinforcements, but by a process of mutual influence of the child's activities on each other. The process of equilibration is not identical with maturation, since it is highly influenced by practice which brings out latent contradictions and gaps in mental structure, and thereby initiates a process of inner reorganization.

Piaget and Inheder (1962) conclude on the basis of their many experiments that initially, children's concept of quantity are undifferentiated; that is, the child does not have distinct separate concepts of man, weight and volume. The quantitative concept of man is the first to separate from the undifferentiated whole when the child becomes able to attest to the invariance of man in the face of transformations. Thus when prensented with two identical clay balls and one of these is altered in shape (rolled into a sausage), the child will attest to identity of quantity in spite of variations in shape. He has made a rational choice not on the basis of appearance, but because he is aware that sheer change of shape does not alter the amount of mass. The child has in effect, conserved mass. Later quantity concepts of weight and volume separate into two rational concepts. Piaget (1952) defines conservation as the conceptualization that the amount or quantity of a matter stays the same, regardless of any changes in shape or position.

The typical conservation problem (Elkind, 1967) involves presenting the subject with a variable and a standard that are initially equivalent in both the perceptual and the quantitative sense. The subject is then asked

to judge their equivalence. After the subject has responded, the variable is transformed, which alters the perceptual, but not the quantitative equivalence between the variable and the standard. The subject is again asked to judge their equivalence. In a number conservation task, two rows of objects are aligned in a one to one correspondence. After the subject has asserted that the two rows are equal, a transformation of one of the rows is made in front of the subject. The usual transformation is either a collapsing of the row or the expansion of the row. The typical child under the age of six or seven, tested with conservation task, will state that the numbers of objects in the two rows are no longer equal (Piaget, 1952). He will focus on the elements in the sequence, rather than on the transformation by which one state is changed to another. The child is "perception bound". Since he does not focus on the transformation or reverse the changes he has seen occur, he resorts to a perceptual response rather than a cognitive response. In other words, he cannot integrate.

What then, is the sequence of development for a child from a preoperational, non-conserving state to a concrete-operational conserving state ? Piaget proposes three stages of development (Hunt, 1961). The first is the recognition of quantitative equivalence, but only when the correspondence between elements is actually perceived. Such equivalence ceases to exist if visual cues for its correspondence are removed. The second stage is the recognition of conservation provided that the geometric redistribution is not too great. The third stage is complete conservation, irrespective of the nature of conflicting perceptual cues. The basic mechanism which Piaget postulates to account for how the child comes to deal with this problem is what Piaget (1952) has called the "equation of differences." The child gradually comes to see that for any given object a change in one dimension is compensated by an equal and inverse change in a second dimension. Such an insight, Piaget believes, is the result of the child's repeated experiences with his environment and maturation. However the richest picture of cognitive developments, following the Piagetian theory, is based entirely on experiments in which age alone is varied. In this view cognitive maturation is made to appear like a biologically determined and universal sequence. While Piaget admits that environmental influences play a role, the admission is pro forma, and inventive experiments remain confined to American and European children, usually middle-class children at that (Greenfield, 1966).

Where Piaget's work has been extended to non-Western societies, the emphasis has been almost entirely quantitative (Flavell, 1963).

The main objective of this paper is to review research studies on Piaget's concept of conservation of number and quantity done in different countries, using more or less the same experimental design and to look for consistencies in their results.

Early work of Piaget and his co-workers at Geneva

A large number of studies on the concept of conservation has been carried out by Piaget and his co-workers during 1935-1960. These studies have been summarized by Piaget and Inhelder and published in several books (Piaget and Inhelder, 1941 ; Inhelder, 1936 ; Piaget, 1960). An attempt will be made to summarize a few of these studies, as most of them are space-consuming. The studies on conservation of quantity follow the basic technique where the experimenter gives the subject a ball of clay and asks him to make another exactly like it—"just as big and just as heavy." After the child has done this, the experimenter retains one of the balls as a standard of comparison and changes the appearance of the other by stretching it into a sausage, flattening it into a cake, or cutting it into several pieces. The experimenter then attempts to find out whether the child thinks the amount of clay, the weight and volume have changed or have remained invariant (i. e. conserved) as a result of transformation. The main findings of these studies were as follows : Each type of quantity concept (matter, weight and volume) showed the same developmental trend : 1) no conservation, 2) "Onand off" sort of conservation, 3) a logically certain, almost assertion of conservation in the case of all transformation for the type of quantity concept in question (Flavell, 1963). Piaget also found that conservation of matter occurred at 8-10 years of age, of weight at 10-12 and of volume at 12 years and after. Of 180 children aged 4-10 years, 55 showed no conservation of any kind, 67 showed conservation of matter alone, 38 of matter and weight but not volume, and only 20 of all the three. Although this is not clearly stated, it seems that developmental reversals (e. g. conservation of volume achieved before conservation of weight) were rare or absent (Flavell, 1963).

There have been several studies which report Piaget's work on number conservation. These studies are enumerated in "The Child's Conception of Number (Piaget, 1952). According to Piaget, number is

essentially a fusion or synthesis of two logical entities: class and assymetrical relation. If one enumerates a set of objets (i. e. 10 chairs) and thereby arrives at its cardinal number, we are in essence treating them all alike and disregarding the object differences in classifying. Thus in enumerating cardinal numbers, order is essential. Numerical operations for Piaget incldues investigation of a child's understanding of ordination, cardination and their interrelation. In a a typical experimental paradigm the child is presented with a row of objects and asked to take the same number from a pile near at hand. In stage 1, the child is content simply to make a rough figural approximation to the row with a different density. In stage 2, the child spontaneously makes use of the method of one-to-one correspondence. In the final stage, one-to-one correspondence is maintained in spite of optical correspondence being destroyed by the experimenter. In one study, the child was shown 10 dolls of differing heights, and 10 miniature walking sticks, also graded in height. He was first told to arrange dolls and sticks "so that each doll can easily find the stick that belongs to it". The experimenter then closed up one of the series and asked the child to find the stick which belonged to some particular doll, singled out by the experimenter. Important findings were that the youngest children found it impossible even to construct a given sereis. They seemed to have at their disposal no rational procedure for doing this. However, once capable of making a series, the child was equally capable of establishing correct ordinal correspondence. Piaget's next experiments were to find out how children expressed their ability to differentiate and coordinate the ordinal aspects of number. The results indicated that ordination and cardination are not at all well coordinated in the young child's mind. The child's ability simply to make vocal enumeration of series elements did not at all guarantee a grasp of this important relationship—a relationship so essential to a real understanding of numbeɪ (Flavell, 1963).

In one study by Piaget and his co-workers (Piaget, Apostel, Mays and Morf, 1957). the supject was shown two rows of buttons placed in one-to-one correspondence. One of the sets was then divided into two or more subsets, e.g., 8 buttons divided into groups of 3, 3, and 2. The child was asked if the two sets were still equal and on what basis equality could be founded, i. e. logical or empirical (one would have to comit to be sure). The developmental stages as found out were as follows : (i) the child asserts nonconservation of sets, (ii) in the second stage

the child neither asserts nor denies it prior to being given a chance to count the buttons, (iii) in the final stage the child (usually 8-9 years of age) no longer feels it necessary to count the sets at all to be sure of their equivalence. Curiously enough in the first two stages counting was a sure guide to equivalence, only for a relatively small number (less than 15 or 20). Some children developed conservation for sets of 7 buttons much earlier than for sets of 23 buttons. Piaget concludes that basic numerical operations do not generalize to all numbers immediately, but undergo a gradual ontogenetic development. Piaget refers to this latter development as the progressive arithmetization (Flavell, 1963).

In one experiment by Morf, as reported by Piaget (1960), a number of objects (e. g. 30) were made to slide an incline, one by one and at either fast or slow speeds. The child was asked whether the number of objects at the top of the slide was numerically equal to another, smaller set (e. g., 9) at some point in its process of depletion from 30 to 0. It appeared that preschoolers were not always sure that the two sets in question were equal at some point in the process. Moreover, the problem was harder when the speed was rapid than when it was slow. In another study Inhelder discovered (Piaget, 1960) that when elements are taken out one by one from each of two numerically unequal sets, the subject tends to think that there are more elements in the subset taken from the larger set than in that (objectively equal) drawn from the smaller set. This result has been interpreted as that the child has not yet completely differentiated numerical and logical class attributes. In another sudy by Greco (Piaget, 1960), an active researcher on number development, it was found that the child appears to conserve the number 'name' of a given set before conserving its numerical quantity proper. That is, the child will count two sets and state that there are "seven" here and "seven" there, whatever their spatial arrangement, but he may argue that there are more in one set than another, if the arrangement is perceptually unequal.

Vinh-Bang and Barbel Inhelder (Vinh-Bang, 1959) administered individually about thirty Piaget tasks drawn from various content areas (number, quantity, space, geometry, etc.) to 1500 children 4-12 years of age. The aim of the study was two-fold : to create a standardized developmental scale of reasoning and to assess the validity of Piaget's conclusions about developmental stages. The results indicate that Piaget's tasks do appear to scale satisfactorily and his developmental conclusions

based on these tasks were in the main confirmed. Attempts have also been made to differentiate levels of mental retardation by means of Piaget's tests for conservation of quantity. In one such study by Inhelder (Flavell, 1963) it was found that the developmental order of acquisition of conservation, (i. e. first substance, then weight, then volume) as established in normal chidren turned out to be reproducible in *feeble*-minded subjects.

Wohlwill (1960) applying Gultman's scalogram analysis attempted to validate Piaget's stage sequence of number conservation. This type of analysis is based on the idea that a mastery of a given task implies the necessary mastry of all tasks below its level of difficulty. A total of 77 *Ss* ranging from 4 to 7 years of aged enrolled in kindergartens and primary schools in Geneva, Switzerland, were tested in this study. The results indicated existence of three fairly sharply differentiated stages in the development of the number concept. An initial stage in which number is responded to wholly on a perceptual basis ; an intermediary one in which inbividual numbers are responded to in conceptual terms ; a final phase in which the relationship among the indivedual number is conceptualized.

To sum up, it is evident that experiments on conservation of quantity and number, using different paradigms, with normals and retaradates, as conducted by Piaget and his co-workers in Geneva have obvious bearing on the validity of Piaget's stage-sequence approach in the attainment of conservation.

Replication and Validation Studies in the United States and Canada

Piaget's researches on number and quantity have been popular targets for validation study during the past several years, probably because of their obvious educational implication (Flavell, 1963). One of the earliest studies in the United States using the same problems of conservation as Piaget was done by Estes (1956). He studied a total of 52 chidren ranging from 4 years to 6 years in number conservation. No evidence was obtained which supported Piaget's theories as to the development of stages or age levels in the acquisition of "mathematical and logical concepts". Hoewevr, Dodwell (1960) contends that Estes' result raises doubts in the reader's mind as he was not familiar with the main body of Piaget's work. Dodwell (1960) gave a battery of Piaget's number tasks, using both individual and group administration, to a sample of 250 subjects from kindergarten through second grade Canadian children. The age range was from 5 to 8 years. The results showed the three stages of cognitive development

described by Piaget as "global", "intuitive", and "concrete operational" occur. There were considerable variations in type of responses given at any age level, and the type of responses varied from one test situation to another for a child. However, the finding did not yield unequivocal support for Piaget's theory of cognitive development. The study showed that the stages do not always follow in the sequence Piaget's theory requires. Moreover, Dodwell (1960) points out that Piaget pays scant attention to the part learning may play in the development of number concepts.

Pinard (Flavell, 1963) systematically replicated Piaget's work using more careful methodology for constructing a scale of mental development. He administered a test battery of 62 subtests, 27 of which were taken from Piaget on 700 French-Canadian children of 2—12 years of age. Piaget's developmental findings did appear to hold up well among French speaking Canadian children.

Elkind (1061a) administered tests of conservation of number, of continuous quantity (the task involves water poured into different-shaped vessels), and of discontinuous quantity (when the vessels contains beads instead of water), to 4—7-year-old chidren. The results showed that (i) all three types of conservation are age-dependent within this age range (ii) conservation of continuous quantity was more difficult than that of discontinuous quantity, and (iii) there was a correlation between conservation scores and subtest scores on the Weschler Intelligence Scale for Children. In a second experiment Elkind (1961b) administered Piaget's tests for conservation of global quantity, weight and volume (ball of clay) to 175 children 5—11 years of age. Results indicated each type of conservation being age-dependent and also supported Piaget's assertion that normal genetic order was global quantity first, then weight and then volume. In a third investigation Elkind (1961c) administered the same three conservation tasks to 469 children 12—15 years old. The most important finding was that the age decalage (according to Piaget this "refers to the fact that one frequently sees similar cognitive developments occurring at different ages across the ontogenetic span", (Flavell, 1963, p. 21) between the first two and the third type of conservation may be considerably greater than Piaget had thought. Seventyfive per cent of *Ss* acquired conservation of global quantity and weight around the 7—9 year period, while 75% for conservation of volume did not occur until age 15.

Rothenberg and Courtney (1966) investigated the presence of conservation of number in 117 children 2 years 5 months to 4 years 4 months. Only 2% of the subjects were found to be conservers. Difference in conservation attainment was found in age and socio-economic status but no differences were found in sex. Comparisons were also made with results of similar procedures used with subjects aged 4 years to 6 years and some increase in conservation skills were found among the older sample.

Mermelstein and Shulman (1967) compared 60 6 to 9-years-old Negro chidren having no schooling with 60 6 to 9-year-old Negro children who had regular schooling, on a series of Piagetian conservation tasks. Findings revealed generally no significant differences attributable to effects of nonschooling, except within one questioning condition. Differences between verbal and nonverbal tasks were found to be highly significant. The evidence indicates that the absence or presence of language itself significantly affects performance. The authors contend that Piaget's clinical approach is deficient in the sense that it does not take into account the language variable.

D'mello and Willemson (1969) employed a scalogram analysis to discover the order of learning of such concepts. Using 38 subjects ranging in age from 3 years to 8 years and testing them with dominoes and cards with numerals, the authors concluded the following order of number concepts : First, the child learns to recite numbers in sequence. Second, the child learns to match visual arrays of similar objects according to visually perceived equality of quantity. Third, the child learns to match number words to spoken words. Finally, the child learns to match the visual symbol with the absolute quantity.

Uzgiris (1968) investigated systematically the effect of varying the materials used to test the conservation of substance, weight and volume on the observed attainment of these concepts. A total of 120 subjects from 1st through 6th grades were tested on conservation tasks using different materials, e. g. plastacine, metal nuts, wire coils and plastic wires. The technique of scalogram analysis was adopted for cross-sectional data. The finding showed conservation of substance, of weight and of volume was clearly attained in the order postulated by Piaget, in spite of different materials being used in the task.

While it is clear that experience of some kind is involved in the learning of conservation, it is not easy to specify just what this experience is. Experimenters in their efforts to induce conservation of number and quantity have used a number of different experience.

A number of Piaget-relevant researchers have studied the effect of training of conservation skills in children. One of the earliest studies of antecedent processes in the area of number development is that by Wohlwill and Lowe (1962). Seventy-two children enrolled in kindergarten classes of public schools in Worchester, Massachusetts, were individually pretested on both a nonverbal and the conventional verbal form of Piaget's conservation-of-number task. The group was divided into 4 subgroups of 18 *Ss* each. The results showed significant pre-to-post-test improvement on the nonverbal measure of conservation. However, no significant difference was found in improvement among training subgroups or between these and the controls. As far as verbal traditional measure of conservation was concerned, there was virtually no training effect in any subgroup.

Feigenbaum (1961) administered various forms of the test for conservation of discontinuous quantity to 146 children ranging from 4 to 7 years of age. The findings were as follows : (i) conservation of discontinuous quantity is strongly correlated with age (ii) there is a corresponding developmental shift away from reliance on perceptual impressions to logical thinking (iii) conservation is correlated with IQ as well as age (iv) certain training procedures facilitate conservation somewhat, while others do not.

Gruen (1965) gave all the 90 subjects with a mean age of 5 years pre-tests and post-tests of conservation of number, length and substance. Half of the *Ss* were given pre-training on verbal discrimination of length and number and half were not. One-third of the *Ss* in each of the pre-training groups were given direct training on number conservation, one-third were exposed to situations designed to produce "internal cognitive conflict", and one-third received no training on number conservation. Subjects in the conflict-plus-verbal pre-training groups outperformed *Ss* in the control group without verbal pre-training. There was very little transfer of training from number conservation to other kinds of conservation. The most obvious conclusion drawn was that neither confronting the child repeatedly with the invariance of numerical values in the face of irrelevant perceptual changes nor devising a situation to induce internal cognitive conflict is particularly effective in inducing number conservation.

Rothenberg and Courtney (1969) hypothesized that conservation of number can be taught when the probable steps necessary for conservation are trained in sequence with sufficient time allowed for learning. Non-conserving kindergarten age subjects were matched on a pre-test. Half of the subjects received training on components assumed to underlie conservation of number. On a conservation post-test, the control group showed no change from their pre-test results. The results from the post-test for the experimental group indicated that the group learned to conserve. A second post-test administered after three months after the first post-test, indicated that the results were durable.

Other researchers have used different procedures of training in inducing conservation of quantity and number. In most of these studies (Wallach and Sprott, 1964 ; Gelman, 1969 ; Halford and Fullerton, 1970) the training had both positive and negative effects on conservation. However, training can only be effective to the extent that it builds on the child's previous learning (Wohlwill and Lowe, 1962). To summarize, all the research studies carried out in the United States and Canada, except for one Estes (1956) support Piaget's assertion of developmental sequenc in the acquisition of conservation of quantity and number. However, some of the studies point to certain inefficiencies in the methodology (which will be discussed later). As regards training for conservation is concerned, more research is required to make any conclusion as the results are contradictory, some having positive while others having negative effect.

Validation Studies in Great Britain and Norway

There have been a number of highly relevant studies carried out in recent years in Great Britain and Norway based on the Piagetian concept of conservation. One of the earliest publications of these studies was a review by Lunzer (1960). Mannix (Lunzer, 1960) did a scalogram analysis to validate Piaget's stage sequence for the conservation of numbers, and found an orderly progression in the mastery of various Piaget or Piaget-related number tasks. Mannix found the following ordered sequence : first, mastery of conservation in the case of provoked correspondence ; then in the case of continuous quantity and still later, grasp of additive composition of numbers. Mannix concluded as did Dodwell (1959), that Piaget was generally correct in his description of the major types of responses children give to his number tasks.

Churchill (1958) has validated Piaget's analysis of number in broad outline. She administered a pre-test battery of Piaget number tasks to 16 five year-olds and used their scores to divide them into two groups. The experimental group received training in grouping, matching, seriating and ordering while the control group received no training. Re-testing with the same battery indicated that the experimental subjects had profitted considerably from training experience. Harker (1960) did a somewhat similar experiment but found less clear-cut improvement, although her training program was briefer than Churchill's. However, Churchill makes the interesting hypothesis, well worth testing, that the development of the concept of conservation might be impeded by lack of order and stability in the child's home life, i. e., a lack of invariant, "conserved" entities in his personal social world. Lovell and Ogilvie (1960) made an intensive study of global quantity conservation in 7-10-year-old British children. Some of the findings were as follows: Piaget's three stages of non-conservation, on-and-off conservation and conservation were identifiable in his subjects and showed expected changes as a function of chronological age.

Hood (1962) tested 137 normal English children ranging in age from 4 to 8 years and 40 mentally subnormal children ranging in age from 10 to 15 years on Piaget's task of number conservation. It was found that pre-number concepts develop as the child gains in years, and most of the subjects in this study did not fully develop until the child was between 6 and 7 years. However, it was not mere chronological age but mental age which was of primary importance. As far as retarded subjects were concerned responses obtained from them showed that as with young children of normal intelligence, Piaget's pre-number concepts tend to mature as the subjects all-round mental capacity increases.

Smedslund [1961 (a), 1961 (b), 1961 (c)] in a series of articles has published his studies on conservation of quantities carried out in Oslo, Norway. In his first study he pre- and post-tested 48 5-7-year-old children on conservation of weight. The subjects were divided into three groups, two of them receiving training and one served as no-training control. The results were essentially negative : all three groups showed some apparent pre- to post-test improvement but had no statistically reliable between-group differences. In a second experiment Smedslund (1961 (b)) attempted to induce conservation in non-conservers by providing experience with perceptual size cues. The subjects were given repeated opportunity

to discover that larger objects are not necessarily heavier than smaller ones. The results showed that 36 training trials of this kind had virtually no effect on the subjects' response orientation ; they continued to rely just as heavily on perceptual cues in post-test as in pre-test. In the next series of experiments Smedslund (1961 c) trained his subjects for inducing conservation based on his cognitive conflict hypothesis. According to this hypothesis as adopted by Smedslund, the essential condition for the development of conservation where there previously had been nonconservation, is a state of cognitive conflict in the subject. Cognitive conflict induces a reorganization of the subject's intellectual actions, one which proceeds along the lines postulated by Piaget's equilibrium model ; and it is this reorganization specifically which leads to the conservation strategy. The training procedure induced cognitive conflict in the subjects. This training group unlike the cases in his previous studies did manage to outperform its control group on post-test.

Sigel, Roeper and Hooper (1969) found positive results in their attempt to induce conservation of quantity through training. Twenty nursery school children between ages of 4 and 5 years were assigned to training and control groups. Post-testing indicated clear differences between the training and control subjects. The authors attributed the failures of previous conservation training attempts to a lack of concern for stage-related, prerequisite operation. The authors further contend that direct training on Piagetian tasks may be unnecessary if attention is directed to the logical precursors of specific levels of cognitive devlopment.

In summay, it can be said that all the studies reviewed do validate Piaget's developmental sequence of acquisition of conservation. However, the experiments on training of conservation in children are inconsistant in their results. More training procedures and follow-ups have to be made before coming to any conclusion.

Studies in Non-Western Countries

The argument put forward by Piaget and Inhelder regarding effects of culture on conservation tasks is that a change in milieu has only a limited effect : it may upset performance on specific tasks or it may alter the age at which a certain stage is reached, but the order and sequence of developement should remain constant (Tanner and Inhelder, 1956). One of the earliest cross-cultural studies was done by Hyde (1959). A large battery of Piaget's number and quantity tasks was adminis-

tered to groups of European (mostly British), Arab, Indian, and Somali school children of 6–8 years of age living in Aden. The tests were given in English to the Europeans and in Arabic to the others (the Indians and Somalis spoke Arabic in school, although it was not their mother tongue). The main findings were as follows : the subjects showed the same general types of responses to number problems as Piaget's ; the developmental changes in responses also followed Piagetian sequence ; and finally, the European subjects generally performed on a higher genetic level than their non-European peers. In addition to number problems Hyde also gave her subjects quantity tasks. She found no strong evidence for the global-quantity-weight-volume decalage (as found in other studies) ; in particular she found a number of subjects who departed from the predicted sequence by conserving weight but not global quantity, volume but not weight, and the like. Careful scrutiny of these studies did not suggest any immediate explanation for the discrepancy in results. And finally there was some tentative information regarding the difficulty level of the various quantity tasks. For example, conservation of global quantity in the plasticine-balls tasks appeared to be more difficult to achieve than in the water-in-vessels setting, but easier than in the sugar-in-water test.

Price-Williams (1961) tested illiterate bush west African (Nigerian) children on Piaget's conservation tasks of continuous and discontinuos quantities. Forty children ranging from age 5 to 8 years were selected as subjects. The ages were rough estimates, as it was very difficult to determine the actual age of the children. Results indicated a progression of comprehension concerning conservation among these African children as postulated by Piaget. On account of the difficulty of obtaining precision in age, this research can only be taken, in this regard, with degree of approximation. It is clear that the general sequence from "global comparisons" to "concrete operations" occurs in this Africans. The author contends that whether the change-over occurs at the age of seven, as Piaget maintains and which others support as regards the conservation of volume, is more difficult to say. These children have had no formal instruction in abstract numbers other than game popular in Africa which involved placement of pebbles in two rows of holes. However, proper playing of this game entailed a good understanding of many of the concepts which are considered under the general category of number. Other than this, children tested had very little experience of the kind of topic which was performed.

Goodnow (1962) tested 10-13-year-old boys in Hongkong who differed in nationality (Western versus Chinese) and in education on five tasks, of which three were Piagetian perceptual tasks of weight, volume and space. Five-hundred subjects tested were drawn from four milieus : 148 were European, mostly English from European schools ; 151 Chinese from high ranking Anglo-Chinese schools ; 80 Chinese school boys with low socio-economic status ; and 80 Chinese boys with low socio-economic status and semi-schooling. The similarities obtained in the result across milieus were far more striking than differences. For the tasks used it made no difference, for example, whether a child has had only one year of school or the regular 6 or 7.

All the Hongkong groups, however, showed some departure from the Geneva results. On the perceptual tasks, the order of difficulty for weights and volumes was predicted, but both the space and volume task appeared as more difficult than the Geneva results imply. Finally, the conservation tasks appeared to be unaffected by wide differences in intelligence.

Ito and Hatano (1963) attempted an experimental education of number conservation on 27 five-year-old Japanese children who were non-conservers. The subjects were divided into three groups. The following programs for an experimental education were applied one for each group : Repeated confirmation of invariance by of a set by counting : Inference based on the change of the quantity by addition or substraction : Inference based on comprehension of number relation. The results of the post-training tasks showed that the experimental education was fairly effective. Acquisition of number conservation seemed to be accelerated by training—i. e. outer stimulation.

Goodnow and Bethon (1966) in a study clarified the results obtained with schooled and unschooled children in Hongkong (Goodnow, 1962) explored the effects of chronological and mental age upon Piaget's tasks. The question raised was : are the conservation tasks insensitive to differences in intelligence ? The subjects were several groups of United States school children, selected to allow a close matching for either Mental Age or Chronological Age and to cover a wide range in IQ. The present data combined with Hongkong data (Goodnow, 1962) gave the following results : (1) lack of schooling did not upset the conservation of weight, volume, or surface, (2) among school children all tasks show a close relation to Mental Age. The interaction between schooling and tasks may

reflect the greater reliance of unschooled children upon perceptually present material or upon action for reasoning.

Greenfield (1966) studied Wolof children from Senegal (West Africa) on Piaget's task of conservation of quantity. The Wolof group was selected from those in Senegal because they were found not only in the French-style schools of Dakar but also out in the bush. The cultural milieu of the first group, the rural unschooled children, had neither schools nor urban influence. The cultural setting of the second group-rural school children was identical with that of the first. Finally, the cultural milieu of the third group-children from city public schools—were characterized by the presence of both aspects of Western culture-urban setting and schooling. The rural as well as urban school children were selected from first, third, and sixth grades, and were also matched in approximate age. The tests were given individually to all children in Wolof language. The exact conservation task was based on the most unambiguous translation of the American and Swiss procedure as could be formulated in Wolof. The most striking result obtained was that conservation ceased for all practical purposes, to be related to age. The oldest unschooled bush children (11 to 13 years old) showed no significant increase in conservation over the eight-and-nine year olds. Only half of the bush children attained conservation at this late age. This study suggests, therefore, that without school, intellectual development, defined as any qualitative change, ceases shortly after age nine. In contrast, however, the results indicated that the children of bush and town yielded the familiar developmental sequence, with conservation, initially always attained by the sixth grade. The author noted that though the interviews were all in Wolof but schooling was in French. It may be that the skills learned in French was in fact carried over into thinking and speaking in Wolof. Bush school children showed 52% conservation in the first grade (probably an average of eight) and 80% in the third grade (average age between nine and ten). In terms of grade level, the Senegalese figures are close to being identical to the Western ones, although the Wolof children are behind in terms of chronological age. The parallel findings certainly cast strong doubts on any simple motivational notion of development. Rural Wolof children exposed to a certain set of cultural influences, namely, the school, differ more from other Wolof children raised without school than they do from European children. The author concludes that as the two groups of Wolof children are from the same

gene pool, whereas the Europeans represent a non-overlapping gene pool, this finding casts deep doubt on any biological-genetic point of view.

All the studies indicate that attainment of conservation does follow the developmental sequence as postulated by Piaget in children coming from non-Western societies. Although the developmental sequence is similar to Piaget's assertion, there is difference in age at which conservation is achieved among western and non-western children. Authors of some studies have assumed that typical Piagetian tasks of conservation require a skill in thinking and speaking which is emphasized more in western societies than in non-western communities with such a limited number of research done such assumptions are doubtful at this stage. In one study Price-Williams (1962) investigated cognitive processes in Nigerian bush and school children using indigenous materials instead of the typical western type tests. He used models of animals and plants familiar to the local children. No difference was found among the bush and school children in spite of using familiar material.

Discussion

The review of research literature dealing with Piaget's actual work in Geneva and its replication in other countries (western and non-western), seems to be a test of validity of the phenomenon of conservation in children as postulated by Piaget. It seems that as more and more research is accumulating and as they are attesting to the reality of this phenomenon skepticism and disbelief in Piaget's assertion is becoming increasingly rare.

The literature discussed bears ample testimony to the viability of the system and its potential for generating research. These studies tended to be more supportive of the sequence of conservation skills but have not confirmed the particular age-period specified by Piaget. There are, however, certain problems inherent in the methodology which might give rise to discrepancy in results. Gruen (1966) discusses one of these problems. There are differences in criteria for conservation. The classic number conservation tasks first used by Piaget (1952) required conservation judgement as well as an adequate verbal explanation for the judgement. Children's understanding of the relational terms involved in conservation problems specifically the terms "more", "same" and "less" determines to a great extent the successful performance of the task. As Rothenberg and Courtney (1969) makes the observation, based on their research, that if a question is phrased so that "yes" is the answer, more conserving responses could

be obtained. Some investigators have suggested that prior to testing under classical procedures ; an assessment should be made of the subject's verbal attributes. Another problem as pointed out by Gelman (1972) is that classic conservation tasks may present the young child with irrelevant or misleading cues. Gelman (1972) proposes that conservation tests in fact evaluate more than one thing. Logical capacity, control of attention, correct semantics and estimation skills are implicit in the test. Therefore, a sophisticated cognitive development is needed by the child to integrate all these factors.

A number of experiments have been done in different countries designed to teach conservation of mass, weight or number to young children. These studies suggest that direct teaching of conservation do not lead to the formation of a general or stable concept of conservation. Few studies did find effect of training. However, more follow-up and longitudinal studies are needed to make any conclusions. Piaget has offered relatively little information, on questions of stage-sequence modification (Sigel and Hooper, 1968). Nevertheless the issue is significant, particularly for those applying Piagetian ideas to the educational scene. Research studies also indicate that just as experimental teaching has limited value for the attainment of conservation, general formal schooling appears to have little influence upon conservation. Conservation of number, man, weight and volume appears at the same age in scooled and unschooled subjects. Probably the most significant study on this question was that of Mermelstein (Mermelstein, 1964 ; Mermelstein and Shulman, 1967). An equally careful study by Goodnow showed no difference between unschooled Hongkong children and comparable IQ schooled children in various types of conservation (Goodnow and Bethon, 1966). Price-Williams (1961) found that African Tiv children without schooling attained conservation on several tasks including number at about the same age western children achieve conservation. Greenfield (1966) found some retardation on conservation in nonschooled Senegalese children, but this retardation disappeared when an appropriate form of conservatian task was used which eliminated set effects due to beliefs about magical attributes of white authorities. Kohlberg (1968) hypothesized that Montessori schooling for young children might accelerate conservation because the Montessori training tasks are directed at experiences of quantitative measurement and comparison. Contrary to this hypothesis Montessori training of nine months failed to have any effects upon Piaget conservation task though it did raise Standfort-Binet IQ.

Evidences, therefore, are ample to assert that "naturally" developing conservation concepts which have structural properties cannot be reversed by trick demonstrations of conservation nor by social pressure from the experimenter (Kolberg, 1963 ; Smedslund, 1961). Children showing conservation on one task are also likely to show conservation on other tasks (Uzgiris, 1968).

It can, however, be stated from the research findings that some genuine acceleration of conservation may be induced if the instruction method used follows from the conception of cognitive structure and of conflict and match implied by Piaget (Rothenberg and Courtney, 1969). It is also evident that some degree of retardation in conservation appears in some semi-literate non-western cultures, regardless of schooling (Greenfield, 1966 ; Hyde, 1959). Research findings thus clearly demonstrate that conservation is not a strict maturational product but is a product of interactional experiences between organismic structure and environment (Kolberg, 1968). Nevertheless to answer the various questions raised regarding the methodological implication according to Wohlwill (1968) more longitudinal data on Piaget type problem is needed. He also regrets that there are virtually no such data yet available, since longitudinal research on Piaget's concept could be carried out in a relatively short time span.

There is, however, a great need for research data describing in detail the cognitive capability of elementary school children so that curriculum innovations may be more rationally based, utilizing knowledge about competencies and abilities of children who are, in the final analysis, the consumers of these new curricula. Piaget's work has considerable significance in achieving such ideas.

References

Churchill, E. The number concepts of the young child. *Researches and studies*. Leeds University, 1958, **17** : 34-39.

D'Mello, S. and Willemson, E. The development of the number concept : a scalogram analysis. *Child Development*, 1969, **40** : 681-688.

Dodwell, P. C. Children's understanding of number and related concepts. *Canadian Journal of Psychology*, 1960, **14** : 191-205.

Elkind, D. Quantity conceptions in junior and senior high school students. *Child Development*, 1961, **32** : 551-560 (a).

———. The develo pment of quantitative thinking : a systematic

replication of Piaget's studies. *Journal of Genetic Psychology*, 1961, **98** : 37-46 (b).

————. Children's discovery of the conservation of mass, weight and volume : Piaget replication, Study II. *Journal of Genetic Psychology*, 1961, **98** : 219-227 (c).

Estes, B. W. Some mathematical and logical concepts in children. *Journal of Genetic Psychology*, 1956, **88** : 219-222.

Feigenbaum, K. D. An evaluation of Piaget's study of the child's development of the concept of conservation of discontinuous quantities, 1961. In J. Flavell (Ed.), *Developmental psychology of Jean Piaget*. New York : Van Nostrand, 1963.

Flavell, J. H. *Developmental psychology of Jean Piaget*. New York : Van Nostrand, 1963.

Gelman, R. Conservation acquisition: a problem of learning to attend to relevant attributes. *Journal of Experimental of Child Psychology*, 1969, **7** : 167-187.

————. Logical capacity of very young children : number invariance rules. *Child Development*, 1972, **43** : 75-90.

Goodnow, J. J. A test for milieu effects with some of Piaget's tasks *Psychological Monogrophs*, 1962, **76** : No. 36 (whole).

Goodnow, J. J. Bethon, G. Piaget's tasks : The effects of schooling and intelligence. *Child Development*, 1966, **37** : 573-582.

Greenfield, P. On culture and conservation. In J. Bruner *et al. Studies in cognitive growth*. New York : Wiley, 1966.

Gruen, G. E. Experiences affecting the development of number conservation in children. *Child Development*, 1965, **36** : 962-979.

————. Note on conservation : methodological and definitional considerations. *Child Devlopment*, 1966, **57** : 977-983.

Halfor, G. S. and Fullerton, T. J. A discrimination task which induces conservation of number. *Child Development*, 1970, **41** : 205-213.

Harker, W. H. Children's number concepts : ordination and cardination, 1960. In J. H. Flavell's *The Developmental Psychology of Jean Piaget*. New York : Van Nostrand, 1963.

Hood, H. B. An experimental study of Piaget's theory of the development of number in children. *British Journal of Psychology*, 1962, **53** : 3, 273-286.

Hunt, J. McV. *Intelligence and experience*. New York : Ronald Press, 1961.

Hyde, D. M. An investigation of Piaget's theories of development of the concept of number. Unpublished doctoral dissertation, University of London, 1959. In J. H. Flavell's *The developmental psychology of Jean Piaget*. New York : Van Nostrand, 1963.

Inhelder, B. Observations sur le principe de conservation dans la physique de l'enfant. *Cah. Pedag. exp. Psychol Enfant*, 1936. No. 9. 16. pp.

Ito, Y. and Hatano, G. An experimental education of number conservation, *Japanese psychological research*, 1963, **5** : 161-170.

Kohlberg, L. Cognitive stages and pre-school education. *Human Development*, 1966, **9** : 5-19.

————. Early Education : A cognitive-developmental view. *Child Development*, 1968, **39** : 1013-1062.

Lovell, K. and Oglivie, E. A study of the concept of conservation of substance in junior school children. *British Journal of Educational Psychology*, 1960, **30** : 109-118.

Lunzer, E. A. *Recent studies in Britain based on the work of Jean Piaget*. London : National Foundation for Educational Research, England, Wales, 160.

Mermelstein E. The effect of lack of schooling on number development : a test of Piaget's theory and methodology. Unpublished doctoral dissertation, Michigan State University, 1964. In L. Kohlberg. Early Education : A cognitive-developmental view. *Child Development*, 1968, **38** : 1013-1062.

Mermelstein, E., & Shulman, L. S. Lack of formal schooling and the acquisition of conservation. *Child Development*, 1967, **38** : 39-52.

Piaget, J. *The psychology of intelligence*. New York : Harcourt, Brace, and World, 1950.

————. The child's conception of number. New York : Humanities, 1952.

————. *Logic and psychology*. New Work : Basic Books, 1957.

————. The general problem of psychobiological development of the child. In J. M. Tanner and B. Inhelder (Eds.), *Discussion on Child Development*, Vol. 4. New York : International University Press, 1960.

————. and Inhelder, B. *The child's conception of space*. London : Routledge and Kegan Paul, 1962.

———————. Apostel, L., Mays, W. and Morf, A. Les liasons analytiques et synthetiques dans les comportements du sujet Etudes d'epistemologie génétique. Vol. 4. Paris : Presses University France, 1957. In J. H. Flavell, *The developmental psychology of Jean Piaget*. New York : Van Nostrand, 1963.

Price-Williams, D. R. A study concerning concepts of conservation of quantity among primitive children. *Acta psychologia*, 1961. **18**: 297-305.

———————. Abstract and concrete modes of classification in a primitive society. *British Journal of Educational psychology*, 1962 **32** : 50-59.

Rottenberg, B. B. and Courtney, R. G. Conservation of number in very young children. Developmental Psychology, 1966, Vol. 1, no. 5, 493-502.

Sigel, I. and Hooper, F. (Fds.), *Logical thinking in chlidren* : research based on Piaget's theory. New York : Holt, Rinehart and Winston, 1968.

Sigel, I. E., Roeper, A. and Hooper, F. H. A training procedure for acquisition of Piaget's conservation of quantity : a pilot study and its replication. *British Journal of Educational Psychology*, 1966, **37**: 301-311.

Smelsmund, J. The acquisition of conservation of substance and weight in children. I. Introduction. *Scandinivian Journal of psychology*, 1961, **2** : 11-20 (a).

———————. The acquisition of conservation of substance and weight in children. II. External reinforcement of conservation of weight and of the operations of addition and subtraction. *Scandinivian Journal of Psychology*, 1961, **2** : 71-84 (b).

———————. The acquisition of conservation of substance and weight in children. III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance scale. *Scandinivian Journal of Psychology*, 1962, **2** : 85-87 (c).

Tanner, J. M. and Inhelder, B. (Eds.) *Discussions on child development : A consideration of the biological, psychological and cultural approaches to the understanding of human development and behavior*. Vol. 1. London : Tairstock, 1956.

Uzgiris, I. Situational generality of conservation. In I. Sigel and F. Hooper (Eds.), *Logical thinking in children : research based on Piaget's theory*. New York : Holt, Rinehart and Winston, 1968.

Vinh-Bang. Elaboration d'une echelle de development du raisonnement (1959). In J. H. Flavell's *The Developmental Psychology of Jean Piaget*.

New York : Van Nostrand, 1963.

Wallach, L. and Sprott, R. L. Inducing number conservation in children. *Child Development*, 1964, 35 : 1057-1071.

Wohlwill, J. A scalogram analysis of the number concept. *Journal of Genetic Psychology*, 1960, 97 : 345-377.

———. Piaget's system as a source of empirical research. In I. Sigel and F. Hooper (Eds.), *Logical thinking in children* : research based on Piaget's theory. New York : Holt, Rinehart and Winston, 1968.

Wohlwill, J. F. and Lowell, R. C. Experimental analysis of the development of the conservation of number. *Child Development*, 1962, 33 : 153-167.

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An Investigation on Improving the Method of Parcel Making at the Despatch Section of Bangladesh Tobacco Company

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Abstract

The study was designed to investigate whether improved work arrangement and better design of tools and equipment would result in increased efficiency in performing a task. The subjects were 20 male employees of Bangladesh Tobacco Company (BTC). Their task was making manually 5 M. Parcel at the despatch section of the company. Every *S* served individually under two work arrangements ; existing and new, and made 10 parcels one after another under each work arrangement. Half of the *SS* started with the new work arrangement and half with the existing one. Time taken to perform the task was the criterion measure and stop-watch time measurement technique was followed.

The hypothesis that the Ss would perform their tasks more efficiently i. e. in less time under new work arrangement than under existing work arrangement was supported partially in this experiment. Total observed time was less under new work arrangement than under existing one but the difference was not significient at the conventional level. Significant differences were observed in terms of time for water proof papers (w. p. p.) and time for removal of parcel although this was not the case with regard to time for packing and time for outer. An malysis of the post-experimental ques tionnaire, however, supported the contention that thenew work arrangement had improved the efficiency of the worker.

Introduction

Time and motion engineers have been in the business of studying jobs for a long time and discovering the best way of doing a work. Time study, originated by Taylor, was used mainly for determining time standards and motion study developed by the Gilbreths, was employed largely for improving methods. In recent years the combined use of motion study and time study has become widespread. Common practice to-day requires that motion study and time study be used together, since the two supplement each other. Thus the combined term-motion and time

study—is used to denote method determination, time appraisal and the development of tools and materials.

In working out an improved method for performing an industrial operation, the time-and-motion analyst is guided by certain commonly accepted rules, or 'principles'. These principles of motion economy can be classified in three broad groups as related to : (i) the efficient use of body members, (ii) the proper arrangement of work place ; (iii) the better design of tools and equipment.

A great deal of work following motion economy principles had been done for finding out the method of maximum efficiency in performing a task. In one of his famous investigations Gilbreth (1911) showed that after proper arrangement of work place and development of easily adjusted scaffold and special tools and their proper handling, the number of motion involved in laying bricks were reduced from 18 to 4½. He, thereby, increased the average number of bricks that could be laid in an hours from 120 to 350. In a series of controlled observations at Bethlehem Steel Works Taylor found that owing to the naphazard selection of shovel shapes and sizes, shovelers were lifting loads varying from 3½ to 38 pounds. Through empirical tryout of different loads, he ascertained that 21½ pounds constituted an optimal load for men working regularly as shovelers. When either heavier or lighter loads were tried, total daily output declined (Copley, 1923). The work of Cox Barnes, 1961 demonstrated that the proper arrangement of work place saves time. A packing bench designed by him for use in the shipping department of Merck and Company shows how the principles of locating materials and tools close in front of the operator made it possible for the operator to do his work more easily and faster (Barnes, 1961). Similarly in the finding of Norem and Mackenzie (Barnes, 1961) it was found that when work place was arranged in such a way that enabled the operator to shorten the hand motions and to reduce the extent of the head and eye movements a substantial saving in time resulted. These and similar other studies indicated that the method of maximum efficiency in performing a task can be achieved by proper arrangement of work place and better design of tools and equipment (Dvorak, Merrick, Dealey and Ford, 1936 ; Farley, 1955 ; Godwin, Habel and Kearful-reported by Barnes, 1961).

The authors of the study felt that motion economy principles would be helpful in those industries of Bangladesh where largely manual operations

are involved. They visited one industrial concern namely, Bangladesh Tobacco Company in Dacca which is largely automated excepting its despatch section. The work arrangement in this section appeared to them less satisfactory. The operation in this section was to make manually 5 M. parcel containing 20 outers for shipment. An informal interviewed with the operators, however, revealed that this was the most difficult job in the company and that it was difficult for anyone to do this job more than half an hour continuously. The operator had to take the outer (a carton of 250 cigarettes) from one platform by turning back each time and walk a long distance to place finished percel on another platform. In order to investigate whether it is possible to reduce these difficulties, a new work arrangement was designed in a pilot study. In this arrangement, the platform for the outers was positioned at the right hand side of the operator and the platform for finished parcel was positioned at the left side. Comparison between the existing and new work arrangement in terms of total observed time and time of each element were made. Though the means of total observed time and elemental time were less in new arrangement than those of the existing arrangement the difference between them was not significant. It was thought that the improved design was inadequate. Thus before undertaking the final study further improvements were made in respect of tools and work arrangement. The purpose of the study was to investigate whether improved work arrangement and better design of tools and epuipment would result in increased efficiency in performing a task. It was hypothesized that workers would perform their tasks more efficiently i. e. in less time under new work arrangement than under existing work arrangement.

Methods

Subjects :

The *SS* were 20 male employees of BTC. They were selected at random from among the workers of cigarette packing department. None of them had done this job before.

Work arrangement :

There were two types of work arrangement for every *S*; existing and new. In the existing arrangement i. e. which was existing in the company, a wooden table with mould was used. The mould was constructed in such a way that it would contain 20 outer. A gum pot was attached with the mould. Water-proof papers (w. p. p.) were kept on a shelf

below the packing table. The end-labels were placed randomly on the packing table. The platform for outer was behind the packing table and its distance from the packing table was 31 inches. The platform for finished parcel was positioned at a distance of 122 inches from the packing table.

In the new work arragement water-proof papers were placed on a tool positioned at the right hand side of the packing table and it was well within the reach of the operator. End-labels were kept on a wooden box placed on the right side of the packing table. The box was made in such a way that its front side was raised about 2 inches and there was a bar inside it to facilitate grasping of end-labels. The platform for outer was positioned at the right hand side of the operator and its distance from the packing table was 49 inches. The platform for finished parcel was positioned at the left hand side of the operator at a distance of 39½ inches from the packing table. As a whole, the new work arrangement was semi-circular.

Design :

Treatments X subjects design was used in this experiment. Each *S* served individually in two work arrangements : existing and new. Half of the *Ss* started with the new work arrangement and half with the existing one.

Procedure :

The task of the *Ss* was to make manually 5 M parcel. Each S was given instruction and shown how a parcel was made. After one practice trial, all *Ss* made individually 10 parcels, one after another, under each work arrangement. Each parcel making operation was broken down into a number of elements and time taken to complete each element was recorded. Total time taken in each operation called 'total elapsed time' was also recorded. Four elements were constituted namely, (1) time for w. p. p., (2) time for outer, (3) time for packing and (4) time for removal of finished parcel. Besides these, the portion of the elapsed time that spent on any activity which is not a specified part of the job called ineffective time was also recorded. The method which was followed for time measurement was repetitive/snapback or flyback method. In this method, after taking time of one element stop-watch dial is snapped back to zero and next reading for next element is taken. In this experiment, instead of one *E*, six *Es* recorded six specific time.

Finally, a post-experimental questionnaire, administered orally to each *S* assessed the views of the *Ss* regarding the existing and new work arrangement.

Results

The dependent measures of the present study were total elapsed time, total time of all elements called total observed time, time of each element, and ineffective and checktime. The accuracy with which stop-watches were used was checked by the following formula :

$$\frac{\text{Total elapsed time}}{\text{The total of observed times, ineffective times and check times}} \times 100$$

Each operation of *SS* was calculated in terms of this formula. For every operation the result that came between 98 percent and 102 percent i e. allowing an error of upto$\pm$2 percent was accepted. Any error beyond this was rejected (Currie, 1965).

In order to compare the existing and the new work arrangement tests were performed between the means of total observed time and time for each element under existing and new work arrangement. These are shown in table 1.

TABLE 1

Comparison table for existing vs. new work arrengement.

Work arange-ment	Mean of totat observed time	Mean time for w. p. p.	Mean time for outer	Mean time for packing	Mean time for removal of parcel
Existing	145.88 sec.	21.68 sec.	21.99 sec.	94.84 sec.	7.44 sec
New	139.75 sec.	19.94 sec.	21.80 sec.	92.00 sec	6.35 sec.
t	2.07*	2.98**	.24	1.37	3.03**

*P$<$.06 with df 19

**P$<$.01 with df 19

Discussion

In this experiment it was hypothesized that the *SS* would perform their tasks more efficiently i. e. in less time under new work arrangement than under existing work arrangement. The findings of the study, however, supported the hypothesis partially. Total obsesved time was less under new work arrangement than under existing work arrangement but the difference was not significant at the conventional level (p$<$.06)

Time for w. p. p. in new work arrangement was significantly less than that obtained under existing work arrangement. This might be due to the placement of the tool for w. p. p. by the side of the operator which was well within his reach. The *SS* were not required to bend for w. p. p. in every operation i. e. they took w. p. p. from side rather than from below the table. But time for outer and time for packing under new work arrangement did not differ significaly from those obtained under existing work arrangement. As there was no clear cut instruction to take outer, it was observed that the *SS* approached differently for taking 20 outers which might have differentially affected time for outer under two work arrangements. Packing time was unusually long which should have been divided into a number of elements. During this long time some uncontrollable variables might have entered into packing time. Though attempt was made to reduce time for paking by making a sloping box which perhaps facilitated the grasp of end-labels, its effect was not recognized since there were many other movements combined with it in paking time. Finally the *SS* took significantly less time for removal of parcel under new work arrangement than under existing work arrangement which may be because of the shortening of distance between the paking table and the platform for finished parcel in the new work arrangement. This result is consistent with the findings of Godwin (Barnes, 1961) who found in one radio-manufacturing company that by shortening the reach of each supply bin by 6", the total saving in time was 34,000 hours a year. But it is to investigate whether the decrease in time is proportional to the decrease in distance.

The findings of the present study were not as decisive as might have been hoped. In this experiment, only limited attempts were made to improve the design of tools and work arrangement. Besides, better results could have been obtained with more controlled research.

The post-experimental questionnaire responses of the *SS*, however, supported the contention that the new work arrangement had improved the efficiency of the *SS* in view of the fact that 60% of the *SS* liked the new work arrangement, 61% felt that they were less fatigued in this arrangement and 90% disclosed that they liked to have the things within the reach. It may be concluded that there is a scope for increased efficiency of the workers if proper care is taken to design appropriate work tools and devise such work arrangement which would reduce unnecessary movements.

References

Barnes, R. M. Motion and time Study (4th ed.) New York : John Wiley and Sons, Inc., 1961.

Cox, C. H. Work simplification applied to the Shipping Department. American Management Association, Production Series 115, P. 3. In R. M. Barnes, Motion and time Study (4th ed.) New York : John Wiley and Sons, Inc., 1961.

Copley, F. B. Frederick W. Taylor. Vol. 1, New York : Harper and Bros., 1923.

Currie, R. M. The measurement of work. London : British Institute of Management, 1965.

Dvorak, A., Merrick, N. I., Dealey, W. L., and Ford, G. C. Typewriting behaviour. New York : American Book Co., 1936.

Farley, R. R. Some principles of methods and motion study as used in Development work. General Motor Engineering Journal, 1955, Vol. 2, Bo. 6. 20-25.

Gilbreth, F. B. Motion Study. New York : D. Van Nostrand Co., 1911.

Godwin, In R. M. Barnes. Motion and time Study (4th ed.) New York : John Wiley & Sons, Inc., 1961.

Habel, O. W. & Kearful, G. G. Machine Design and Motion Economy. Machanical Engineering, Vol. 61, No. 12, P. 897. In R. M. Barnes, Motion and time Study (4th ed.) New York : John Wiley and Sons, Inc., 1961.

Norem, B. H. and Machenzie, In R. M. Barnes, Motion and time Study (4th ed) N. Y.: John Wiley, and Sons, Inc., 1961.

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Item Composition of the Kundu's Introversion Extraversion Inventory

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Abstract

This research paper endeavours to study the strength and weakness of the items of the KIEI in terms of the within block homogeneity and between block heterogeneity. For this porpose inter-block coefficients of correlation were determined and also the item-item coefficients of correlation within each block were determined in terms of Phi-coefficient. Tetrachoric coefficient of correlation for each item was determined to find the relative contribution of each item to the trait measured by the total test. Strength and weakness of each item were adjudged by comparing the obtained coefficients. Results show that there are some weak items in the inventory but none to the extent of rejection. There are some items which could be dropped due to their very little contribution towards the assessment of introversion-extraversion but actually was not done so considering the fact that none of them were negatively correlated with the total test and also considering the question of reliability.

Early attempts to develop tests of personality were chiefly confined within the development of inventories for the assessment of the traits like emotional maturity, introversion-extraversion etc. Inventories developed to measure the trait introversion-extraversion were based upon different concepts. The inter-correlations of the scores of such inventories were found to range from .19 to .62, none high enough to support the idea that they are alternate measures of the same trait (Guilford and Hunt 1931).

Low inter-correlations do not necessarily mean that there exists no such genuine trait as introversion-extraversion, rather they suggest to indicate that no unique set of trait indicators had been found to demonstrate or to represent the concept behind the development of the measures of introversion-extraversion. Jung, in his later days also advocated for several types of introversion (Guilford 1959). It is on the basis of such idea Sen and Kundu (1958) assumed in their working hypothesis for the development of Kundu's Intraversion-Extravertion Inventory, that ..."introversion has different dimensions which are either uncorrelated or

very insignificantly correlated. Thus a man's reactions may be extraverted in social situations, but he may be less extraverted or introverted in other life situations. So the position of an individual in the scale of introversion-extraversion depends on his situational behaviour patterns. We, therefore, propose to consider introversion-extraversion with respect to situations or conditions that may be classified into some typical groups."

This assumption that the trait 'introversion-extraversion is multidimensional is important due to a number of reasons. On the first hand since it has been found that there is no unique set of trait indicators, while developing an introversion-extraversion inventory, ideally, attempts are to be made to include all possible types of trait indicators. On the second, if the different sets of trait indicators are considered to be independent dimensions of the trait 'introversion-extraversion', each of these are to be taken into consideration for the selection or career guidance purpose. This necessitates independent treatment of the factor-wise scores whenever required.

Kundu's Introversion-Extraversion Inventory (abbreviated as K. I. E. I.), originally developed with a view to use it for diagnostic, vocational and career guidance purposes, consists of 5 blocks of items each block having uneven number of items. For example, Block A consists of 11 items, Block B 17 items, Block C to E 14 items each. Sen and Kundu (1959) reported the item selection procedure for the K. I. E. I. The general principle was to maximise within group homogeneity and between group heterogeneity in the five blocks.

They determined tetrachoric co-efficient of correlation for each item separately with each of the five block total scores, total test score without the 5th block and total test score with all the blocks as criteria. Thus there were seven coefficients of correlation for each item. On the basis of the maximum coefficient of correlation given by the items, these items were included in one group or another rejecting a few ones showing negative correlation with total test score. Mode of response in each block was different. The general characteristics of the items in each block were as follows :

Block A : Items in this block are slightly projective in nature. Introversion-extraversion has been attempted to be depicted through the choice of occupations, movies, friends etc. Four response choices for each item are mostly some objective situations and activities.

Block B : Non-aggressive types of items to be responded categorically over a 5 point scale ranging from "like the activity most or always true etc." to "dislike the activity most or never true etc". Items are mostly introspective in nature.

Block C : Non-aggressive types of items to be responded categorically over a 3 point judgement scale as in the block B. Statements in the items are mostly of objective nature regarding oneself.

Block D : Non-aggressive types of items with the scale of three judgement categories as in the block C. Statements in this block were presented in a comparative manner, i. e., the subjects were to indicate how does he prefer one activity or person or the like over another.

Block E : Forced choice type of items mostly introspective in nature to be responded in two categories 'Yes-No'.

A tabulation of the maximum values of the tetrachoric coefficient of correlation for each item reveals that actual block-wise distribution of the items should have been as follows :

Blocks	A	B	C	D	E	Total
Existing Number	11	17	14	14	14	70
Number should have been	14	16	12	13	15	70

Due to some practical convenience, the block-wise arrangement of items was kept as in the present form. The purpose of this investigation is (a) to find how far the within group homogeneity has been maintained in K. I. E. I. inspite of the changes in the block-wise arrangement of the items mentioned, (b) to find how far each item contributes towards the assessment of introversion-extraversion and also (c) to test how far the blocks represent really orthogonal dimensions of introversion-extraversion.

Method

A sample of 318 individuals were tested with K. I. E. I. The sample was drawn from the male and female students of the Teachers' Training Colleges, 3rd year Honours class of the degree colleges, Institute of Business Management and Social Welfare, Post-graduate departments of the University and from the service holders. The minimum educational standard for the sample was B. A./ B. Sc./ B. Com. Part 1 examination. A sample of 100 cases were taken out from these 318 individuals systematically for the computational convenience.

Inter-block coefficients of correlation were determined and also within each block, item-item correlation coefficients were computed in terms of

Phi-coefficients using the abac prepared by Guilford (1654). Tetrachoric coefficient of correlation (Guilford 1954) for each of the items were computed with total score as the criterion dichotomised at the median. Strength and weakness of the items were considered individually by comparing the different coefficients obtained.

Results and Discussion

In Table 1 inter-block coefficients of correlation have been presented.

Table 1

Inter-block Coefficients of Correlation*

	A	B	C	D	E
A	( )	15	17	15	11
B	15	( )	13	24	18
C	17	13	( )	01	22
D	15	24	01	( )	23
E	11	18	22	23	( )

*Decimal points have been omitted.

In the tables 2 to 6, item-item coefficients of correlations have been shown. In all these tables decimal points have been omitted.

Table 2

Item-Item Coefficients of Correlation : Block A

Items	1	2	3	4	5	6	7	8	9	10	11
1	( )	43	32	55	62	48	43	45	33	23	20
2	43	( )	15	33	12	02	55	16	78	19	11
3	32	15	( )	50	45	45	31	42	35	32	20
4	55	33	50	( )	-18	62	44	53	36	38	-12
5	62	12	45	-18	( )	15	16	77	62	68	13
6	48	02	45	62	15	( )	15	62	14	63	10
7	43	55	31	44	16	15	( )	15	22	12	18
8	45	16	42	53	77	62	15	( )	03	15	11
9	33	78	35	36	62	14	22	03	( )	50	06
10	23	19	32	38	68	63	12	15	50	( )	16
11	20	11	20	-12	13	10	18	11	06	16	( )

Table 3

Item-Item Coefficient of Correlation : Block B

Items	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
12	( )	19	33	42	16	15	15	32	16	26	51	43	25	15	23	35	38
13	19	( )	42	41	31	35	38	15	18	28	18	35	45	30	40	21	28
14	33	42	( )	38	-12	08	11	56	19	50	33	33	32	45	16	15	23
15	42	41	38	( )	09	50	25	23	41	32	18	35	40	19	26	22	41
16	16	31	-12	09	( )	-01	18	45	32	18	-10	61	43	24	18	26	25
17	15	35	08	50	-01	( )	32	41	33	35	25	35	22	26	32	35	18
18	15	38	11	25	18	32	( )	-13	24	19	18	28	33	15	15	20	18
19	32	15	56	23	45	41	-13	( )	24	19	18	28	33	15	15	20	18
20	16	18	19	41	32	33	24	24	( )	15	12	16	23	36	41	51	13
21	26	28	50	32	18	35	19	19	15	( )	09	-05	16	23	36	41	51
22	51	18	35	18	-10	25	18	18	12	09	( )	18	28	16	66	45	40
23	43	35	33	35	61	35	28	28	16	-05	18	( )	-19	41	25	15	15
24	25	45	32	40	43	22	33	33	23	16	28	-19	( )	60	51	45	40
25	15	30	45	19	24	26	15	15	36	23	16	41	60	( )	15	08	-10
26	23	40	16	26	18	32	15	15	41	36	66	25	51	15	( )	51	-15
27	35	21	15	22	26	35	20	20	51	41	45	15	45	08	51	( )	25
28	38	28	23	41	25	18	18	18	13	51	40	15	40	-10	-15	25	( )

Table 4

Item-Item Coefficient of Correlation : Block C

Items	29	30	31	32	33	34	35	36	37	38	39	40	41	42
29	( )	10	19	33	35	25	23	26	38	19	28	35	42	31
30	10	( )	59	38	42	28	15	-13	42	20	22	25	35	30
31	19	59	( )	06	15	26	19	25	33	18	25	30	43	25
32	33	38	06	( )	45	38	25	13	45	23	42	40	35	38
33	35	42	15	45	( )	25	43	41	50	31	-16	09	18	-15
34	25	28	26	38	25	( )	55	43	42	63	-18	19	42	42
35	23	15	19	25	43	55	( )	25	70	62	-12	15	19	22
36	26	-13	25	13	41	43	25	( )	18	-16	25	28	35	25
37	38	42	33	45	50	42	70	18	( )	35	42	38	50	42
38	19	20	18	23	31	63	62	-16	35	( )	25	38	42	13
39	28	22	25	42	-16	-18	-12	25	42	25	( )	61	08	-18
40	35	25	30	40	09	19	15	28	38	38	61	( )	23	32
41	42	35	43	35	18	42	19	35	50	42	08	23	( )	43
42	31	30	25	38	-15	42	22	25	42	13	-18	32	43	( )

Table 5

Item-Item Coefficient of Correlation : Block D

Items	43	44	45	46	47	48	49	50	51	52	53	54	55	56
43	( )	55	18	43	18	55	62	38	42	19	15	22	48	38
44	55	( )	16	15	10	11	15	15	19	-18	20	25	-18	10
45	18	16	( )	43	33	35	26	25	18	26	45	52	43	41
46	43	15	43	( )	38	06	50	43	42	38	35	46	41	-28
47	18	10	33	38	( )	-11	12	42	18	33	18	26	33	31
48	55	11	35	06	-11	( )	26	43	28	61	25	-03	08	19
49	62	15	26	50	12	26	( )	28	71	63	21	15	19	20
50	38	15	25	43	42	43	28	( )	41	-23	31	31	43	25
51	42	19	18	42	18	28	71	41	( )	18	55	30	51	19
52	19	-18	26	38	33	61	63	-23	18	( )	63	18	55	32
53	15	20	45	35	18	25	21	31	55	63	( )	-18	29	20
54	22	25	52	46	26	-03	15	31	30	18	-18	( )	31	32
55	48	-18	43	41	33	08	19	43	51	55	29	31	( )	29
56	38	10	41	-28	31	19	20	25	19	32	20	32	29	( )

Table 6

Item-Item Coefficients of Correlation : Block E

Items	57	58	59	60	61	62	63	64	65	66	67	68	69	70
57	( )	22	40	35	21	36	38	22	40	43	12	61	44	28
58	22	( )	51	33	38	25	22	29	32	28	24	52	53	-12
59	40	51	( )	36	39	30	32	31	28	31	37	38	35	19
60	35	33	36	( )	42	08	-01	44	38	19	28	24	61	32
61	21	38	39	42	( )	31	-05	18	28	39	62	43	41	38
62	36	25	30	08	31	( )	42	13	61	70	18	15	63	08
63	38	22	32	-01	-05	42	( )	52	18	16	26	67	25	-02
64	22	29	31	44	18	13	52	( )	18	19	20	42	41	35
65	40	32	28	38	28	61	18	18	( )	18	10	28	35	23
66	43	28	31	19	39	70	16	19	18	( )	43	18	22	19
67	12	24	37	28	62	18	26	20	10	43	( )	41	32	-18
68	61	52	38	24	43	15	67	42	28	18	41	( )	26	41
69	44	53	35	61	41	63	25	41	35	22	32	26	( )	40
70	28	-12	19	32	38	08	-02	35	23	19	18	41	40	( )

Item-total coefficients of correlation have been presented belowin the table 7.

Table 7

Item-Total Coefficients of Correlation *

Sl. No.	r	Sl. No.	r	Sl. No.	r	Sl. No.	r	Sl. No.	r
1	15	15	28	29	05	43	15	57	22
2	20	16	15	30	32	44	52	58	10
3	13	17	22	31	45	45	49	59	12
4	05	18	45	32	18	46	10	60	15
5	32	19	10	33	15	47	22	61	10
6	43	20	18	34	20	48	17	62	33
7	13	21	70	35	51	49	24	63	48
8	31	22	29	36	16	50	05	64	51
9	20	23	19	37	10	51	23	65	40
10	15	24	25	38	12	52	08	66	33
11	25	25	42	39	00	53	48	67	62
12	20	26	45	40	21	54	53	68	41
13	32	27	48	41	31	55	07	69	24
14	18	28	15	42	05	56	45	70	09

*Decima! points have been omitted.

It appears from the table 1 that the blocks are more or less independent of each other. Since none of the coefficients of correlation are negative, it may be tentatively taken as graneted that a composite score with all the block scores added together may be taken as an index of the degree of introversion-extraversion.

It also appears from the comparison of the table 2 and table 7 that in the Block A, items 1, 3, 4, 7 and 10 contribute very little to the assessment of introversion-extraversion. Item number 4 appears to be the weakest item as it also correlates negatively with items 5 and 11. Rest of the 5 items mentioned, maintains within group homogeneity quite well and, therefore, their inclusion in this block is justified. Item 4, however, could be dropped, but was not actually done so considering its face validity.

Comparison of the tables 3 and 7 reveals that the items 16, 19 and 29 are rather weaker items. Their contribution towards the total test criterion is less and these items correlate negatively with some of the items within

group (e. g., item 16 with 14, item 19 with 13 and 25 and item 28 with 25 and 26). Other items are more or less satisfactory.

Comparative study of the tables 4 and 7 indicate that the itmes 29, 33, 37, 38, 39 and 42 bear very low correlation with the total test of which items 39 ana 42 correlate negatively with a number of items within group. Particularly the item 39 appears to be the weakest item in the test as it contributes nothing to the total test score.

When the table 5 is compared with the table 7 it appears that the items 43, 46, 50, 52 and 55 are weaker items. Of these, item 43 correlates satisfactorily with other items within group. Item 46 correlates negatively with 56, 50 with 52, 52 with 44 and 50 and the item 55 correlates negatively with 44. All the negative correlations are, however, sufficiently low except the correlation between items 46 and 56 (r=-.28).

Lastly the comparison of the tables 6 and 7 shows that the items 58, 59, 61 and 70 are the weaker items. Correlations of the items 58 and 59 with other items are more or less satisfactory. Item 58 correlates negatively with item 70, item 61 correlates negatively with 63 while item 70 correlates negatively with 58, 63 and 67.

These negatively correlated items were not, however, dropped from the inventory due to the fact that none of them are negatively correlated with the total test and also that the over-all inter-item correlations are not unsatisfactory.

Conclusions

(a) It seems from the results presented above and from the subsequent discussions that the items within each group tend to maintain within group homogeneity, although some of the items in each group correlate negatively with some other items. These negative correlations are not sufficiently high. Further factor analytic studies may be undertaken to ascertain the nature and extend of their within group homogeneity.

(b) All the items have some positive contribution towards the assessment of introversion-extraversion with an exception of a few ones which either correlates very little or nil with the total test score. But none of the items correlate negatively with the total test score. This implies that at least, these items should not be rejected from the inventory outright for the sake of reliability.

(c) It also appears from the coefficients of correlation presented in the table 1 that the blocks of items tend to be independent of each other. But none of the coefficients are negatively correlated indicating that there is no set of behaviours which tend to represent opposite dimensions.

References

Guilford, J. P. Psychometric Methods, Mcgraw-Hill Book Co. N. Y., 1954.

———— Personality, McGraw Hill Book Co. N. Y., 1959.

———— and Hunt, J. McV, Some Further experimental Tests of McDougall's Theory of Introversion-Extraversion. Journal of Abnormal and Social Psychology, 1931, **26** : 324-332.

Sen, Tapas K. and Kundu Ramanath. Development of a New Introversion-Extraversion Inventory (First Report), Psychologia, 1958, **1** : 257-264.

Sen, Tpas K. and Kundu Ramanath Development of a New Introversion-Extraversion Inventory (Second Report) Psychologia, 1959, **2** : 128-132.

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A new Technique of Item Analysis

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Abstract

In the pages to follow an attempt has been made to evolve a simpler method for item analysis in the context of psychological measure ment. The results obtained by this method give a better "Microscopic" view of the components of a test entailing its fidelity. The method also involves minimum time for its operation.

In the construction of any psychological test the most important characteristic that is to be considered first is item analysis. There exists various methods in this context. The important studies that deserve special mention in regard to item analysis have usually been made by T. L. Kelley (1924), Smith (1934), Long and Sandiford (1935), Swineford (1936), Thorndike (1949), Gulliksen (1950), Guilford (1954) and Nunnally (1967). The efficacy of the methods is largely a matter of balancing convenience against precision. Those who have electronic computors available apparently prefer either the bi-serial or the point—bi-serial coefficient of correlation. But those of us who must use hand tabulation and calculation, generally prefer one of the simpler methods—simpler in the sense that they take the least time to calculate.

With this end in view an attempt has been made to evolve a new technique of item analysis.

An item analysis yields information about each item in a test in the form of

(a) a difficulty index and
(b) a validity index

The difficulty index tells us how stiff the item is, and as we shall see an item which is too easy or too stiff is regarded as unsatisfactory.

The validity index tells us how good the item is. A high validity index is yielded by an item where "good" testees get the item right and "poor" testees get the item wrong. In other words, the item has high discrimination. Hence "discrimination index" would be a better term than "validity index".

On the other hand, a low validity index shows that for the item, just as many "poor" testees get the item right as do "good" testees. The item does not discriminate between testees in the required way. In other words, the item "does not work".

Occasionally, we may find items which discriminate negatively. And the inclusion of such items actually reduces the power of the test. Here the item works against the test. And the test as a whole is thus improved by exclusion of the item.

In practices, the difficulty and the validity of an item are determined in the same item analysis, and so we shall treat the two topics together.

Let us take a simple example to illustrate the main points of the method of item analysis. Suppose that we have a test with 6 items and give the test to 10 testees. For each of these 10 testees, we mark the items as right or wrong. Each testee thus has a score on the test and the testees may accordingly be arranged from good to poor.

Thus we may have—

	Poor-Person-Good										
Item	A	B	C	D	E	F	G	H	I	J	Total
I	−	+	+	+	+	+	+	+	+	+	9
II	−	−	−	−	+	+	+	+	+	+	6
III	−	−	−	−	−	−	−	−	+	+	2
IV	−	+	−	+	−	−	+	−	−	+	4
V	−	−	+	+	+	+	−	+	+	+	7
VI	−	−	+	−	−	−	−	+	+	+	4
Total	0	2	3	3	3	3	3	4	5	6	32

We have a test with 6 items, numbered I-VI and we have 10 testees A-J. The testees are arranged from left to right in increasing order of total score. Note that there is ambiguity in the order of placing the persons when they have the same total score, e. g. B and C, or D, E, F and G. This ambiguity is not important in practice, provided that there is a reasonably large number of items, say 30 or more. Where the scores are equal the testees should be arranged at random, for instance, by the initial letter of their names.

We enter in each cell whether the candidate had the item correct (+) or otherwise (−). We add across each row to a total which tells how many persons had that particular item correct. We add each column to get each testee's score. The sum of the sums in rows and the sum of the sums in columns should be equal which is a useful arithmetic check.

Now a testee may mark an answer and his answer may be right or wrong or he may not mark it at all. How shall we treat an unanswered question—ignore it or mark it wrong ?

In conducting an item analysis study we handle this problem by giving sufficient time for all (or substantially all) candidates to finish the test, and then assume that any question not answered has been attempted by the testee but that he cannot handle it. Therefore, we regard unattempted answer as wrong or incorrect. This assumption, however, may be wrong, and seriously so, if the testees have not been given sufficient time to attempt all items.

Under ordinary actual testing condition with speed power conditions the average candidate will finish only 50 – 70 per cent of the items and only the best will reach 100 per cent. Thus special conditions have to be set for item analysis.

Let us return again to our small example.

Item	Person										Total
	A	B	C	D	E	F	G	H	I	J	
I	−	+	+	+	+	+	+	+	+	+	9

Nine persons have the item correct. One has not. The nine who have the item correct are the top nine persons, and the one wrong the poorest. The item is, therefore, a perfect discriminator.

We observe that the item is one which 90 per cent of the persons get right and 10 per cent wrong. So, we can say that the difficulty of the item is 90 per cent. A high difficulty index means that the item is easy and a low one that it is difficult (It would perhaps be better to call the index an index of "easiness", but the term difficulty index is now widely used and understood).

Now look at items II and III

Item	Person										Total
	A	B	C	D	E	F	G	H	I	J	
II	–	–	–	–	+	+	+	+	+	+	6
III	–	–	–	–	–	–	–	–	+	+	2

These items are also perfect discriminators but differ from item I and from each other in having different levels of difficulty. Item II is harder than item I and Item III harder again than both Items I and II.

Now look at item IV.

Item	Person										Total
	A	B	C	D	E	F	G	H	I	J	
IV	–	+	–	+	–	–	+	–	–	+	4
Rank	10	9	8	7	6	5	4	3	2	1	

Four persons get the item right but they are not exclusively the top 4. Indeed the second highest person I get the item wrong, the second worst B gets it right. If the item were a perfect item the top 4 persons would have it correct and no others. It is useful to put a heavy line or a red line at the point of discrimination (in this case between F and G).

We look at the 4 top cases G, H, I and J and find that 2 have it correct (as it should be) and two have it wrong. These 2 who have the items wrong are called discrepancies. We look at the poorest 6 who would have the item wrong, if the item were perfect, but we find that only 4 have it wrong and 2 have it correct. These 2 who have the item correct constitute the discrepancy in the lower end. The discrepancy of "wrongs in the upper group" and the discrepancy of "rights in the lower group" are always equal (and so constitute a useful arithmetic check).

	Lower Group	Upper Group	Total
Giving Right Answer	2	2	4
Giving Wrong Answer	4	2	6
Total	6	4	10

This table shows that of the four giving correct answers, 2 were in the top 4, and 2 were in the lower 6. And of the six giving the wrong answer 4 were in the lower group and 2 in the upper group.

More generally :—

	Lower Group	Upper Group	Total
Giving Right Answer	d	a	a+d
Giving Wrong Answer	b	d	b+d
Total	b+d	a+d	T

Where T is the total number of persons and d is the discrepancy.

Note that the totals of the rows (a+d) and (b+d) are the same as the totals of columns (b+d) and (a+d), and this must be so because we define the upper group as being equal to the number who give the right answer.

What we desire to get so as to have highly discriminating items is "d", the discrepancy, as small as possible, or rather we will select and ratain in our test items where "d" is small.

We cannot, however, consider the absolute size of "d" only. For example, where (a+d) is very large or very small, "d" must be small. "d" must be considered in the whole pattern.

A very convenient device exists for doing this called the coefficient ∅ (Greek letter—Phi)

The general form of ∅ for any 2×2 table is —

c	a	a+c
b	d	b+d
c+b	a+d	T

$$\varnothing = \frac{ab - cd}{\sqrt{(c+d)\,(a+d)\,(a+c)\,(b+d)}}$$

In our particular table (which differs from the general table in that c=d and in that the row totals are equal to the column totals)—

d	a	a+d
b	d	b+d
b+d	a+d	T

and this is the measure we shall use to measure the validity of discrimination of each item.

The ø coefficient takes an upper limiting value of + 1.00 when the item is a perfect discriminator, e. g., for item II, ø is worked out as under :—

	Lower Group	Upper Group	Total
Right answer	0	6	6
Wrong answer	4	0	4
Total	4	6	10

$$\varnothing = \frac{6\times4 - 0\times0}{6\times4} = 1.00$$

ø is zero when proportionality as many of the good candidates have the answer correct as of the poor candidates. (we have put 12 cases in this example as it is impossible preciously to have ø = 0.00 when there are 10 cases).

	Lower Group	Upper Group	Total
Answer right	3	3	6
Answer wrong	3	3	6
Total	6	6	12

Where

$$\varnothing = \frac{3\times3 - 3\times3}{6\times6} = 0$$

Intermediate validities occupy values between zero and +1.00.

For example, Item IV shows

$$\varnothing = \frac{4\times2 - 2\times2}{6\times4} = +0.17$$

Items which have negative validity will have negative values. For exgmple, if we had

	Person									
Item	A	B	C	D	E	F	G	H	I	J	Total
X	+	+	−	+	−	−	+	−	−	−	4

The tabulation would be

	Lower Group	Upper Group	Total
Answer Correct	3	1	4
Answer Wrong	3	3	6
Total	6	4	10

Where $\phi = \frac{1 \times 3 - 3 \times 3}{6 \times 4} = -.25$

The lower limit of ϕ is-1.00, but this value may be attained only where the discrepancy is maximal and where preciously a half of the persons have the items right. (There are other limitations to ϕ taking negative values where the difficulty departs from 50 per cent but these are not important in practice since quite generally any negative value leads to the rejection of the item).

The ϕ coefficient is a measure of the relatedness of the item to the test as a whole. (It is in fact a particular case of Bravais—Pearson poduct-moment correlation coefficient for 2 × 2 table).

The ϕ coefficient has one further great advantage in that a test through X^2 for the significance of its departure from zero is available since approximately

$$\phi^2 = \frac{X^2}{N}$$

Where X^2 (Greek letter-Chi) is distributed with one degree of freedom.

We may then find a value of ϕ, for some given number of cases, above which the item may be said to be significantly related to the test.

In a fairly usual case we may has 80 testees given a test for item analysis.

X^2 must reach a value of 3.841 to be significant at the 5 per cent value. We can compute the corresponding value of ϕ.

$$\phi = \sqrt{\frac{3.84}{80}} = \sqrt{0.048} = .218$$

And for a 1 per cent significance ϕ must reach the value of +0.288.

A "rule of thumb", that is rather conservative, is to require ϕ to reach the value +0.30 for item acceptance where there are say 60 – 80 cases.

It is to note that the method outlined here differs slightly from the standard method which uses upper and lower fractions (usually 27 per cent) for it is one designed deliberately to establish Gutmann type monotonic scales. Under certain conditions (e. g. where the test maker is aiming to make a test with maximum discrimination at the median) both methods give the same results. In most cases the results are not much different. The method given here—which might be called "discrimination determined at the difficulty point"———is, however, more refined and allows a better "microscopic" view of the components of a test. It is more precise and uses more information and as such it is likely to give better results and in any case no worse.

References

Guilford, J. P. Psychometric Methods. New York : McGraw-Hill, 1954.

Gulliksen, Harold. Theory of Mental Tests. New York : John Willey and Sons, Inc., 1950.

Kelley, T. L. Statistical Method. New York : The Macmillan Co., 1924.

Long, John, A. and Sandiford, P. The validation of Test Items. Bulletin No. 3, Dept. of Educ. Press, University of Toronto, 1935.

Nunnally, J. C. Psychometic Theory. New York : McGraw-Hill, 1967.

Smith, M. The relationship between Item validity and Test validity. Contributions to Education, No. 621, Teachers College, Columbia University, 1934.

Stanley, C. Julian. Measurement in To-day's school. London, Printice Hall International Inc., 1964.

Swineford, P. Validity of Test Items. J. Educ. Psychol. 1936, **27** : 68-78.

Thorndike, R. L. Personnel Selection—Test and Measurement Techniques. London, John Willey and Sons, Inc., 1949.

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Achievement Motivation, Knowledge of Results and Performance

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Abstract

A previous study (Ali, 1976) failed to show any significant difference between the performances of factory supervisors with high and low achievement motivation in actual work situations. The present study was designed to investigate whether: (1) the supervisors with high achievement motivation will perform better than the supervisors with low achievement motivation in laboratory situations; (2) these supervisors will perform still better when they are given knowledge of results (KR) of their performance.

Fifty-six supervisors, thirty-one high achievers and twenty-five low achievers, served as subjects. Their ages ranged between 22 and 50 years. They were given two tasks (Reaction Time Test and Crawford Small-parts Dexterity Test) to perform under normal and feedback conditions. The results showed that the high achieving supervisors performed better than the low achieving supervisors under normal condition but they failed to perform better when they were given KR of their performance.

The results thus indicate that achievement motivation alone may not help improve performance; a suitable environment is also essential. Secondly, KR does not always help the high achievers in improving their performance. This finding supports the views of Locke and Bryan (1969) that KR improves performance only when the individual appraises it as signifying inadequate performance.

Introduction

In a previous study (Ali, 1976) it was found that high achieving industrial supervisors failed to produce more than the low achieving supervisors. No apparent reason was available to explain out this negative result. It was, however, pointed out that probably the negative result was due partly to the unnatural conditions prevailing in the industrial sector in Bangladesh immediately after the war of liberation. Industrial indiscipline, management gap, badly managed human relations, irregular supply of power, and non-availability of spare-parts were some of these factors. The present study was designed to see whether those high achieving

supervisors would perfrom better than the low achieving supervisors in a controlled situation where extraneous variables were not allowed to operate. The following hypotheses were tested : (*i*) in a laboratory condition high achieving supervisors will perform better than the low achieving supervisors ; (2) the high achieving supervisors will perform still better when they will be given knowledge of result (KR) of their performance.

Method

Subjects :

Fifty-six supervisors of industrial firms were randomly selected as subjects (*Ss*) for this study. These supervisors were administered an achievement motivation questionnaire, prepared following the procedure of Lynn (1969), to measure their achievement attitudes. On the basis of their scores in this test, the supervisors were divided into two categories, namely high achievers and low achievers. Those who fall above the median value were called high achievers and those who fall below it were called low achievers. Of the fifty six supervisors, thirty one were high achievers and twenty five low achievers. The ages of the supervisors ranged between 22 and 50 years. They were selected from both private and nationalized firms.

Tasks :

The *Ss* were given two tasks to perform : (1) Choice Reaction Time (CRT) Test ; and (2) Crawford Small Parts Dexterity Test (CSPDT). In the Choice Reaction Time Test, *Ss* were asked to respond to a light from the RT apparatus as quickly as possible by pressing the appropriate key. In the CSPDT, Ss were asked to put pins inside the holes of a wooden frame and screw them down as quickly as possible with the help of a holder and a screw-driver. Each task consisted of three trials. The *Ss* were given a rest pause of five minutes between the two tests.

Design and procedure :

The experiment was conducted within the factory, but in a room free from disturbances. A laboratory situation was created in this room. By laboratory situation we mean a situation when all other variables remain constant except the one(s) whose effect we intended to investigate. The *Ss* performed the tasks in this room under normal (control) and feedback (experimental) conditions. The control *Ss* performed the tasks (CRT and CSPDT) without KR. The experimental *Ss* performed the tasks with KR *i. e.* they were informed of the results of their previous trials.

Results

1. Achievement motivation and performance under normal conditions :

The *Ss* were asked to perform the tasks in a calm and quiet room when they were given no KR of their performance. The purpose was to see if there would be any difference between the performences of the high and low achievers. Table 1 shows the results. The Table shows that there is a significant difference between the performances of high and low achieving *Ss*.

Table-1

Mean performances of high and low achieving supervisors under normal condition and their t values

N=56

Test	High achiever	Low achiever	t
CRT (in centi-second)	0.67	0.77	2.12*
CSPDT	14 min. 40 sec.	16 min. 50 sec.	2.08*

* P<.05 df=54

2. Achievement motivation, feedback and performance :

Choice Reaction Time and Crawford Small Parts Dexterity Tests were administered to *Ss* in an identical situation but they were given KR of their performances. Table 2 and Figure 1 summarize the results. The performances of the high and low achieving *Ss* with and without KR were compared. t-tests for related measure were computed. The comparison

Table-2

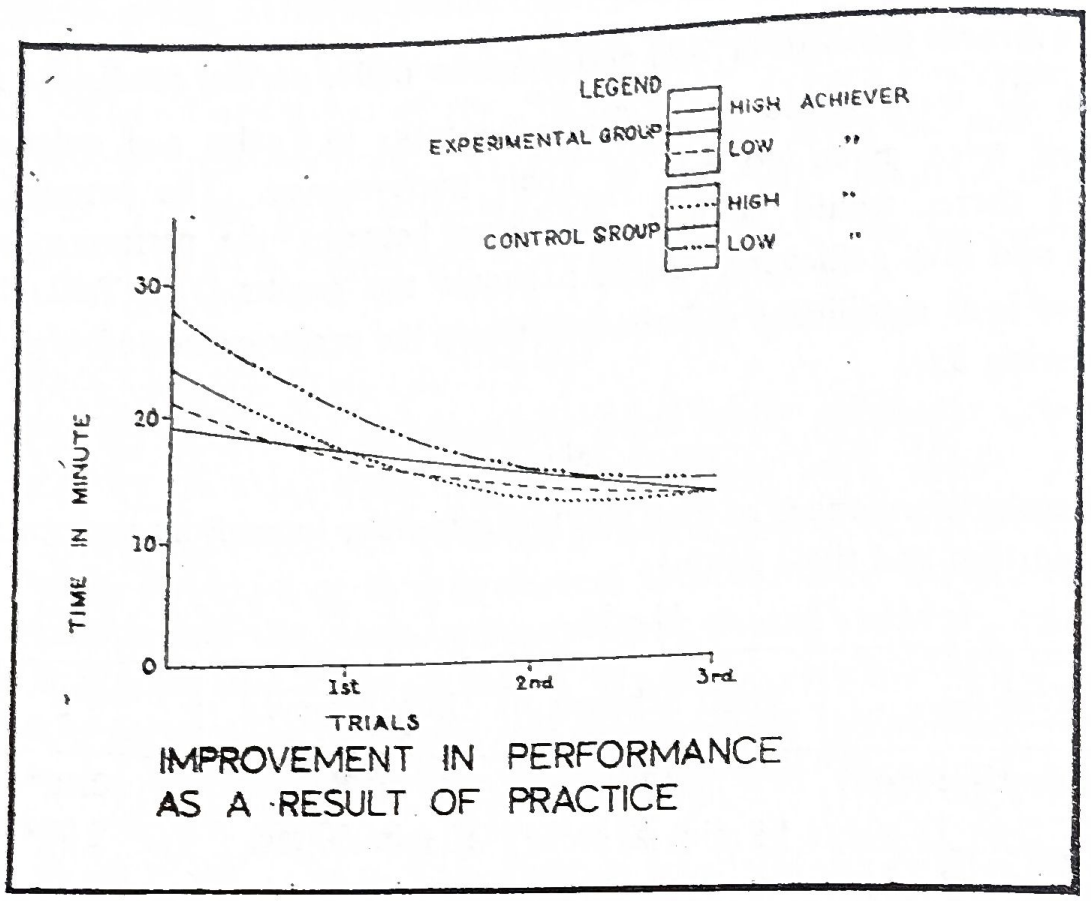
Mean performances of high and low achieving supervisors with and without knowledge (k) of results and their t values

N=56

Test	High achievers			Low achievers		
	Without k	With k	t	Without k	With k	t
CRT (in centi-sec.)	.67	.64	.72	.77	.59	2.45**
CSPDT	14 min. 40 sec.	14 min. 20 sec.	1.12	16 min. 50 sec.	14 min. 34 sec.	2.05*

* P<.02

* P<.05



IMPROVEMENT IN PERFORMANCE AS A RESULT OF PRACTICE

shows that there was no significant difference between the performances of high achieving *Ss* under the two conditions. There was, however, a significant difference between the performances of the low achieving *Ss* under KR and no KR condition.

Discussion

The results show that the high achieving *Ss* performed significantly better than the low achieving *Ss* in the laboratory situation. This finding supports the first hypothesis. In a previous study (Ali, 1976) the same high achieving *Ss* could not perform better in the actual work situation. The two work conditions were, however, different. In the first condition, the *Ss* performed their tasks in factory situation where innumerable variables were operating. In the second condition, the *Ss* performed their tasks in a controlled situation free from disturbances. So, the findings of the present study indicate that possibly a set of variables was operating in the first study (Ali, 1976) which was responsible for the negative result. These variables were isolated and reported elsewhere (Ali, 1976). They also indicate that achievement motivation alone may not improve performance; a suitable environment is also essential.

The results of the present study also show that KR could not improve the performances of the high achieving *Ss*. KR, however, significantly improved the performances of the low achieving *Ss*. This finding indicates that the relationship between feedback and performance is not as simple as it appears. French (1958) points out that feedback does not always improve performance. She found that *Ss* with high achievement motivation performed significantly better under accomplishment oriented feedback than under feeling oriented feedback.

Locke and Bryan (1969) offer a different explanation. They point out that if an individual appraises KR as signifying inadequate performances, he will usually set a goal to improve his subsequent performance. If he appraises KR as signifying adequate or superior performances, he will ordinarily set a goal to maintain his level of performances. If the KR is appraised by him as irrelevant, he will just ignore it. In the present study, the high achieving *Ss* were probably confident about their performances and as such they tried to maintain their level of performances and ignore KR as irrelevant. The low achieving *Ss*, on the other hand, were not confident about their performances and considered KR as signifying inadequate performances and as such they tried hard to improve their performances.

References :

Ali, M. R. Achievement motivation and industrial productivity in Bangladesh. *Proceedings of the Seminar on Motivation and Industrial Productivity in Bangladesh.* Dacca : Department of Psychology, Dacca University, 1976, 39-75.

French, Elizabeth G. Some characteristics of achievement motivation. In J. W. Atkinson (Ed.), *Motives in Fantasy, Action, and Society.* Princeton, N. J. : Van Nostrand, 1958, 270-277.

Locke, E. A. and Bryan, J. F. Knowledge of score and goal level as determinants of rate. *Journal of Applied Psychology, 1969,* **53**, No. 1, 59-65.

Lynn, R. An achievement motivation questionnaire. *British Journal of Psychology,* 1969, *60*, No. 4, 529-534.

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Comparison between a Group of Rajshahi University (Psychology) Students and a Group of Graduate Foreign Students at the University of Minnesota on D 48 test

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Abstract

In the present study the D 48 test was administered to a group of Bangladeshi students at Rajshahi University and to a group of foreign graduate students, mostly from the sub-continent, registered at the University of Minnesota. The purpose of the study was to compare the two groups with each other, and with American and European populations as well. The study also aimed at confirming or rejecting the Universality of the test. From the data obtained it was found that on the whole the mean of the Asian students was much below the American and the European populations as reported in the manual and journals. A number of plausible factors for low scores of the Asian students have been discussed and the universality of the test has been questioned. Non-familiarity with the game of domines, non-testmindednes, and slow speed might account for the poorer scores of the Asian students. Between the two groups, Minnesota group was found to have higher mean which was not unexpected. A number of situational factors have been discussed to account for this difference. It was suggested that futher studies should be conducted on a larger sample to test the universality of the test and to establish norms on Asian populations.

Introduction

The D 48 test is a non-verbal analogies test. More specifically, it is a test of abstract reasoning measuring primarily the 'g' factor in intelligence. It consists of 44 problems and 4 examples. The examples are meant to give the testee an understanding of what he is supposed to do in the test. The patterns of the problems in the booklet change very frequently. The problems are arranged in order of increasing difficulty with the exception of five quite hard items placed in the middle The testee's task is to find out the number of dots in each half of the blank domino which is made with the broken lines. The blank domino in most cases is the last one. The principles involved include simple additions, identities, identities with reversals, double progression, subtraction, substraction with progression, etc (Gough & Domino, 1963).

The test was first developed by Austey and Illing in 1943 for the Directorate of Selection of Personnel of the British War Office (Black). This test is based on four other editions developed for different agencies, now in use in England. A new experimental version in colour has also been recently completed. A French adaptation of the test was prepared by Binois, and published by the Centre de Psychologie Appliquee. This version has also been published in Italy.

Spearman found that his general factor 'g' was present in almost all tests and to the highest degree in homogeneous tests involving the education of correlates. He held that "all branches of intellectual activity have in common one fundamental function (or group of functions), whereas the remaining or specific elements seem in every case to be wholly different from that in all the others." Herein lies the justification for attributing so much importance to 'g' despite its purely formal character (Spearman, 1961). For example, the relationship between two elements must be discovered and applied to a third element in order to find a fourth element which is related to the first. Stephenson in early 1930's showed that tests with the greatest saturation of 'g' were those involving non-verbal perceptive material. In 1938, Penrose and Raven constructed a similar test applying the same principle. It is regarded by most British psychologists as the best measure of Spearman's 'g'. It was used as a general intelligence test in the British Army (Anastasi, 1964).

By factor analysis, Vernon found the D 48 test to have a saturation of 0.86 on 'g' as against 0.79 of Progressive Matrices. As a result, this test was adopted by the British Army and used as an intelligence test. This test was brought to America in 1962 by the Consulting Psychologist INC. Attention is being paid on this test in America for a number of reasons. It is claimed by its author to be a universal test, in the sense that it has no effect of culture, language or region. A test in order to be cross-cultural has to have either of the two principles : (a) items or materials are to be new and/or unknown to all so as to minimize differentials of past experience ; (b) utilize test stimuli known to every one. The D 48 test is based on the second assumption. It is easy to administer. The time limit for the test iteself is 25 minutes and a few minutes are spent on instruction. Thus, the over-all simplicity of the test is very appealing. Gough and Domino have suggested that it may be used as a power test without giving any time limit.

The D 48 test has been widely used in Europe both in the Army and the civilian as a test of intelligence. Very few studies have been done in other countries showing the applicability of the test. The odd-even reliability is reported to be 0·89 while the test-retest reliability with an interval of two months between the two testings is 0.69. It is shown to have high correlations with other tests of intelligence in Europe. The correlation between D 48 and the Binois-Pichot Vocabulary test, on a sample of 185 male subjects representing the over-all French population between the ages of 20 and 25, was found to be 0.64.

In the United states only two studies have been published in the periodicals so far. Gough and Domino (1963) gave the D 48 test to 85 5th and 6th grade children in California elementary school. They concluded the relative difficulty of the 44 items to be constant for different age groups, in different countries and in different languages. Higher graders had higher average. 6th grade had an average score of 20.02 as against 18.68 secured by 5th grade. Their findings suggest that the average score for subjects of similar age and educational level in different countries will be approximately the same. No definite sex differences was found as it sometimes favoured boys and sometimes girls. It correlated more highly with G. P. A. than any other part of the Stanford Achievement Test. The correlation betweed the D 48 and G. A. P. in the 5th and 6th grades are 0.58 and 0.45 respectively. It can thus justifiably be said that the D 48 is an adequate predictor of scholastic performance at the grade school level. Domino (1964) administered D 48 along with other tests to a sample of lower division males in introductory psychology courses at the University of San Francisco. None of these tests correlated very highly; but only the D 48 correlated significantly (0.22 significant at 0.05 level). Statistical treatment of the data showed that the D 48 has slightly more predictive validity than the Cattell Culture Fair or Army Beta. The D 48 was found to be similar in its pattern of relationship to other measures of ability. Lindley compared D 48, Progressive Matrices, and Army General Classification Test on a sample of 40 patients at Veterans Administration Hospital, St. Cloud, Minnesota, each holding the diagnosis of schizophrenic reaction. The age range was 29 to 49 years with a mean of 38.9 a median of 38.5, The mean score was found to be 14.18 with a SD of 7.08. It was found to have a greater ceiling which could be a definite advantage over the Progressive Matrices when testing individuals of higher intelligence. It could not be found that the

Progressive Matrices measures the space factor to a greater degree than the D 48. The relationship of D 48 and Progressive Matrices with the AGCT did not suggest a basis for the selection of one over the other.

The present study was designed to investigate whether the D 48 Test can be applied on different samples having comparable age and educational levels. Secondly, the study was aimed at comparing the two groups (Bangladeshi students and foreign students) with American and European norms.

The following hypotheses were tested :

(1) D 48 will yield similar scores when applied on different sample having comparable age and educational levels ;

(2) there will be no significant difference between the scores of the two groups and those of American and European norms.

Method

Subjects : 123 (110 males and 13 females) students.

(a) 63 male and 13 female students at Rajshahi University at third Year Honours, Master's Previous and Master's Final levels in Psychology with age levels 21-28, most cases between 22-25.

(b) 47 foreign male students at the University of Minnesota at Master and Ph. D. levels in different fields of study with age levels 21-47, most cases between 22-30 years. These were Asian students most of them from the Sub-continent who were studying at the University of Minnesota.

Procedure

The D 48 test was administered to the Rajshahi University group of students by the writer in the year 1976. The test was administered in four sessions—one session each for Third Year Honours, Master's Previous, Master's Final and a small group of students from these classes who were absent on day of testing and were willing to take the test. The writer had also administered the test to the foreign students at the University of Minnesota (while the writer himself was a graduate student over there in the years 1964-1966) in groups of 5-8 students and individually as well depending on the availability of the students. Every effort was made to maintain time limit and control other factors as given in the manual of the test. The class-wise distribution of the testees is given below :

(a) Rajshahi University : 76 (63 males and 13 females)

Third Year Honours Psychology	10+1=11
Master's Previous Psychology	32+2=34
Master's Final Psychology	21+10=31
Total :	63+13=76

(b) University of Minnesota : 47 males only.

These 47 students were at Master and Ph. D. levels in different fields.

All the answer-sheets were hand scored and the raw scores were obtained and rechecked a second time. Range, mean, median and standard deviation for the two groups were calculated for comparison purposes. 't' tests were run to see if there was any significant difference.

Results :

Table 1

The Range, Mean, Median and Standard Deviation of the different groups on D 48 test

	N	M	MD	SD	Range
Minnesota (Foreign Students)					
Males	47	25.70	26.25	5.7	11—36
Rajshahi : males & females	76	17.97	18.93	4.5	8—31
Classwise breakdown of Rajshahi results :					
Third Year Honours	11	19.27	19.0.	4.68	13—30
Master's Previous	34	16.79	17.25	3.76	9—25
Master's Final	31	18.58	19.87	4.84	8—31

As seen in Table 1 mean of Minnesota group is much higher than that of Rajshahi group. As regards SD Rajshahi group has smaller than that of Minnesota. Mean and median are very close and the range is very wide in each case.

The class-wise breakdown of results show that the Honours group is highest in mean, then come Final and Previous respectively ; with respect to SD Previous is the smallest and then are Honours and Final in order. Other measures have the same trends as in Minnesota and Rajshahi groups in general.

Table 2

Significance of difference between means

	t	df	significance
Minnesota (males) & Rajshahi (males females)	8.91	121	$p<0.001$

The 't' test was applied and it was fond that the mean difference between the two groups was very highly significant in favour of Minnesota group.

Table 3

Summary of Means and Standard Deviations of D 48 Scores

Study	Population	N	Mean	SD
Present Study	Rajshahi	76	17.97	4.5
	Third Year Honours	11	19.27	4.68
	Master's Previous	34	16.79	3.76
	Master's Final	31	18.87	4.84
	Minnesota	47	25.70	5.70
Gough and Domino	Calif. 5th graders	34	18.68	5.38
	Calif. 6th graders	52	20.02	5.86
Domino	Calif. male colleg students		28.06	5.44
Lindley	V. A. psychiatric males	40	14.18	7.08
Reported in Black's D 48 manual	U. S. college male	42	30.29	5.34
	U. S. college females	96	31.22	4.86
	French secondary school males			
	ages 13-14	27	21.70	6.20
	ages 14-15	61	22.20	7.10
	ages 15-16	65	23.60	5.20
	ages 16-17	55	25.90	6.40
	ages 17-19	60	28.40	6.40
	ages 20-24	68	29.00	5.20
	French secondary school females			
	ages 13-14	19	23.30	6.90
	ages 14-15	47	23.66	5.40
	ages 15-16	64	23.40	5.40
	ages 16-17	53	24.00	6.60
	ages 17-19	47	26.40	5.30
	ages 20-24	114	27.50	5.20

Discussion and Conclusion

The test was administered only to males at Minnesota as a comparable sample of females (foreign students) was not available. In Rajshahi group there were only 13 females (1 in Honours, 2 in previous & 10 in Final) as against 63 males. The females constituted a very small portion of the sample and so any conclusion or generalization based on this small portion of the sample may be misleading. Hence, the females have not been treated separately.

A glance at the results shows that the means of the present study are much below the means of the American and the European populations and the differences obviously seem to be statistically significant. It is hard to make any generalization here on the basis of this study as it is found that the foreign students at the University of Minnesota are competing with the American students at M. A. and Ph. D. levels. Low score on D 48, therefore, does not indicate low level of intelligence. The universality and validity of the test may, thus, be suspected.

A number of factors may be suggested as the plausible reasons of low scores obtained by foreign (Asian) students. In the first place it may be that these students are not familiar with the game of domino, which goes against the basic assumption of the authors of the test.

Secondly, it is difficult to say that Asian students are test-minded. There are very few, if any, such tests in Asia. The Asian students rarely come across such tests. They should not, therefore, be expected to have developed test-taking attitudes. But the European and most American students on the contrary, are exposed to such tests right from the primary stages. This difference in attitudes may have to do something with the test scores.

Thirdly, factor of speed also seems to have played a role. There was a general complaint from the Asian students that they did not have sufficient time to attempt all the items. Hardly any student was able to have attempted all the items. It is an assumption of the writer that the American students seem to have faster speed. The test manual and the available literature do not say anything regarding whether the American and the European students were able to attempt all the items of the test within the specified time limit. Hence, further investigations are needed to be undertaken in this field in order that the validity of the assumption is tested.

The mean of Minnesota group (foreign students) was 25.70 while that of Rajshahi group was 17.97. This difference of means of Minnesota and Rajshahi was significant at 0.001 level. This is not very unexpected. A number of factors seem to have contributed here. Majority of the foreign students in the present study were from the sub-continent. The foreign students studying at the United States are a highly selected group. They represent the top few percents of their countries with respect to education and socio-economic factors. They are so to say, the cream of students of their countries. This is perhaps also true of the rest few foreign students coming from other Asian countries. While on the other hand, Rajshahi students are not so highly selected. They represent the general average population who have the opportunities of attending colleges and universities. It, therefore, seems quite logical that the group of foreign students have a higher mean significantly different from Rajshahi group. But this discussion does not in any way prove the universality of D 48 test.

The process of test administration is an important factor and has definite bearing on test scores obtained. It is assumed that the test was administered in both cases strictly according to the test manual and the time limit was observed. The results obtained also warrant the universality of the test.

Suggestions for Further Study

No generalizations could be made from the present study because of smaller samples. The sample should be random and the test should be given to as large samples as can be available and manipulated.

It will be interesting to investigate if students of a particular discipline score significantly better than others. The test should be repeatedly given over time to determine the reliability of the test.

As no studies are available on D 48 from Asian countries, more and more studies should be conducted for the purpose of establishing norms for various groups with respect to age and educational levels. These studies will go a long way in indicating if the Asian students have trends different from those of American and European populations. This will also confirm or question the universality of culture-fairness of the test.

The authors of the test claim that the game of domino is a fairly common and universal game. On this assumption, bases the universality of the test. It is also interesting to find out how common the game of

domino is in Asian countries. Again if in the same country closer familiarity with the game of domino give higher scores.

References :

Anastasi, A. *Differential Psychology.* New York : Macmillan, 1964.

Anastasi, A. Psychological Testing (2nd Edition). New York ; Macmillan, 1964.

Black, J. D. *Preliminary Manual : The D 48 Test.* Palo Alto, Calif, : Consulting Psychologists Press Inc.

Domino, G. "Comparison of the D 48, Cattell Culture-Fair, and Army Beta Test in a sample of College Males," *Journal of Consulting Psychol., Vol. 28 No. 5, 1964.*

Gough, G. H. & Domino, G. : "The D 48 Test as a Measure of General Ability Among Grade School Children" *Jaurnal of Consulting Psychol., Vol. 27 No. 4, 1963.*

Gourevitch, V. Statistical Methods: A Problem Solving Approach. Boston : Allyn Bacon, Inc. 1965.

Lindley, Marcia. "*Comparison of the D 48, Progressive Matrices 1938 and Army General Classification Test in a Male Psychiatric Population*"

Spearman, C. "The Abilities of Man" in Jenkin, J. J. and Paterson, D. G. *Studies in Individual Differences* : New York : Appleton-Century-Crofts, Inc. *1961.*

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