DOCUMENT RESUME

ED 063 328 TM 001 345

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TITLE Methodological Variables in the Study of Field Dependent Behavior of Young Children.
PUB DATE Apr 72
NOTE 15p.; Paper presented at the annual meeting of the American Educational Research Association (Chicago, Illinois, April 1972)

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Age Differences; Analysis of Variance; *Comparative Analysis; Correlation; Educational Research; Elementary School Students; Individual Tests; *Intelligence; Intelligence Differences; Intelligence Tests; Performance Tests; *Sex Differences; *Test Reliability; Test Validity
IDENTIFIERS Lorge Thorndike Intelligence Test; *Rod and Frame Test

ABSTRACT

The rod and frame performance of 70 children, 5 to 7 years of age, with respect to sex and age differences, reliability, and its relationship to general intelligence, was investigated. The rod and frame test was administered individually and again following a period of 35 to 69 days, at which time the Lorge Thorndike Intelligence Test, form 1A, was also administered to groups of 4 to 5 children. Distributions, means and standard deviations of both rod and frame and intelligence data were computed. Results of the study showed the following: (1) There were significant differences found on the age factor; the difference between 5 and 6 and between 5 and 7 year olds was significant. The indication is that older subjects are more accurate than younger subjects; (2) There was a significant difference between the sexes with males performing more accurately than females; (3) The data indicate a good deal of internal consistency within the performance of subjects on both rod and frame tests. The data on the stability of performance was less impressive; and (4) It appears that there is a relationship between rod and frame performance and intelligence; however, the correlation is not of very great magnitude. (DB)

METHODOLOGICAL VARIABLES IN THE STUDY OF FIELD DEPENDENT BEHAVIOR OF YOUNG CHILDREN

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Paper Presented

American Educational Research Association Meeting

Chicago, Illinois

April 4, 1972

Problem

The field dependence construct postulated by Witkin and others (1954, 1962) has stimulated a great deal of systematic research. In a recent review (Klein, Barr, and Wolitzky, 1967), this construct was characterized as one of "the most systematic applications of the cognitive-control approach and certainly one of the most influential on research (p.508)." The Witkin studies have described two basic perceptual styles, field independence and field dependence, and have utilized the rod and frame test as well as other instruments to measure the styles. The rod and frame test requires a S to set a rod in the upright position despite the distracting influence of field stimuli (a tilted frame). An individual whose perception of a stimulus was influenced by the organization of the field was field dependent (one who made an inaccurate setting); an individual perceiving parts of the field as discrete from the background (one who made an accurate setting) was termed field independent.

The field dependence construct appears to have potential for research on the behavior of young Ss in an educational environment. Research with adults and older children has investigated the relationship of field dependence to a variety of learning, personality and social variables.

The study of this variable in educational research has been limited by the fact that the principal instrument employed in its study, the rod and frame test, has not been employed extensively with a population of young Ss. There is very little information available dealing with basic methodological questions concerning its research use with Ss below 8 years. The present study attempts to deal with some of these problems.

There is an increase in field independence (greater accuracy of perception) with age, beginning at age 8 (Witkin, Goodenough and Karp, 1967). The same investigators found generally consistent sex differences, with females more field dependent than males. However, Busch (1970) did not find sex differences in the performance of 5 year old disadvantaged children. The present study investigated age and sex differences in performance of children 5,6, and 7 years of age.

There is also little evidence available concerning the internal consistency and stability of this performance for children, ages 5 to 7 years.

Busch and DeRidder (1971) have suggested that the correlation between rod and frame performance and general intelligence of 5 year old Head Start Ss was low and non-significant. These findings required verification with another sample of different age and socioeconomic background.

The present study investigated the rod and frame performance of Ss 5 to 7 years with respect to sex and age differences, reliability, and its relationship to general intelligence. The study attempted to provide basic methodological data as a basis for further research with young Ss.

Method

Subjects

Ss were 15 five year old, 30 six year old and 25 seven year old male and female pupils in the kindergarten and first grade of a suburban North Carolina school.

Procedure

Ss were administered the rod and frame individually during the Spring of 1971. Following a period of 35 to 69 days, the rod and frame was readministered as well as the Lorge Thorndike Intelligence Test, form 1A (1957). Because of the time required to administer the rod and frame, it was planned to re-administer the second rod and frame a constant period of time after the initial administration for each of the Ss. School schedules, teacher priorities, etc., prevented this and the period of time between the first and second administrations for individual Ss varied between one and two months. For this reason, reliability (stability) coefficients are reported for three separate, relatively homogeneous, test-retest time periods.

The Lorge Thorndike Intelligence Test was administered to groups of 4-5 children; subparts of the test were given over several sessions because of the age of the children and to minimize fatigue.

A portable rod and frame apparatus (model PR-20, Research Media Inc., Syosset, N.Y.) was employed. This apparatus consisted of a frame (19 X 19 cm) within which was mounted a rod (18.3 cm) both painted on a black background. When observed in the dark, ultra-violet lamps excited the paint and only the rod and frame were visible. Both rod and frame could be rotated independently about a central axis. The apparatus permitted E to sit and read the deviation of both rod and frame from the perpendicular position in degrees.

S sat two feet from, and at eye level with the apparatus, and was able to move the rod with a knob mounted on the face of the apparatus.

A standard procedure was employed to train S on the task: First in a lighted condition with the frame side perpendicular to the ground, E demonstrated perpendicular settings of the rod to the ground by rotating the rod to the desired position. Second, while E moved the rod, S verbally directed E to stop when the rod was perpendicular. When this was performed satisfactorily, E moved the rod 20° off perpendicular and requested S to manually reset the rod to the perpendicular position. If S failed (tolerenace $\pm$ 2°) at any of these steps, the previous training step was repeated. Following this, the same procedures were repeated in a completely darkened condition. Data collection began after satisfactory performance. All verbal behavior by E was specified in advance for the training and data collection procedures in order to reduce possibility of accidental shaping of behavior.

During data collection, frame was tilted at 20° from perpendicular for five trials from the left side and five from the right side. Initial side of frame setting was alternated for each S. The deviation of the rod from upright was recorded for ten trials. Mean total deviations, mean odd and even deviations and IQ scores for each S were computed.

Analysis of Data

Distributions, means and standard deviations of both rod and frame and intelligence data were computed. Data from the two rod and frame administrations were subjected to a 3 (age) X 2 (sex) X 2 (administrations) analysis of variance with repeated measures on the third factor. There were unequal Ns in the cells and an unweighted means analysis was performed.

Because there were unequal $\underline{N}$s and because the rod and frame scores were skewed , there was concern that the data would not meet the assumptions underlying the analysis of variance procedure. Inspection of the form of the distributions indicated that they were homogeneous . Because of the unequal number of cases, it was considered necessary to test for homogeneity of variance with Cochran's test. This test indicated that the assumption regarding homogeneity of variance was met. Kirk (1968) also reports that this test is also sensitive to departures from normality. It was concluded that the test would be robust in relation to the data of the present study.

To assess the reliability of performance, the Spearman rank correlation between mean odd and mean even rod and frame scores for each administration were computed; rank correlations between the mean total scores of the two administrations were computed; rank correlations between the two mean total rod and frame scores and the intelligence test scores were also determined. They are reported for the total group and separately for age groups. Also, stability coefficients are reported for three separate time intervals between testings on the rod and frame test.

Results

The intelligence test scores were approximately normal in distribution; the rod and frame scores on the other hand were skewed. Means and standard deviations of these measures are given in Table 2 and Table 3.

Age, Sex and Administration Differences

The analysis of variance data are presented in Table 1. There were significant differences found on the age factor. The difference between

5 and 6 year olds was significant, and between 5 and 7 year olds, however, the difference between six and seven year olds failed to reach the critical level for significance. The results indicated that older Ss are more accurate (received smaller mean deviation scores) than younger Ss. Also there was a significant difference ($p < .10$) between the sexes with males performing more accurately than females. There were no differences between the first and second performances on the rod and frame, for the group.

Reliability

Split-half reliability coefficients are reported in Table 2. It may be seen that a high degree of internal consistency exists within the performance of Ss on both occasions when the rod and frame was administered. As might be expected, the coefficients for the youngest group were slightly lower, especially for the second RFT. On the whole, however, the data indicate a good deal of internal consistency.

The data on the stability of performance on the rod and frame over time is less impressive. Stability coefficients are reported in Table 3. When test-retest correlations were computed separately on the total group and three age groups without respect to specific time intervals, the coefficients are of moderate level and, as expected, lower than internal consistency estimates. When the test-retest time interval is examined and coefficients are reported for three somewhat more homogeneous time periods, it appears that the greatest correlation exists when the period is shortest and is somewhat less at the two, longer test-retest intervals. This also was an expected occurance. When specified time intervals are examined for each of the three age groups, the resulting stability coefficients range between .43 and .72. The stability coefficients for six year olds are generally higher than those of both the five and seven year olds. While these may not be significant differences, one would normally expect to find higher reliability estimates for the older (7 year) group.

Relationship with Intelligence

Previous research had indicated that the correlation between verbal intelligence and rod and frame performance of 5 year olds was low and nonsignificant. The results in the present set of data are not as clear-cut. The correlations were negative, i.e., brighter children obtained smaller mean deviation scores. The correlation for the total group was significant for both administrations of the rod and frame; however, it was low and indicated only a slight degree of common variation between the two variables. While there is a moderate degree of relationship between the first rod and frame and intelligence scores for the five and seven year groups, it is not consistent with the low and non significant coefficients for the second rod and frame administration. Two out of the six coefficients (excluding those for the total group) were significant. It might be postulated that there is a relationship between rod and frame performance and intelligence that is greater than a chance relationship, however, the correlation is not of very great magnitude. Data are presented in Table 3.

Discussion

Previous research had indicated that there was a progressive increase in accuracy in judging the upright position, i. e., performance became relatively more field independent with increased age. The results of the present study serve to support this assertion for Ss in a lower age range. While one of the individual comparisons between age groups failed to reach the specified level of significance, the other individual comparisons as well as the overall F and mean values for individual age groups follow in the predicted direction. It may be concluded that rod and frame behavior follows a developmental function even for very young children.

The results regarding sex differences are somewhat less conclusive. There were overall mean differences between males and female Ss. Previous research (Witkin et al., 1967) with cross sectional groups found significant sex differences for Ss age eight years and older, while other research (Busch, 1970) found no sex differences for Ss, age five years and older. This suggested that an interaction between sex and age might be postulated with sex differences being related to the age of S. The present study found overall sex differences to be significant at what apparently was a marginal level ($p. < .10$) and no evidence of an interaction. Witkin et al. (1967), found differences significant at the .05 and .01 levels of confidence. It became apparent that the magnitude of treatment (sex differences) effects had to be examined. The difference in level of significance was found to be more apparent than real when η^2 was computed for the previously cited and the present study. Cohen (1965) suggests η^2 as a post-test measure of the magnitude of treatment effects. This statistic provides information on the proportion of the total sum of squares in the dependent variable that is associated with the independent variable. The Witkin studies had value of η^2 equal to .08 and .09 (with $p < .05$, and $p < .01$) which suggests a low degree of association but which are significant because of the power of the statistical test. The present study with $p < .10$ had $\eta^2 = .05$. While there appears to be reliable sex differences in rod and frame performance, they are not of great magnitude. Moreover, there does not appear to be a change toward greater sex differences with increased age through the range five to seven years. The lack of significant sex differences for five year old Ss of the Busch (1970) study is a function of marginal differences not being detected in a statistical test with minimal power.

The data provided by rod and frame performance appear to be quite consistent when single administration data (split-half) are utilized. The researcher interested in identifying extremes in performance would be relatively safe in utilizing extreme scores to characterize the most field-independent and field-dependent subjects and would have little concern about error. For example, if Pearson Product Moment r's were computed and utilized to calculate a standard error of measurement, the values would be relatively low; that is, they would be low enough to distinguish between subjects falling at both ends of the continuum.

If on the other hand, the researcher required the estimate of the characteristic (rod and frame performance) to be relatively stable across time while further experimental manipulation and investigation was to take place, he would have less confidence. The stability coefficients reported in Table 3 are only of a moderate level and suggest that rod and frame performance at least for young Ss is variable over time. Test-retest reliability coefficients reported for eight year old Ss (Witkin et al., 1967) are +.48 (females) and +.76 (males). The test-retest interval, however, in that instance was much longer (5 years) than that utilized in the present study. It is apparent that the stability of performance is less satisfactory than it is for older Ss. One would expect lower reliability estimates with younger children. For example, test-retest coefficients for the WPPSI (Wechsler, 1963) subtests vary between .60 and .93 with a median of .69 when a time interval slightly longer ($\bar{X}$= 11 weeks) than that of the present study, was utilized. The split-half reliability coefficients of the WPPSI and rod and frame were quite comparable.

One source of error is present in the experimental design of the present study. Ideally, the time interval should be constant for all subjects so that the effects for length of time are constant for all individuals. In the present study not only were the dates at which tests were administered different for individual Ss, but the time interval varied for individual subjects. Even with the artificial manipulation that involved grouping data into three separate time intervals, the time variable was not constant. The extent to which this source of error had effected the stability coefficients was unknown and could not be determined from the present data.

The correlation observed between rod and frame performance and intelligence is probably not great enough to warrant concern by researchers that the rod and frame construct is not sufficiently distinct from general intelligence. The common variation between the variables lies between six and seven percent. Utilizing intelligence as a control through either blocking or the use of covariance would not be an especially efficient procedure since the regression of intelligence on rod and frame performance is not particularly strong.

It is important to note that the paucity of research utilizing the rod and frame performance of young Ss leaves in doubt specifically what this construct represents. The present study indicated some similarity in field dependent behavior of young Ss to what is known about older subjects. Further validation of the rod and frame as an instrument and further definition of the construct will be necessary.

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Table 1

Analysis of Variance of Age, Sex and Test Administration Differences In Rod and Frame Performance

Source	df	MS	F
Between Ss			
Age	2	273.66	5.78**
Sex	1	149.70	3.16*
Age X Sex	2	.16	<1.00
Subjects w/i Groups	64	47.31	
Within Ss			
Administrations	1	.21	<1.00
Age X Administrations	2	57.62	2.24
Sex X Administrations	1	3.51	<1.00
Age X Sex X Administrations	2	5.22	<1.00
Administrations X Subjects W/i Groups	64	25.77	

* $p<.10$

** $p<.01$

Table 2

Split-Half Reliability Coefficients [a] for Two Rod and Frame (RFT) Administrations

Age Group	RFT I				RFT II			
	N	$\bar{X}$	S	ρ	N	$\bar{X}$	S	ρ
5 years	15	12.37	13.41	+.95**	15	15.14	4.64	+.85**
6 years	30	10.24	5.63	+.95**	30	9.34	6.18	+.97**
7 years	25	9.56	5.13	+.98**	25	7.96	5.03	+.97**
Total	70	10.45	5.46	+.97**	70	10.09	6.11	+.96**

a Spearman Rank Correlation Coefficients
** $p < .01$

Table 3

Stability Coefficients[a] of Rod and Frame Performance and Correlation with Intelligence

Age Group	Stability Coefficients. By Test-Retest Interval				Correlation with Intelligence			
	1[b]	2[c]	3[d]	Without Regard To Time Interval	$\bar{X}_{IQ}$	s_{IQ}	$\rho_{RFT\ I}$	$\rho_{RFT\ II}$
5	N/D	N/D	+.48*	+.48*	96.93	17.02	-.51*	-.26
6	+.72*	+.49	+.72**	+.61**	98.50	11.87	-.14	-.29
7	+.56*	+.43	N/D	+.50*	98.08	13.53	-.41*	-.17
Total Group	+.60**	+.46*	+.50**	+.57**	98.01	13.72	-.27*	-.25*

a Spearman Rank Coefficients
b Time Interval: $\bar{X}$=40.5 days; s= 4.0; N=26
c Time Interval: $\bar{X}$=51.4 days; s=1.5; N=18
d Time Interval: $\bar{X}$= 63.1 days; s=2.9; N=26
N/D= no data
* $p < .05$
** $p < .01$