SOCIAL BEHAVIOR AND PERSONALITY, 1979, 7(2), 179-184

DOI 10.2224/sbp.1979.7.2.179

PERFORMANCE COMPONENTS OF FIELD-DEPENDENCE MEASURES AND THE APPLICATION OF MULTIVARIATE PROCEDURES

ROBERT LOO
University of Calgary

Components underlying performance on field-dependence measures were examined. On the basis of these components and of the relationships between field-dependence measures and intelligence tests, it was suggested that field-dependence measures form 2 somewhat distinct clusters: embedded-figures and adjustment tests. It was noted that embedded-figures tests are related to intelligence, whereas adjustment tests are independent of intelligence. It was recommended that comprehensive rather than limited studies be conducted with an emphasis on the application of multivariate techniques to the understanding of the field-dependence dimension and especially in the study of its developmental and cross-cultural aspects.

Keywords: field-dependence measures, multivariate measures, performance components.

The work of Witkin et al. (1954) on the dimension of perceptual field-dependence-independence stimulated much research over the years. Such research focused mainly on relating field dependence to a wide variety of behaviors, personality and cognitive dimensions, and pathological syndromes. However, several researchers (e.g., Arbuthnot, 1972; Vernon, 1972; Wachtel, 1972) expressed concern over the validity of some claims made by Witkin and over the methodology used in many studies in this area. In spite of such criticisms and cautionary notes, research on field dependence is thriving, and apparently much of this research is done either in ignorance of or in disregard for such cautionary information. The aims in this paper are (a) to consider possible components or factors which underly performance in various measures of field dependence and suggest a grouping of these measures into two clusters, and (b) to recommend the use of multivariate and multiple regression techniques, possibly in a hierarchical approach, to the study of field dependence and the study of its relationships to other dimensions, especially in cross-cultural, developmental, and sex-differences studies.

It has been suggested that, on the basis of determinants of performance, typical measures of field dependence can be clustered into two groups, embedded-figures tests and adjustment tests such as the Rod-and-Frame Test. This position differs from that of Witkin, who would claim that these tests have high convergent validity in the measurement of the construct field dependence.

Perhaps the earliest evidence for the two-clusters position espoused in the present paper can be found in Goodenough and Karp's (1961) factor-analytic study. Although they were concerned with the relationship between field dependence and intellect-

Correspondence and reprint requests should be addressed to: Robert Lao, Bell-Northern Research, P.O. Box 3511, Station C, Ottawa, Canada KJY 4 H7.

ual functioning, their results can be interpreted to suggest that the various field-dependence variables they used do not clearly identify a homogeneous clustering of field-dependence measures. They performed two oblique factor analyses, one on data from a group of 25 boys and 25 girls (Group A) and the other on data from a group of 30 boys (Group B). Factor loadings in the solution for Group A showed that no one factor identified all eight field-dependence variables. However, loadings for the even smaller Group B showed that Factor III identified all five field-dependence variables used with that group. In both oblique solutions, each of the various field-dependence variables typically loaded on more than one factor. Unfortunately, the authors did not report the correlations among the primary factors or second-order analyses. Obviously, oblique primaries indicated that higher-order analyses should have been performed, and if they had been, then the results might have been more meaningful both for their purposes and for those of the present paper.

A second more comprehensive and direct source of evidence for the position is found in Vernon's (1972) large-scale factor-analytic study with adolescents. First, his two Rod-and-Frame Test scores intercorrelated higher (0.63) than the two scores did with Embedded-Figures Test scores (0.32, 0.40); and, secondly, Vernon found that when general intelligence was partialed out of all correlations, only the intercorrelation between the two Rod-and-Frame Test scores remained significant (0.53), while the remainder of the correlations, including those between the two Rod-and-Frame Test scores and the Embedded-Figures Test scores (0.15, 0.18), became non-significant. These points suggest that performance on the Rod-and-Frame Test is essentially independent of intelligence, whereas performance on the Embedded-Figures Test is highly related to intelligence level.

Finally, Arbuthnot (1972) reviewed 40 studies which reported correlations among various field-dependence measures. He noted that the mean correlation between performance on the Rod-and-Frame Test and the 24-item Embedded-Figures Test from 21 correlations was 0.54, and between the Rod-and-Frame Test and the 12-item Embedded-Figures Test from 9 correlations was 0.37. The magnitude of the correlations indicated the low common variance shared by these two clusters of measures and thus the lack of convergent validity.

Components Underlying Performance in Embedded-Figures and Adjustment Tests

Several possible components or factors affecting performance on field-dependence tests may be extracted to explain the low covariation between tests in the two clusters, embedded-figures and adjustment tests, and the high covariation within clusters. There seem to be components required for the solving of embedded-figures tests but not for adjustment tests and vice versa.

One distinction between the various embedded-figures and adjustment tests such as the Rod-and-Frame Test, the portable Rod-and-Frame Test, and the Tilting-Room-Tilting-Chair Test, Room-Adjustment Test is the requirement in the embedded-figures tests[1] to remember for at least a few seconds the given simple geometric form in order to find it when given the complex form. Secondly, a perceptual-motor component also

[1] Multiple-choice group-administered embedded-figures tests were excluded because they have been shown to be independent of other measures of field dependence (Arbuthnot, 1972).

underlies performance on embedded-figures tests in that the subject is required not only to remember a simple form but also to outline it within the complex form.

A third factor found only in embedded-figures tests is reversible-perspective items. Vojtisek and Magaro (1974) reported that psychiatric patients had greater difficulty solving items with reversible perspective than with other items on embedded-figures tests. On the other hand, Loo (1978) reported that normal females were at least as successful in solving reversible-perspective items as in solving the remaining items in both individual and group forms of the Embedded-Figures Test. However, he also found that when extreme groups were formed based on ease and difficulty of solving reversible-perspective items, greater difficulty was associated with greater sociability and more minor "psychiatric" complaints than was greater ease of solving such items.

Finally, the time restraints placed on solution time to items in embedded-figures tests also distinguish these tests from adjustment tests.

At least one factor or component is required in the adjustment tests but not in the embedded-figures tests. The adjustment tests require that a kinesthetic component be linked with the visuospatial component to achieve high accuracy in these test situations.

Having stressed the components required in one cluster of tests versus the other, the components required in the solution of both clusters of tests are itemized. As in all tests, an optimal level of motivation and arousal (e.g., Oltman, 1964) on the participants' part is necessary to achieve "best" performance. In addition, the pattern of eye movements is related to performance in both clusters of tests if visual stimuli are used. For example, Blowers and O'Connor (1978) found that with the Rod-and-Frame Test, field-independent participants, unlike field-dependent participants, showed large magnitude eye movements and high rates of eye movements.

Additional, although indirect, support for the eye-movements component is found in Baron's (1978) study which investigated the eye movements of 85 children during their television watching. She found that field-independent participants oriented to the target words faster, had more fixations on target, and had longer fixation durations than did field-dependent participants.

An extension of the research relating eye movements and field dependence to include eye tracking may prove fruitful. Recently, several groups of researchers (e.g., Holzman et al., 1976; Kuechenmeister et al., 1977) reported impaired eye tracking in various groups of psychotic patients. Essentially, such studies found that in a simple test of smooth-pursuit eye movements, a high proportion of psychotic patients showed impaired performance which was due to velocity arrests. Further investigation (e.g., Holzman et al., 1976) suggested that velocity arrests were due not to voluntary processes but to neurophysiological dysfuncdons probably located in the brain stem. However, Acker and Toone (1978) demonstrated that impaired eye tracking could be induced in normals by the addition of a distracting task. They concluded that contrary to previous research which stressed a neurophysiological deficit, superficial inattention or deficits in selective attention might account for the schizophrenics' poor performances. In any event, research in this area is very active and may prove very fruitful for many areas of psychology.

In addition to eye movements and eye tracking, lateral eye movements as studied in relation to information processing and hemispheric dominance (Huang & Byrne,

1978) may be of importance in the study of field dependence. Along the same lines, handedness and other laterality indicators are of significant interest in relating cortical organization to the field-dependence dimension (e.g., O'Connor & Shaw, 1978).

The comprehensive examination through multivariate and univariate techniques of the interrelationships involving eye movements, eye tracking, lateral eye movements, laterality, and field-dependence measures in various populations[2] might yield important information on the role of cortical and subcortical structures and processes in the field-dependence dimension.

Field-Dependence Measures and Intelligence

The controversy over the relationship between field dependence and intelligence is long-standing and unresolved. Findings from studies which examined the relationship tend to indicate that the relationship between scores on performance subtests (black design, object assembly, picture completion) from both the Wechsler Intelligence Scale for Children and the Wechsler Adult Intelligence Scale and field-dependence measures is carried by the embedded-figures tests and not the adjustment tests.

The rotated factor matrix for Group A reported by Goodenough and Karp (1961) showed that the Room-Adjustment Test and Body-Adjustment Test loaded highly on factors separate from subtests on the Wechsler Intelligence Scale for Children. In contrast, the rotated factor matrix for Group B showed that all the field-dependence tests and the three subtests, block design, object assembly, and picture completion, loaded on one factor.

Although the focus has been on relating field-dependence measures to performance subtests from intelligence scales, some researchers identified relationships between embedded-figures but not adjustment tests and verbal subtests. Two groups of researchers (Karp & Silberman, 1966; Riley & Denmark, 1974) found that with samples of black participants, performance on the children and adult forms of the Embedded-figures Test was related to performance on verbal subtests from Wechsler's intelligence scales. More recently, O'Leary et al. (1977) found that field dependence as measured by the group Embedded-Figures Test was related to several verbal and performance subtests on the Wechsler-Bellevue Intelligence Scale for both alcoholic and nonalcoholic groups of males. In contrast to these findings, Vernon (1972) noted that when intelligence was held constant the correlation between the two Rod-and-Frame Test scores was only slightly attenuated from 0.63 to 0.53, while the correlations between these two scores and the Embedded-Figures Test scores were reduced in magnitude by half to nonsignificant levels (0.15, 0.18).

Findings such as these suggest that performance on embedded-figures tests is highly related to performance on both performance and verbal intelligence tests. On the other hand, performance on adjustment tests such as the Rod-and-Frame Test is apparently only slightly related to performance on intelligence tests. The differing relationships between embedded-figures and adjustment tests indicate that critics who state that field dependence is highly related to or even the same as intelligence must qualify

[2]Samples of alcoholics should be included because of the wide interest in relating alcoholism, field dependence, and cognitive functioning (e.g., O'Leary et al., 1977).

their statement as applying to embedded-figures tests only (see Fine, 1973, Note 5).

The finding that performance on verbal subtests is related to performance on embedded-figures tests (O'Leary et al., 1977; Riley & Denmark, 1974), combined with the finding that sex differences exist in reported strategies for solving visuospatial tests, suggests a further component, verbal mediation, underlying performance on embedded-figures and possibly, too, adjustment tests. It is suggested that greater field independence as measured by embedded-figures tests may be due, in part, to the effective use of verbal mediation by participants in their problem-solving approach to test items. Loo and Townsend (1977) found that greater field independence, as measured by the group Embedded-Figures Test, was associated with lower impulsivity, specifically slower decision time. This finding provided indirect support for a possible verbal mediation component. Verbal mediation, a time-dependent and reflective behavior, would necessitate low impulsivity and slow decision times.

Future Directions

Given the number and variety of components underlying performance in the two clusters of tests, embedded-figures and adjustment tests, it is obvious that the understanding of the high-order construct field dependence and of its relationship to other cognitive, personality, and performance dimensions requires the execution of comprehensive rather than limited studies which simply conduct one-way analyses of variance or Pearson correlations. It is recommended that studies employ samples which adequately cover the range of possible scores on field-dependence measures, that multiple measures and scores of field dependence be used as within-subjects variables, and that multivariate and multiple regression techniques be considered.

The examination of the components underlying performance on field-dependence tests, and the relative importance of the components, may be achieved through canonical correlation,[3] factor, discriminant, and multiple regression analyses. Such analyses, or a combination of these within one study as in a hierarchical approach, may be conducted provided, of course, that the statistical techniques selected reflect the researcher's theoretical framework and the assumptions underlying the selected techniques are met. Three points regarding factor analyses are warranted. First, Skinner and Howarth (1973) found that in an R-technique factor analysis which used Q- and T-data, the principle of indifference of medium was not supported. Their finding suggests that factor-analytic solutions must be carefully examined when different kinds of data, for example, T-data such as field-dependence scores and Q-data such as personality scores, are used within one analysis. An alternative to the R-technique when such data are used may be canonical correlation analysis.

Secondly, the application potential of factor-analytic models to the study of change or specifically, in the present concern, to the study of the developmental aspects of field dependence has been ignored. The application of P-technique (see Cattell, 1973) deserves consideration, and certainly, too, the innovative work by Buss (e.g., Buss, 1974; Buss & Royce, 1975a). Thirdly, factor-analytic techniques provide

[3]The relationships among the various statistical procedures under the general linear model should be noted so that the similarities and not just the differences are seen among these statistical procedures (see Knapp, 1978).

valuable tools for detecting factors common across cultural groups and factors unique within cultural groups (see Buss & Royce, 1975b).

REFERENCES

Acker, W., & Toone, B. (1978). Attention, eye tracking and schizophrenia. British Journal of Social and Clinical Psychology, 17, 173-181.

Allen, M. J. (1974). Sex differences in spatial problem-solving styles. Perceptual and Motor Skills, 39, 843-846.

Arbuthnot, J. (1972). Cautionary note on measurement of field independence. Perceptual and Motor Skills, 35, 479-488.

Baron, L. J. (1978, June). *Relating eye movements to reading proficiency, field articulation, and stimulus mode.* Paper presented at the meeting of the Canadian Psychological Association, Ottawa, Canada.

Blowers, G. H., & O'Connor, K. P. (1978). Relations of eye movements to errors on the rod-and-frame test. Perceptual and Motor Skills, 46, 719-725.

Buss, A. R. (1974). A recursive-nonrecursive factor model and developmental causal networks. Human Development, 17, 139-151.

Buss, A. R., & Royce, J. (1975a). Ontogenetic changes in cognitive structure from a multivariate perspective. Developmental Psychology, 11, 87-101.

Buss, A. R., & Royce, J. (1975b). Detecting cross-cultural commonalities and differences: Intergroup factor analysis. Psychological Bulletin, 82, 128-136.

Cattell, R. B. (1973). Personality and mood by questionnaire. San Francisco, CA: Jossey-Bass.

Fine, B. J. (1973). Field-dependence-independence as "sensitivity" of the nervous system: Supportive evidence with color and weight discrimination. Perceptual and Motor Skills, 37, 287-295.

Goodenough, D. R., & Karp, S. A. (1961). Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 63, 241-246.

Holzman, P. S., Levy, D. L., & Proctor, L. R. (1976). Smooth pursuit eye movements, attention, and schizophrenia. Archives of General Psychiatry, 33, 1415-1420.

Huang, M., & Byrne, B. (1978). Cognitive style and lateral eye movements. British Journal of Psychology, 69, 85-90.

Karp, S. A., & Silberman, L. (1966). Field dependence, body sophistication, and socioeconomic status. Research Reports: Sinai Hospital, Baltimore, 1, 1-9.

Knapp, T. R. (1978). Canonical correlation analysis: A general parametric significance-testing system. Psychological Bulletin, 85, 410-416.

Kuechenmeister, C. A., Linton, P. H., Mueller, T. V., & White, H. B. (1977). Eye tracking in relation to age, sex, and illness. Archives of General Psychiatry, 34, 578-579.

Loo, R. (1978). Personality dimensions and reversible perspective in embedded figures test. Perceptual and Motor Skills, 46, 1016-1018.

Loo, R., & Townsend, P. (1977). Components underlying the relation between field dependence and extraversion. Perceptual and Motor Skills, 45, 528-530.

O'Connor, K., & Shaw, I. C. (1978). Field dependence, laterality and the EEG. Biological Psychology, 6, 93-109.

O'Leary, M. R., Donovan, D. M., & Chaney, E. F. (1977). The relationship of perceptual field orientation to measures of cognitive functioning and current adaptive abilities in alcoholics and nonalcoholics. Journal of Nervous and Mental Disease, 165, 275-282.

Oltman, P. K. (1964). Field dependence and arousal. Perceptual and Motor Skills, 19, 441.

Riley, R. T., & Denmark, F. L., (1974). Field dependence and measures of intelligence: Some reconsiderations. Social Behavior and Personality: An international journal, 2, 25-29.

Skinner, N. F., & Howarth, E. (1973). Cross-media independence of questionnaire and objective-test personality factors. Multivariate Behavioral Research, 8, 23-40.

Vernon, P. E. (1972). The distinctiveness of field independence. Journal of Personality, 40, 366-391.

Vojtisek, J., & Magaro, P. (1974). The two factors present in the embedded figures test and a suggested short form for hospitalized psychiatric patients. Journal of Consulting and Clinical Psychology, 42, 554-558.

Wachtel, P. L. (1972). Field dependence and psychological differentiation: Reexamination. Perceptual and Motor Skills, 35, 179-189.

Witkin, H. A., Lewis, H. B., Hetzman, M., Machover, K., Meissner, P. B., & Wapner, S. (1954). Personality through perception. New York: Harper.