ESTIMATION AND TESTING OF POCKET MEANS USING MULTIPLE LINEAR REGRESSION TECHNIQUES

by

George P. McCabe, Jr. and Sharron A. McCabe
Purdue University

Department of Statistics
Division of Mathematical Sciences
Mimeograph Series #502

August 1977

ESTIMATION AND TESTING OF POCKET MEANS USING MULTIPLE LINEAR REGRESSION TECHNIQUES

George P. McCabe, Jr. and Sharron A. McCabe

Purdue University

Key words: Regression, Multiple comparisons

ABSTRACT

The problem of predicting a continuous criterion variable from two continuous predictors is considered. Stratification on the predictors is one common procedure for construction of subgroups which are easily labeled and discussed. Through the appropriate use of regression techniques, data can be used more efficiently and inferences regarding carefully selected subpopulations, called pockets, can be made. An example using cognitive styles to predict performance on problem solving tasks is discussed.

INTRODUCTION

In educational research, one frequently encounters the following type of problem: relate a criterion variable Y to two predictor variables X_1 and X_2. If X_1 and X_2 are dichotomous variables, analysis of variance techniques are commonly used. Of course, if the numbers of observations for each of the (X_1,X_2) possibilities are widely disparate, particular care must be exercised in choosing the appropriate form for the unbalanced anova. Generally, the results of such an analysis are readily interpretable. One can discuss estimated means and comparisons among the four groups.

In contrast, consider the complications which arise when X_1 and X_2 are continuous. One common practice is to dichotomize the predictor variables and proceed with the analysis of variance as described above. Occasionally, cases corresponding to central values of X_1 and X_2 are discarded. Some aspects of this problem have been studied by McCabe (1977). A significant advantage of this approach is that the results can be interpreted in terms of four groups. On the other hand, technical difficulties with the underlying model for this type of analysis are substantial. In most cases, some sort of regression model with the original X_1 and X_2 would be much more tenable.

There are no particular difficulties with using regression methods to construct a model for predicting Y from X_1 and X_2. Quadratic terms, cross product terms, etc. in X_1 and X_2 can be added to build a model which fits the data reasonably well. If necessary, transformations can be applied. The regression approach is theoretically attractive since the fine structure of the data (rather than dichotomized values) is used and the assumptions are more reasonable than those underlying the anova approach. One disadvantage with this approach is that results can be exceedingly difficult to interpret.

While the resulting model might predict well, it may not lead the educational researcher to clear conclusions. Rather, when results emerge from a collection of highly correlated regression coefficients estimates, clear statements concerning the effects of each predictor variable and interactions are often elusive.

It appears then, that the educational researcher must choose either an analysis based on an incorrect model which makes inefficient use of the data but gives meaningful results or one which is based on sounder assumptions but does not directly provide meaningful results. In this paper, an attempt is made to reconcile these two approaches. A procedure is proposed for translating the results of a regression analysis into statements about means and differences between means for particular subgroups, which we call pockets. This procedure is applied to data from a study in which two cognitive style measures were used to predict performance on three separate problem solving tasks.

PROBLEM BACKGROUND

The procedure described in this paper was developed to analyze part of the data from a large study (McCabe, 1976). Relevant aspects of that study are described below.

The predictor variables used were cognitive style measures. The dependent variables were problem solving tasks, namely verbal fluency, syllogistic reasoning and concept identification (French, Ekstrom and Price, 1963).

COGNITIVE STYLES

Cognitive styles are adaptive controls which affect cognitive processes and lead to adaptive solutions (Gardner, Holzman, Klein, Linton & Spence, 1959).

Several particular cognitive styles have been identified (Kogan, 1971) and are presumed to coexist within the personality (Gardner, Jackson & Messick, 1960). Research suggests that the combined effects of two or more cognitive styles might better differentiate among persons than the effect of a singular cognitive style (Gardner, et al., 1960). Two cognitive styles were examined as predictor variables for this research. These styles are labelled field-dependence and breadth of categorization.

Field-dependence refers to individual differences in tendency to overcome the influence of conflicting perceptual cues. There are numerous indications that field-dependence level has wide implications for cognitive task performance in females (Barratt, 1955; Ehri & Muzio, 1974; Kogan & Wallach, 1964; Fitzgibbons, Goldberger & Eagle, 1965). For the data reported herein, the Group Embedded Figures Test (Witkin, Oltman, Raskin & Karp, 1971) - a measure which distinguishes field-dependent from field-independent subjects, was used.

Breadth of categorization indicates a style continuum,which encompasses personal preferences for dealing with relatively narrow, exclusive conceptual realms (categories), through preferences for relatively broad, inclusive categories. Aside from the time consuming object sorting tasks, the most widely used measure of breadth of categorization is the Estimation Questionnaire, henceforth denoted EQ (Pettigrew, 1958). Since the EQ is based upon quantitative content, it has been suggested that this measure is biased against females (Sherman, 1967). Such an argument is based upon the relative unfamiliarity of female subjects with quantitative content, and is supported by evidence that subjects tend to be broader in areas which they judge as personally relevant (Glixman & Wolfe, 1967). This particular objection to use of the Estimation Questionnaire could not be raised in connection with another breadth of categorization measure, namely the Synonymity Task (Fillenbaum, 1959), henceforth denoted ST, since the ST is based upon semantic content. Although the ST is listed along with the EQ, as a breadth of categorization measure, the degree of their relationship is a pertinent consideration. The study from which the current data is derived examined performance differences among subjects when breadth of categorization was defined by either the EQ or the ST.

COGNITIVE STYLE POCKETS

Four cognitive style pockets, each defined by a preselected level of field-dependence and breadth of categorization, were examined in relation to their performance on the three problem tasks. Each of the four pockets is denoted by one of the following combinations of the two cognitive styles:

FIBC (field-independent and broad categorizer)

FINC (field-independent and narrow categorizer)

FDBC (field-dependent and broad categorizer)

FDNC (field-dependent and narrow categorizer)

The question was asked: Do different pockets have significantly different dependent variable means? For each problem task, comparisons are made among the pockets.

METHOD

One hundred and six female undergraduates, participated in the study for credit in an Introductory Psychology course. All subjects were tested together by a female experimenter during one evening session. Each task was a paper-and-pencil type, group administered. Since the data analyzed herein is part of a larger study involving test anxiety, tasks were administered under a particular type of preperformance instruction (Sarason, 1972) and a concealed stop watch was used for strictly timed tasks.

THE PROCEDURE

Application of regression analysis techniques to produce meaningful statements about the prediction of Y from X_1 and X_2 involves four steps. First a regression equation which fits the data well must be constructed. Second, appropriate definitions of pockets must be determined. Finally, pocket means are estimated and tests for making comparisons among these means are performed.

CONSTRUCTION OF THE REGRESSION EQUATION

Construction of a regression model which fits the data well is the crucial first step in the proposed procedure. An inappropriate equation is likely to result in, at best, misleading statements about pocket means.

Sophisticated computer programs are no substitute for careful human judgement at this stage. Step-type regression procedures are inappropriate here. Residual plots and transformations are potentially useful tools. A thorough discussion of how to construct regression models is given in Draper and Smith (1966) and Neter and Wasserman (1974).

In general, one should take a rather liberal attitude with regard to inclusion of variables. Hence, marginal terms should be included in the equation and only those which are clearly insignificant should be discarded. The estimation of and comparisons made among subpopulation means (which is the point of this analysis) will not be seriously affected by the inclusion of a useless term or two but deletion of a potentially important term may have serious consequences.

A model with all terms up to order two has worked well with the examples considered. For convenience, this model, i.e.

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{1i}^2 + \beta_4 X_{2i}^2 + \beta_5 X_{1i} X_{2i} + \varepsilon_i \quad (1)$$

will be used in the subsequent discussion. Models of the general form

$$Y_i = \beta_0 + \Sigma\beta_j Z_{ji} + \varepsilon_i \quad (2)$$

where each Z_j is a known function of X_1 and X_2 are treated in an analogous fashion.

DEFINITIONS OF POCKETS

Four pockets are defined, corresponding to the combinations resulting from considering high and low values for each of the predictor variables X_1 and X_2. In the example used to illustrate this procedure, the pockets are denoted FIBC, FINC, FDBC and FDNC where FI, FD, BC and NC are abbreviations for field independent, field dependent, broad categorizer and narrow categorizer, respectively. For notational convenience in the following section, HH, HL, LH and LL will be used interchangeably with their correspondents, namely FIBC, FINC, FDBC and FDNC.

Each pocket corresponds to a particular pair of values for (X_1, X_2). In some cases, a priori reasoning may lead to appropriate choices for these definitions. In the absence of such considerations, we use values of the form

$$\overline{X}_i \pm c_i s_i \quad (3)$$

where $\overline{X}_i$ and s_i are the mean and standard deviation, respectively, of X_i. In the examples studied, we have used $c_1 = c_2 = 1$. Thus, we have the following correspondences:

$$\begin{aligned} &\text{FIBC:} \quad (\overline{X}_i + s_i, \overline{X}_2 + s_2) \\ &\text{FINC:} \quad (\overline{X}_1 + s_1, \overline{X}_2 - s_2) \qquad (4) \\ &\text{FDBC:} \quad (\overline{X}_1 - s_1, \overline{X}_2 + s_2) \end{aligned}$$

and

$$\text{FDNC:} \quad (\overline{X}_1 - s_1, \overline{X}_2 - s_2)$$

Thus, FIBC denotes the pocket which is one standard deviation above the mean on both field dependence (X_1) and breadth of categorization (X_2). The definitions of the other pockets are similarly translated.

Of course, there may not be any observations at (X_1,X_2) values corresponding to the group definitions. This fact causes no serious difficulties as long as there is some data around these points. If X_1 and X_2 are highly correlated, some difficulties may arise. In such cases, the (X_1,X_2) values corresponding to two of the pockets may appear to be unreasonable and uninteresting. One might consider using the principal components $(Z_1 + Z_2)/2$ and $(Z_1 - Z_2)/2$ (where $Z_i = (X_i - \overline{X})/s_i$) or some other means for avoiding this problem. However, care should be taken to avoid pocket definitions which are not easily interpreted. In any case, if the pockets are far from the center of the sample (in the Mahanalobis distance sense), the pocket means will be estimated with large standard errors and no significant useful results are likely to be obtained.

ESTIMATION OF POCKET MEANS

If we write the regression model (1) in matrix form as

$$Y = X\beta + \varepsilon \tag{5}$$

where

$$Y = (Y_1, Y_2, \ldots, Y_n)',$$

$$X = \begin{pmatrix} 1 & X_{11} & X_{21} & X_{11}^2 & X_{21}^2 & X_{11} & X_{21} \\ 1 & X_{12} & X_{22} & X_{12}^2 & X_{22}^2 & X_{12} & X_{22} \\ \vdots & & & & & & \\ 1 & X_{1n} & X_{2n} & X_{1n}^2 & X_{2n}^2 & X_{1n} & X_{2n} \end{pmatrix}$$

$$\beta = (\beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5)'$$

and

$$\varepsilon = (\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n)'$$

then the least squares estimate of β is

$$\hat{\beta} = (X'X)^{-1} X'Y.$$

If the elements of the error vector ε are independently distributed with mean zero and variance σ^2 then $\hat{\beta}$ will have mean β and covariance matrix $\sigma^2(X'X)^{-1}$. Let

$$G = \begin{pmatrix} g_{00} & g_{01} & \cdots & g_{05} \\ g_{10} & g_{11} & \cdots & g_{15} \\ \vdots & & & \\ g_{50} & g_{51} & \cdots & g_{55} \end{pmatrix}$$

be the usual estimate of this matrix, i.e.

$$G = s^2(X'X)^{-1} \tag{6}$$

where s^2 is the mean squared error (residual mean square) from the regression analysis.

Let x_{HH}, x_{HL}, x_{LH} and x_{LL} denote the designs corresponding to the four pockets. Using (4), this gives

$$x_{HH} = (1, \bar{X}_1+s_1, \bar{X}_2+s_2, (\bar{X}_1+s_1)^2, (\bar{X}_1+s_1)(\bar{X}_2+s_2))', \tag{7}$$

$$x_{HL} = (1, \bar{X}_1+s_1, \bar{X}_2-s_2, (\bar{X}_1+s_1)^2, (\bar{X}_1+s_1)(\bar{X}_2-s_2))', \tag{8}$$

$$x_{LH} = (1, \bar{X}_1-s_1, \bar{X}_2+s_2, (\bar{X}_1-s_1)^2, (\bar{X}_2+s_2)^2, (\bar{X}_1-s_1)(\bar{X}_2+s_2))', \tag{9}$$

and

$$x_{LL} = (1, \bar{X}_1-s_1, \bar{X}_2-s_2, (\bar{X}_1-s_1)^2, (\bar{X}_2-s_2)^2, (\bar{X}_1-s_1)(\bar{X}_2-s_2))'. \tag{10}$$

The usual estimates of the pocket means are given by

$$\hat{\mu} = x'\hat{\beta} \tag{11}$$

where x is x_{HH}, x_{HL}, x_{LH}, or x_{LL}. The variance of $\hat{\mu}$ is

$$s_{\hat{\mu}}^2 = x'G_x. \tag{12}$$

The estimation can be summarized by tabulating $(\hat{\mu}_{HH},s_{HH})$, $(\hat{\mu}_{HL},s_{HL})$, $(\hat{\mu}_{LH},s_{LH})$ and $(\hat{\mu}_{LL},s_{LL})$. If the errors are assumed to be normally distributed, then the $\hat{\mu}$'s are normally distributed and confidence intervals based on the t distribution with n-6 degrees of freedom are appropriate.

Note that, in general, the four estimated pocket means are correlated, since the same regression equation is used for each. Assessment of the exact overall error rate for the four confidence intervals is difficult. A practical solution is to use a Bonferroni approach. Use of 99% intervals for each mean will assure an overall error rate of not more than 4%.

COMPARISON OF SUBPOPULATION MEANS

Due to the already mentioned dependence among the four $\hat{\mu}$'s, the table of $\hat{\mu}$ and s values does not contain sufficient information to construct tests for comparisons among the means. For definiteness, let us consider comparing $\hat{\mu}_{HH}$ and $\hat{\mu}_{HL}$.

It is evident that the coefficients $\hat{\beta}_0$, $\hat{\beta}_1$ and $\hat{\beta}_3$ are not directly relevant to this comparison. Since

$$\hat{\mu}_{HH} = \hat{\beta}_0 + (\overline{X}_1+s_1)\hat{\beta}_1+(\overline{X}_2+s_2)\hat{\beta}_2+(\overline{X}_1+s_1)^2\hat{\beta}_3 + (\overline{X}_2+s_2)^2\hat{\beta}_4+(\overline{X}_1+s_1)(X_2+s_2)\hat{\beta}_5 \tag{13}$$

and

$$\hat{\mu}_{HL} = \hat{\beta}_0+(\overline{X}_1+s_1)\hat{\beta}_1+(\overline{X}_2-s_2)\hat{\beta}_2+(\overline{X}_1+s_1)^2\hat{\beta}_3 + (\overline{X}_2-s_2)^2\hat{\beta}_4+(\overline{X}_1+s_1)(\overline{X}_2-s_2)\hat{\beta}_5, \tag{14}$$

the difference between the two is simply the following linear combination of the $\hat{\beta}_i$:

$$\hat{\mu}_{HH}-\hat{\mu}_{HL} = (0)\hat{\beta}_0+(0)\hat{\beta}_1+(2s_2)\hat{\beta}_2+(0)\hat{\beta}_3 + (4\overline{X}_2s_2)\hat{\beta}_4+(2(\overline{X}_1+s_1)s_2)\hat{\beta}_5. \tag{15}$$

The null hypotheses

$$H_0: \mu_{HH} = \mu_{HL} \tag{16}$$

is thus translated into

$$H_0: 2s_2\beta_2 + 4\overline{X}_2 s_2\beta_4 + 2(\overline{X}_1+s_1)s_2\beta_5 = 0. \tag{17}$$

Testing the hypothesis (17) is trivial. Let

$$a = (a_0,a_1,a_2,a_3,a_4)'$$

denote the coefficients of the β's in the null hypothesis of interest. Values of a for the other comparisons are given in Table I. For comparing HH and HL,

$$a = (0,0,2s_2,0,4\overline{X}_2 s_2,2(\overline{X}_1+s_1)s_2).$$

The estimated difference between HH and HL is

$$\hat{\mu}_{HH}-\hat{\mu}_{HL} = a'\hat{\beta} \tag{18}$$

The estimated variance of this difference is

$$s^2_{HH-HL} = a'Ga. \tag{19}$$

Thus, to test the null hypothesis that the two subpopulation means are equal we calculate

$$t = \frac{a'\hat{\beta}}{\sqrt{a'Ga}} \tag{20}$$

which has a t distribution with n-6 degrees of freedom.

Again problems of multiplicities arise when considering error rates for the six possible tests. Using a Bonferroni approach, one could run each test at the .01 level and have an overall rate of not greater than .06. Alternatively, a Scheffe type approach could be used.However such is likely to be too conservative in the present case.

The possibility of running one-sided tests using (20) should be recognized. If appropriate one-sided hypotheses can be generated a priori, this approach can be profitably exploited.

It should be noted that while most multiple regression package programs do not have the options available for calculating (20), the matrix G is often available. Some multivariate programs which have options for multivariate regression can be used to obtain (20). The output is usually in the form of an F-statistic. If probabilities are given they will usually be Scheffe-type. For two-sided tests use of the F distribution with 1 and n-6 degrees of freedom is appropriate whereas for one-sided tests, taking the square root and affixing the proper sign will give (20).

FORMING OTHER POCKETS

Various other criteria can be used to define pockets. For instance one might prefer to make inferences about the average expected value for those subjects in the upper thirds on both X_1 and X_2 (Rubin, 1977).

For any subgroup of subjects, the average expected value of the dependent variable can be obtained by evaluating the regression equation at the average values of all predictor terms, e.g. $X_1, X_2, X_1X_2, X_1^2, X_2^2$. This procedure is equivalent to using a pocket defined by the average value for all predictor terms. Moreover, pockets may be defined by integrating all predictor terms with respect to any appropriate probability distribution.

RESULTS AND INTERPRETATION

Pocket means and standard errors are presented in Table 2 and the statistics for making comparisons among these means are presented in Table 3. Correlations among the variables are given in Table 4. To highlight the differences obtained by using the two different breadth of categorization measures (ST and EQ) graphical displays of the pocket means are provided by Figures 1, 2, and 3.

For all three performance measures, field-dependence produces the clearest and largest effects. In all cases, field-independent (FI) pockets outperform field-dependent (FD) pockets. While these differences are statistically significant at the .05 level for only 50% of the cases, the general pattern is apparent from Figures 1, 2, and 3.

The breadth of categorization measures add little information to the field-dependence measure for distinguishing pocket performance. In comparing the field-dependent (FD) pockets, there are no significant differences due to either breadth of categorization measure. For the field-independent (FI) pockets only one difference is evident: field-independent broad categorizers (FIBC) perform significantly better on the verbal fluency task than field-independent narrow categorizers (FINC), when breadth of categorization is defined by the Estimation Questionnaire (EQ).

Examination of Figures 1, 2, and 3 reveals patterns which, although not statistically significant, are suggestive. When pockets are defined by the Estimation Questionnaire, the broad categorizers (BC) outperform the narrow categorizers (NC) in both field-independent and field-dependent pockets on all three performance tasks. This pattern still holds true for syllogistic reasoning when the Synonymity Task (ST) is used as the breadth of categorization measure. However, for verbal fluency and concept identification, the pattern is reversed when the ST is used instead of the EQ. Specifically, in these cases, the narrow categorizers (NC) outperform the broad categorizers (BC).

To conclude, when predicting the problem solving performance of this female population, field-dependence is a more useful measure than breadth of categorization. However, the differences in results obtained by the choice of breadth of categorization measure is a topic which merits further investigation.

REFERENCES

Barratt, E. S. The space-visualization factors related to temperament traits. Journal of Psychology. 1955, 39, 279-280.

Draper, N. R. and Smith H. Applied regression analysis. New York: Wiley, 1966.

Ehri, L. C. & Muzio, I. M. Cognitive style and reasoning about speed. Journal of Education Psychology, 1974, 66, 569-571.

Fillenbaum, S. Some stylistic aspects of categorizing behavior. Journal of Personality, 1959, 27, 187-195.

Fitzgibbons, D., Goldberger, L. & Eagle, M. Field-dependence and memory for incidental material. Perceptual and Motor Skills. 1965, 21, 743-749.

French, J. W., Ekstrom, R. B. & Price, L. A. Kit of Reference Tests for Cognitive Factors. New Jersey: Educational Testing Service, 1963.

Gardner, R. W., Holzman, P. S., Klein, G. S., Linton, H. B. & Spence, D. P. Cognitive control: A study of individual consistencies in cognitive behavior. Psychological Issues, 1959, 1, 1-185.

Gardner, R. W., Jackson, D. N. & Messick, S. J. Personality organization in cognitive controls and intellectual abilities. Psychological Issues. 1960, 2, 1-148.

Glixman, A. F. & Wolfe, J. C. Category membership and interitem semantic-space distances. Journal of Personality, 1967, 35, 134-143.

Kogan, N. Educational implications of cognitive styles. In G. S. Lesser (Ed.), Psychology and Educational Practice. Illinois: Scott, Foresman and Company, 1971, pp. 242-292.

Kogan, N. and Wallach, M. Risk-Taking. New York: Halt, Rinehart & Winston, 1964.

McCabe, G. P. Use of the 27% rule in experimental design. Purdue University Department of Statistics, Mimeo Series No. 492, 1977.

McCabe, S. A. Prediction of female problem solving skill from cognitive style measures under motivating task-orienting conditions. Ph.D. Dissertation, Purdue University, 1976.

Neter, John and Wasserman, William. Applied Linear Statistical Models. Homewood, Illinois: Richard D. Irwin, 1974.

Pettigrew, T. F. The measurement and correlates of category width as a cognitive variable. Journal of Personality, 1958, 26, 532-544.

Sarason, I. G. Experimental approaches to test anxiety: Attention and the uses of information. In C. D. Spielberger (Ed.), Anxiety: Current Trends in Theory and Research. Vol. 2, New York: Academic Press, 1972, pp. 383-409.

Witkin, H. A., Oltman, P. K., Raskin, E. and Karp, S. A. Manual: Embedded Figures Test, Children's Embedded Figures Test, Group Embedded Figures Test. Palo Alto: Consulting Psychologists Press, Inc., 1971.

AUTHORS

MCCABE, GEORGE P., JR. Address: Department of Statistics, Purdue University, West Lafayette, IN 47907. Title: Associate Professor of Statistics and Head of Statistical Consulting. Degrees: B.S. Providence College, Ph.D. Columbia University. Specialization: Applied Statistics and Applicable Statistical Theory.

MCCABE, SHARRON A. Address: 2600 Covington Street, West Lafayette, IN 47906. Degrees: B.A. Molloy College, M.A. Columbia University, Ph.D. Purdue University. Specialization: Educational Psychology.

TABLE I

Coefficients of β's for comparison Tests

Comparison	a_0	a_1	a_2	a_3	a_4	a_5
HH vs HL	0	0	$2s_2$	0	$4\bar{X}_2 s_2$	$2(\bar{X}_1+s_1)s_2$
HH vs LH	0	$2s_1$	0	$4\bar{X}_1 s_1$	0	$2(\bar{X}_2+s_2)s_1$
HH vs LL	0	$2s_1$	$2s_2$	$4\bar{X}_1 s_1$	$4\bar{X}_2 s_2$	$2(\bar{X}_1 s_2+\bar{X}_2 s_1)$
HL vs LH	0	$2s_1$	$-2s_2$	$4\bar{X}_1 s_1$	$-4\bar{X}_2 s_2$	$2(\bar{X}_2 s_1-\bar{X}_1 s_2)$
HL vs LL	0	$2s_1$	0	$4\bar{X}_1 s_1$	0	$2(\bar{X}_2-s_2)s_1$
LH vs LL	0	0	$2s_2$	0	$4\bar{X}_2 s_2$	$2(\bar{X}_1-s_1)s_2$

TABLE 2

Estimated Pocket Means and Standard Errors

Task	Breadth of Categorization Measure	Pockets: FIBC	FINC	FDBC	FDNC
Verbal	ST	23.44 ± 1.31	23.44 ± 1.40	19.77 ± 1.24	20.27 ± 1.34
Fluency	EQ	25.52 ± 1.33	21.85 ± 1.36	20.75 ± 1.22	18.89 ± 1.46
Syllogistic	ST	11.39 ± 1.42	10.60 ± 1.51	5.55 ± 1.34	3.54 ± 1.45
Reasoning	EQ	11.80 ± 1.50	10.17 ± 1.53	4.73 ± 1.37	4.51 ± 1.64
Concept	ST	96.27 ± 7.56	104.20 ± 8.05	77.83 ± 7.17	82.48 ± 7.73
Identification	EQ	103.45 ± 7.87	98.17 ± 8.05	85.62 ± 7.21	73.40 ± 8.61

Table 3

F-Statistics and Significance Values for Compared Pockets

Task	Breadth of Categorization Measure*	Compared Pockets: FIBC FINC		FIBC FDBC		FIBC FDNC		FINC FDBC		FINC FDNC		FDBC FDNC	
		F**	p	F**	p	F**	p	F**	p	F**	p	F**	p
Verbal Fluency	ST	0.00	ns	3.98	.05	2.38	.13	3.03	.09	2.30	.14	0.10	ns
	EQ	4.07	.05	6.16	.02	9.94	.01	0.26	ns	1.71	.20	1.06	ns
Syllogistic Reasoning	ST	0.17	ns	8.63	.01	12.49	.01	4.90	.03	9.77	.01	1.37	ns
	EQ	0.63	ns	10.66	.01	9.46	.01	0.01	ns	4.90	.03	0.01	ns
Concept Identification	ST	0.59	ns	3.03	.09	1.35	ns	4.70	.04	3.25	.08	0.26	ns
	EQ	0.24	ns	2.46	.12	5.85	.02	0.41	ns	3.41	.07	1.31	ns

*ST designates Fillenbaum's Synonymity Task and EQ designates Pettigrew's Estimation Questionnaire.

**Degrees of freedom for all F-statistics are 1 for the numerator and 100 for the denominator.

Table 4

Correlations Among Variables (N = 106)

	1	2	3	4	5
1. ST					
2. EQ	.14				
3. Field-dependence	-.06	-.04			
4. Verbal Fluency	-.06	.19*	.29**		
5. Syllogistic Reasoning	.05	.04	.34**	.24**	
6. Concept Identification	-.09	-.11	.23**	.01	.21*

* $p < .05$

** $p < .01$

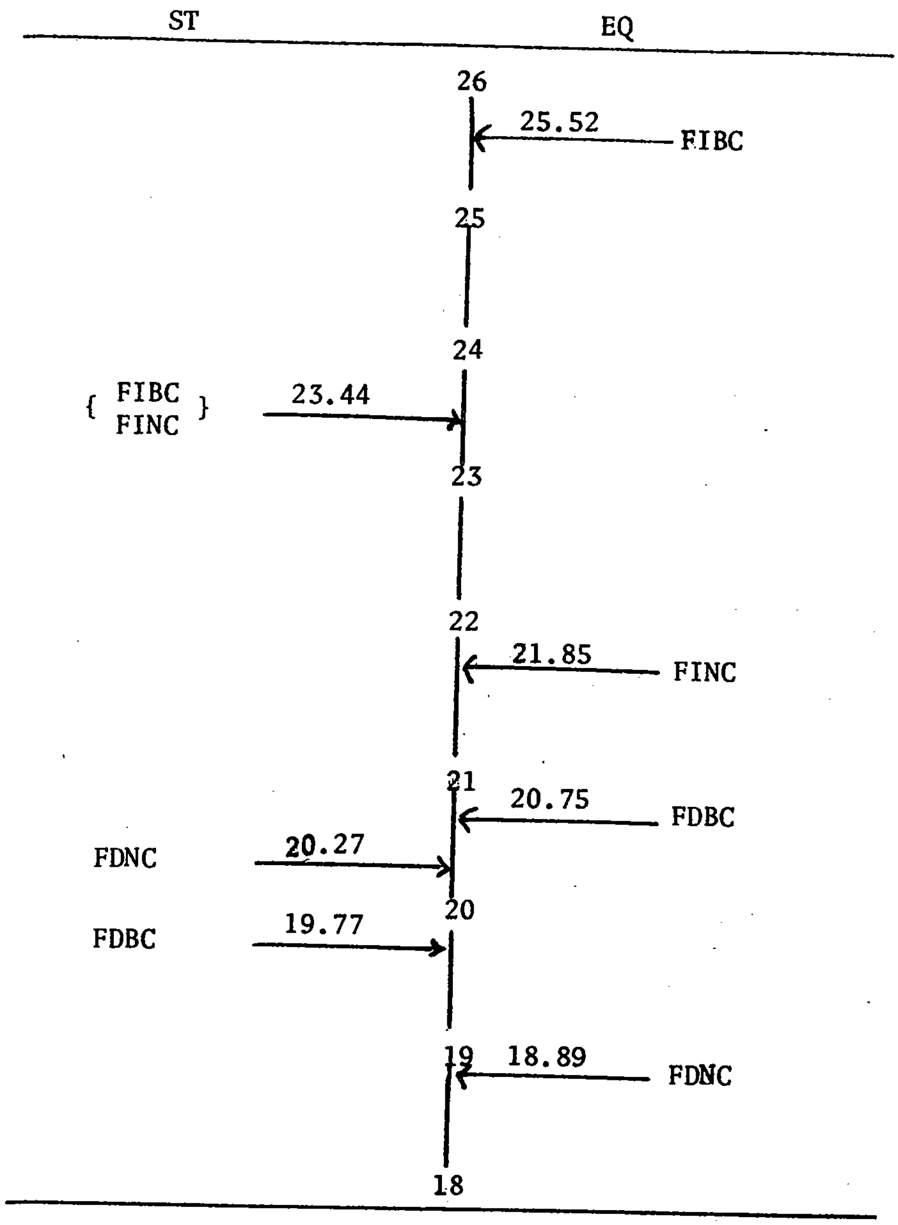

Figure 1. Pocket Means For Verbal Fluency

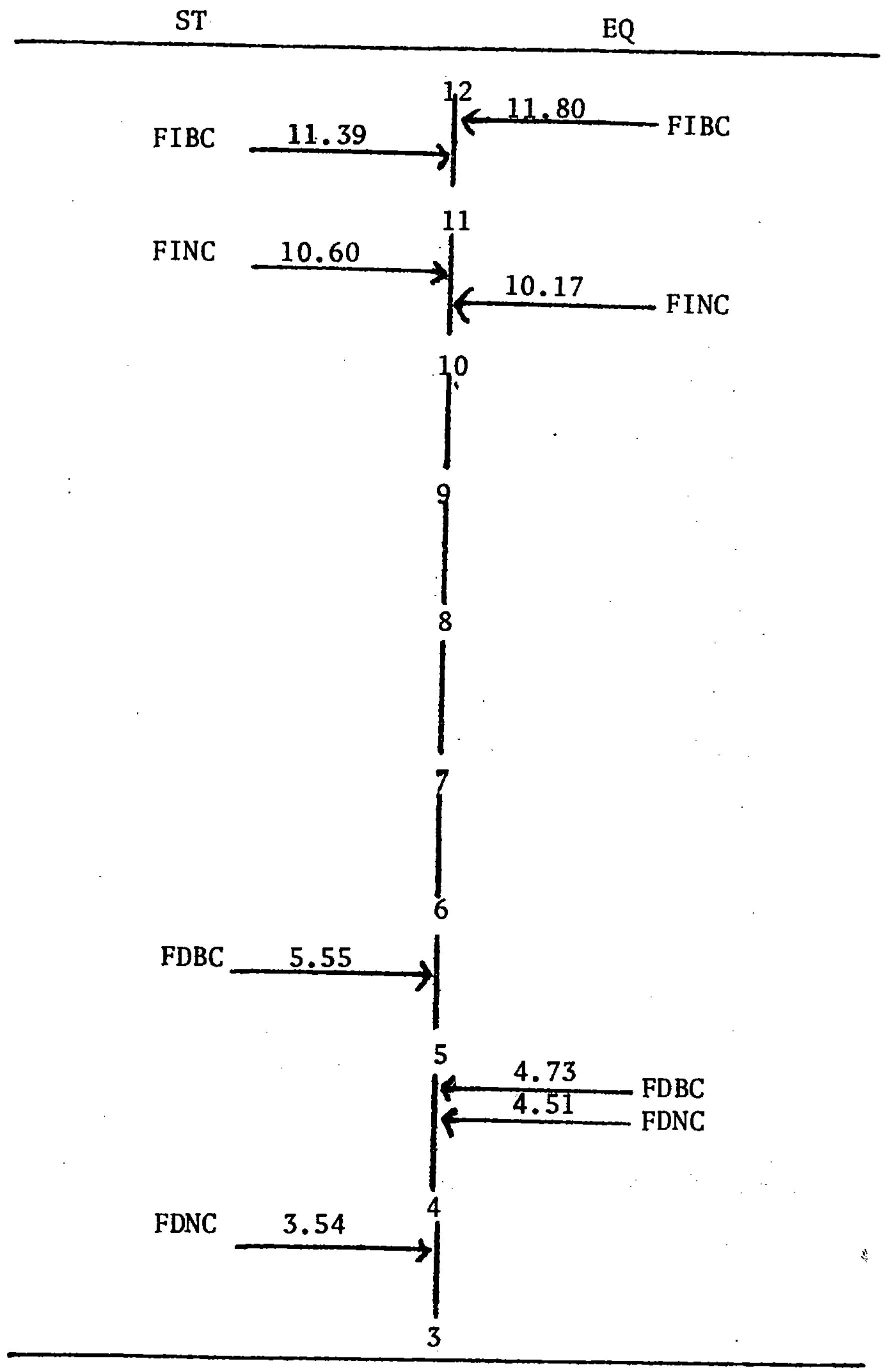

Figure 2. Pocket Means for Syllogistic Reasoning

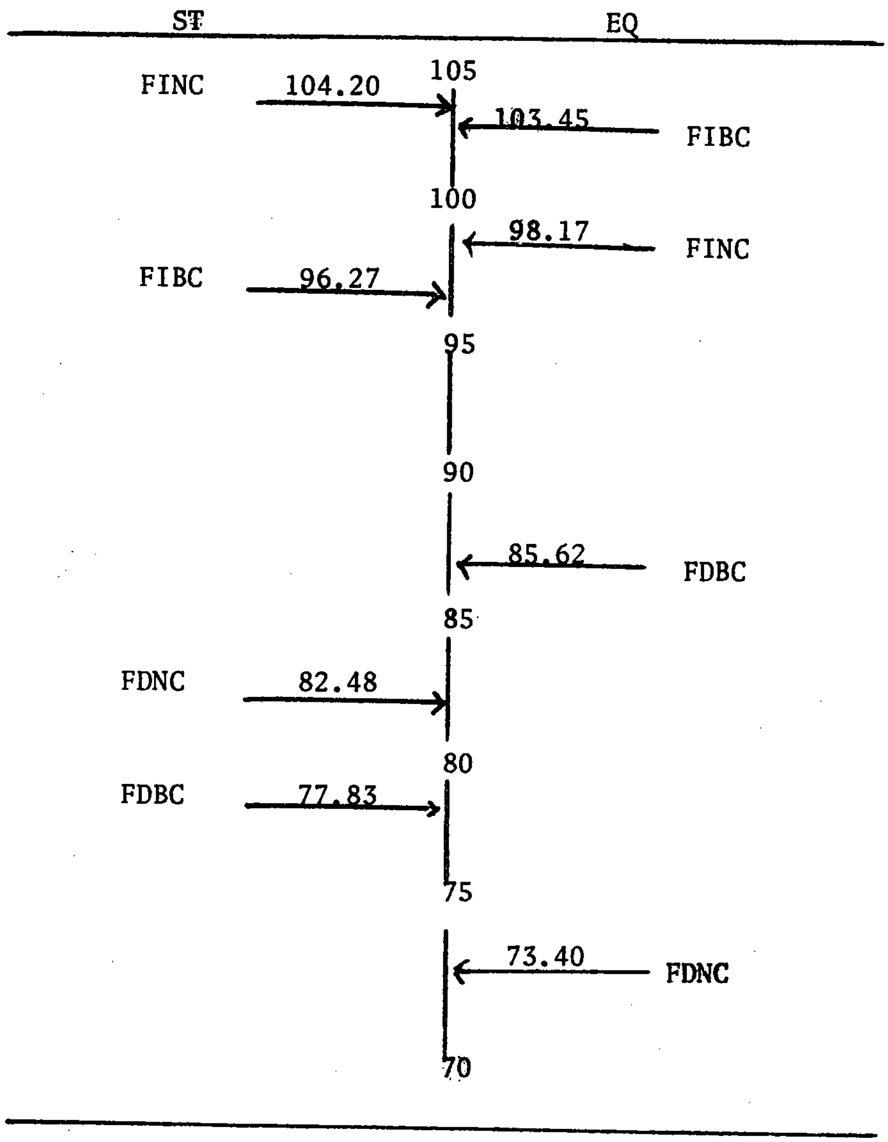

Figure 3. Pocket Means for Concept Identification