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Conceptual and Empirical Analysis of Some Assumptions of an Explicitly Typological Theory

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The criteria for typology described by Mendelsohn, Weiss, and Feimer (1982) are reexamined. It is argued that the first of the two criteria for single-variable typologies, multimodality, is a weak one for psychological data and that only the second criterion, discontinuity against an external variable, is telling. It is agreed that these authors' requirement that multiple-variable typologies combine interactively to predict external variables is a mandatory one, although it is not one that is diagnostic of typology. These issues are illustrated by a multiple-variable, explicitly typological system specified by the Myers-Briggs Type Indicator (MBTI). This system predicts both single-variable and interactive relationships against external criteria and explicitly proposes discontinuity at the scales' midpoints. The present MBTI study, like others, yielded no predictor bimodality, though the distribution displayed platykurtosis, the index of which is maximized with bimodal distributions. Similarly, the criterion distribution did not display bimodality, though conventional assessments of differences in distribution location evidenced sharp discontinuities at the midpoint for one variable, Sensing–Intuition, against two criteria, and for a second variable, Extraversion–Introversion, against one criterion. Predictor variable interactions were only weakly displayed. A review of relevant MBTI research, coupled with these findings, challenges pessimism about the verifiability of all typological systems, suggesting that further investigation of this approach, using appropriate data analytic procedures, would be fruitful.

A cogent discussion of the conceptual issues associated with use of typologies was recently provided by Mendelsohn, Weiss, and Feimer (1982), who reexamined what were described as the "implicitly typological" assumptions underlying the interpretation of a well-known data set (Block, von der Lippe, & Block, 1973). The Mendelsohn et al. critique produced a heated response by the Block group (Block & Ozer, 1982) and a retort by the Mendelsohn faction (Weiss, Mendelsohn, & Feimer, 1982). This debate, though marked by passion and occasional hyperbole, actually begins to provide a useful airing of the scientific and psychometric criteria for explicit and implicit typologies, as well as for the nontypological labels that psychologists are notoriously fond of emitting.

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Mendelsohn et al. (1982) observed that many psychologists use typologies when they categorize, whether the groupings be sensitizers versus repressors, internal versus external locus of control, Type A versus Type B behavior, or multiple categories on other variables of interest. The point is well taken that much of this kind of typological sorting is convenient but may be misleading when there is an implicit assumption of variable discontinuity that is not tested. Mendelsohn et al. proposed that appropriate criteria for discontinuity in the single-variable case would consist of (a) a multimodal score distribution, where the clearest single-variable case would be a bimodal distribution with a dip at the midpoint of a bipolar scale and (b) a discontinuous regression against an external variable, with the discontinuity occurring at the scale midpoint. This discussion takes issue with the importance of the first criterion to any single-variable typological approach in the field of psychology, arguing that only the second criterion is telling.

It is possible to meet the second criterion without meeting the first. And where only the

second criterion is met, most psychologists would be willing to grant that the two ends of the scale measure something categorically different. For example, imagine raggedly unimodal data on a bipolar scale that assesses the tendency to show Type A or Type B behavior. Then suppose that low-scoring Type As, like extreme-scoring Type As, are much more prone to coronary infarction than are low-scoring Type Bs. Surely one could legitimately speak of Type As and Type Bs, even in the absence of bimodality. Although such evidence of variable discontinuity has not been presented for the various measures of Type A versus Type B behavior (see Matthews, 1982), some evidence has been presented for some of the four scales that constitute another explicitly typological inventory, the Myers-Briggs Type Indicator (MBTI).

The MBTI (Myers, 1962/1975) is a forced-choice normative instrument (Hicks, 1970) that yields directional preference scores on each of four bipolar dimensions. These dimensions are named *extraversion–introversion* (E–I), *sensing–intuition* (S–N), *thinking–feeling* (T–F), and *judging–perceiving* (J–P). These variable abbreviations are also used to identify a person who possesses a particular bipolar preference. The posited and the validated content of this test was recently reviewed (Carlyn, 1977; McCaulley, 1981; Myers & Myers, 1980). The four directional preference scores on each scale are believed to combine both additively (Myers, 1962/1975, pp. 66–67) and interactively in ways specified by extensions of Jungian temperament theory.

The descriptions of the bipolar preferences lead to the expectation that the two poles of each of the four variables would relate in categorically different ways to four arrays of main effects on external variables that differ from the familiar within-group by between-group heterogeneity comparisons in that sharp discontinuities should occur at the scales' midpoints.

The empirical evidence on this fundamental point is sparse. Stricker and Ross (1964) report a V-shaped relationship of a vocabulary test to the T–F scale but failed to find such relationships for other scales. This V-shaped function appeared in the absence of bimodal T–F scale score frequencies. The MBTI manual (Myers, 1962/1975) depicts a number of apparently discontinuous functions for the separate scales, but in only two cases are statistical tests reported. In one case the relationship between faculty ratings of students' gregariousness and the students' E–I scores describes a step function with a significant break at the scale midpoint. A similarly significant discontinuity is presented for a variable relevant to the T–F scale. Again, in neither case are the step functions associated with bimodal distributions on the predictor scales. Webb (1964) did not report on the shape of his S–N frequency distribution but did report a regression that displayed a significant discontinuity at the midpoint when the Verbal portion of the Scholastic Aptitude Test (SAT) was the criterion: The regression is flat in the S portion of the scale and displays a positive slope in the N portion.

In their discussion of typological criteria, Mendelsohn et al. (1982) offered an additional standard for multiple-variable typological systems, and this standard bears further examination: "In a statistical sense, one should observe interactions among the variables, not merely an additive relationship" (p. 1159). The explicit statement of this standard is a useful contribution on the part of these researchers, and it is a requirement that applies when any typological system avers, explicitly or implicitly, that the various patterns formed by the combining variables are uniquely different from each other. However, one should note that hypothesized interactions of this sort are not peculiar to typological systems. Such interactions are often predicted, and found, in nontypological systems, in which the predictors are continuous variables. An example here might be the studies that suggest that measures of anxiety and ability combine multiplicatively, as suggested by Hullian theory, to predict performance on moderately difficult learning tasks (Spielberger & Katzenmeyer, 1959; Spielberger & Smith, 1966). Thus, variable interactions are a necessary, but not a sufficient, condition for a typology. The first two criteria proposed by Mendelsohn et al. (1982) and Myers (1962, 1962/1975) are only relevant to putative typologies.

The theory behind the MBTI does not propose that the four variables composing the predictor set would always combine interactively to predict external criteria. The theory

lists a multitude of "main effects" to be expected for each of the preferences taken singly. For example, Myers (1962/1975) stated that the I preference adds "depth and concentration" (pp. 66–67) regardless of the other typological variables with which it combines, whereas the E preference adds "ease with the environment" regardless of the other MBTI preferences. Other main effects are specifically hypothesized for each of the other MBTI variables. The bulk of research on the MBTI has focused on validation of the proposed main effects for each of the variables taken singly (Carskadon, 1981, 1982; Myers & Myers, 1980).

The theory behind the MBTI also, however, includes the sine qua non of a multiple-variable typology: explicit proposals as to the interactive nature of various sets of the typological variables. For example, the stylistic characteristics and the targets of an introvert's depth and concentration are said to vary, depending on whether he or she exhibits the T or the F preference. Three- and four-way interactions are also predicted, as the other bipolar preferences are considered. The various interactions proposed by the theory are said to embellish the 16 types with unique characteristics beyond the additive effects resulting from directional preferences on the four basic bipolar variables. Evidence is scant on this point, perhaps partly because data analysis methodologies that could detect such interactions have only occasionally been employed by MBTI researchers.

The present study offers some simple data related to the posited dichotomy on the S–N scale of the MBTI. Multiple methods are used to check the possibility that the S–N scale combines additively or interactively with another scale to predict the criterion. Because Myers (1962/1975) emphasized that discontinuous functions of single MBTI variables can only be expected when the external variable is theoretically relevant to the predictor, an effort was made to maximize the likelihood of finding variable discontinuity by selecting an appropriate cognitive criterion. Among the four MBTI scales, S–N has been shown to be the one that behaves most like a "cognitive style" measure.

Compared with persons with the S preference, those with the N preference show higher grades and academic aptitude on a multitude of measures in a variety of samples but no differences in practical skills, such as arithmetic, spelling, clerical–administrative aptitude, and motor skills (McCaulley, 1981; McCaulley & Natter, 1974). Most of the participants in MacKinnon's small-sample studies of highly creative persons scored in the N direction (MacKinnon, 1961; Myers, 1962/1975). Persons with the N preference offer more inferential constructs on the Kelly Role Construct Repertory and make more imaginative efforts in communication (Carlson, 1980) than do those with the S preference. It is theorized that the S-versus-N preference also reflects differences in the extent to which indirect experience is found credible: "Whatever comes directly from the senses is part of the sensing types' own experience and is therefore trustworthy. What comes from other people indirectly *through the spoken or written word* is less trustworthy" (Myers & Myers, 1980, p. 57). As noted earlier, discontinuity has been reported for SAT Verbal scores regressed on the S–N scale (Webb, 1964). Because of these findings and theoretical expectations, voluntary book reading was chosen as the external cognitive variable deemed relevant to the S–N scale, and persons with the N preference were expected to be categorically more bookish than those with the S preference, both on a continuous self-report measure and on a related categorical behavioral measure.

It was believed that the E–I variable was the one most likely to combine interactively with the S–N dimension to predict the bookishness criterion. The E–I variable, taken alone, has only occasional weak relationships to scores on cognitively demanding tasks (McCaulley & Natter, 1974). Myers (1962/1975, pp. 36–37) does, however, report an apparent E–I × S–N interaction on an untimed ability measure. The statistical significance of this apparent interaction is not reported, but I have calculated several significant E–I × S–N interactions on achievement tests from data provided by McCaulley and Natter (1974, p. 143). The usual form of the interaction involves a difference between the IN and the EN group that is larger than that between the IS and the ES group. There may be some basis for expecting a similar kind of interaction when the criterion is a voluntary cognitive activity.

It was also believed that E–I differences

might figure more prominently with the present criterion than they do with ability test measures. The E–I scale has been shown to validly index gregariousness (Myers, 1962/1975), so that the solitary nature of the book-reading activity might differentially appeal to Es and Is, producing a main effect, or enhancing an E–I × S–N interaction, or both.

The results of the present study are presented using standard MBTI scoring procedures. Because, as Lord (1958) has observed, it is possible to produce apparent typological characteristics by scoring artifacts, the scoring system for the MBTI will be detailed at this point.

The MBTI yields either preference scores or continuous scores; these two kinds of scores have very different properties. The preference scores were devised to display scale bipolarity. They are also transformed so as to eliminate zero values when there is no difference between a subject's summed item weights from each of the ends of a bipolar scale.[1] These summed item weights can be termed *raw scores.* To obtain a *preference score,* the smaller raw score is subtracted from the larger, the difference is doubled, and then one point is added. This convention makes all MBTI scores assume odd values. Zero scores are arbitrarily eliminated by specifying that the direction of the one-point assignment is I, N, T, or P for males, and I, N, F, or P for females with tied raw scores. (The T–F scale shows significant gender differences.) Preference scores are arrayed symmetrically about a zero midpoint, although no subject actually obtains a zero score.

Preference scores are useful when discussing results in terms of the bipolarity that is fundamental to the typological theory. Such scores do not, however, accommodate statistical analyses very well unless one performs separate analyses for subjects scoring in each half of the scale. MBTI *continuous scores* are more adaptable to statistical analysis, although sometimes at the cost of obscuring changes that occur at the scale midpoint when correlational analyses are used. For an I, N, F, or P score, the continuous score is the preference score plus 100; for an E, S, T, or J score, the continuous score is the preference score minus 100. This calculation reverses the magnitude of E, S, T, and J scores, compared with their values when expressed as preference scores (see the abscissa of Figure 2, discussed later) and makes the bipolar scales (misleadingly) phenotypically similar to traditional unipolar scales. The researcher may be lured into misleading unipolar statistical analyses with continuous scores.

One might ask whether all of this arithmetic is really necessary. Webb (1964) reported that the correlation between S raw scores and N raw scores is −.88.[2] Furthermore, the correlation between S raw scores and a score very similar to the S–N continuous score was −.97; the correlation between N raw scores and Webb's variant of the S–N continuous score was .96.[3] Whether some of the standard score transformations are necessary or not, they are performed here so that the present results will be comparable to those of other studies. It is, however, comforting to know that the derived scores appear to relate well to their raw-score substrate. The present study uses preference scores primarily for expository purposes and continuous scores, grouped continuous scores, or dichotomously scored categories for statistical analyses.

The existence of continuous scores that underlie the theoretical type classifications presents an opportunity to contrast the utility of multiple regression analyses that obscure the theoretical midpoint discontinuity with analyses of variance (ANOVAs) based on class intervals formed so that a break occurs at the scales' midpoints. Mendelsohn et al. (1982)

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[1] At one point in the development of the MBTI, these scores were termed "indeterminate" and eliminated from bipolar analyses because the subject had provided no information as to directional preference. Before the publication of the manual (Myers, 1962/1975), the decision was made to assign the indeterminate subjects an arbitrary score. Because their incidence is rare—about 2.3% on the S–N scale in an adolescent sample (Stricker & Ross, 1958, p. 161)—it was hoped that the resulting diminution in reliability would be slight.

[2] The correlations between the two sets of raw scores from a bipolar scale will always assume a high negative value because items representing a given bipolar scale are never paired with items representing another bipolar scale. This method of pairing prevents the MBTI from displaying the artifactual characteristics of ipsative scales (Hicks, 1970), in which paired comparisons are made between items from all scales. This negative correlation will not be −1.00 because item weightings vary.

[3] The direction of these correlations has been reversed to conform to the scoring conventions described in the MBTI manual (Myers, 1962/1975).

observed that "it is quite unlikely that predictions from types will be substantially better than multiple regression predictions based on the variables that define the types" (p. 1169).

In an effort to give the typological theory a fair hearing, consideration was given to the fact that the internal consistency and test–retest reliability of the MBTI, like many tests, increases as a function of respondent age (Carlyn, 1977; McCaulley, 1978). Because score reliability, particularly of those scores falling near the midpoint of the bipolar scales, is a crucial issue when seeking a discontinuous function breaking at the midpoint, an adult sample was selected rather than an adolescent one.

Method

Subjects

The 104 participants were employees of a rural public school system in the deep South. Volunteers offered to take the MBTI (Form F) after hearing the author briefly describe typological theory in staff training sessions. A total of 72 MBTIs were received from subjects showing an S preference; 52 subjects showed an N preference, including two subjects whose S and N raw scores were tied and who were arbitrarily assigned a preference score of 1 on the N scale. The pool of S-preference subjects (Ss) was randomly reduced to 52, to match the number of N-preference subjects (Ns). The subject distribution according to the 16 possible MBTI patterns[4] is depicted in Table 1.

Of the study participants, 54 were teachers or substitute teachers, 11 were administrators, 9 were clerical staff, and 30 held other full- or part-time white-collar positions in the school system. There were 33 males and 71 females, 20 blacks and 84 whites. Ten of the subjects were high school graduates; 84 were college graduates; 10 had master's degrees. Their average age was 37.4 years.

Table 1
Distribution of Subjects by Myers-Briggs Type Indicator Pattern

ISTJ	ISFJ	INFJ	INTJ
5	10	4	2
ISTP	ISFP	INFP	INTP
2	3	10	5
ESTP	ESFP	ENFP	ENTP
2	8	17	4
ESTJ	ESFJ	ENFJ	ENTJ
8	14	5	5

Note. The format of this table is standard for presenting MBTI patterns. The 16 possibilities represent all combinations of Introversion (I) or Extraversion (E), Sensing (S) or Intuition (N), Thinking (T) or Feeling (F), Judging (J) or Perceiving (P).

Criterion Measures

Bookishness was quantified by administering a questionnaire that obtained self-reported book-reading quantity and by recording participation or nonparticipation in the book-lending services of the local public library.

A two-page questionnaire headed "Reading Habits Inventory" was administered several days after the MBTI was received. In an effort to enhance the acceptability of low levels of book reading, the questionnaire was prefaced with the query, "Would you agree with the statement that life is more important than books?" (All respondents indicated general or total agreement.) Respondents were also asked to rank order their preferences for books, magazines, and newspapers; this query was intended to give those who rarely read books a way to convey their general literacy. Subjects were also asked to check their favorite reading topics from a lengthy list. The dependent variable of interest consisted of responses to the request to recall annual book-reading quantity, or if this was too difficult, to estimate monthly quantity and multiply by 12. No other questionnaires were administered, and no other queries were made in the Reading Habits Inventory.

Participation or nonparticipation in library book-lending services was determined by examining the public library's file of names of persons in the county who had a check-out card. (In this county these data are public information.) Two of the Ns did not live in the county and could not have had cards, so the sample was reduced by two for this measure.

Results

No analyses of the questionnaire's list of reading topics were undertaken. This list was provided largely as filler; all subjects checked many topics. Hypotheses predicting Ss' and Ns' attraction to types of writing would probably be more appropriately couched in terms of the stylistic characteristics of the writing (see Helson, 1982) than the topical labels.

In this white-collar sample, subjects' education, race, and sex all showed no significant correlations with the bookishness criteria. There were no significant differences between Ss and Ns in years of education or occupational status, using Mercer and Lewis's (1977) method of coding the latter variable. The preference rankings for three kinds of written media showed that Ns ranked books first sig-

[4] In the present usage, *score patterns* refers to the 16 empirically obtained combinations of the four bipolar categorical preferences on the MBTI. *Types* refers to the theoretical "platonic true types" that the MBTI seeks to assess, invariably with some degree of unreliability. This distinction is not made by Mendelsohn et al. (1982) and does not correspond to the distinction made by Block and Ozer (1982).

nificantly more often than did Ss, $\chi^2(2, N = 104) = 14.35, p < .001$. Despite this difference, a majority of the Ss ranked book reading as their favorite reading.

Predictor Bimodality

As was expected, the distribution of S–N scores was not bimodal. It was unnecessary to subject the distribution, depicted in the top portion of Figure 1, to Wainer's (1978) test for gaps in data or to Lord's (1958) approximate test for multimodality because the distribution's dip at the midpoint was equaled or exceeded by other dips. The distribution is approximately symmetric (skew = 0.08, where a normal distribution's skew is zero) and platykurtic (kurtosis = 1.13, where a normal distribution has zero kurtosis). The depicted score distribution is composed of class intervals spanning two MBTI scores. Bimodality did not appear in the distribution of ungrouped scores or with the larger groupings employed in subsequent analyses.

Self-Reported Bookishness Criterion

The bottom portion of Figure 1 displays the frequency distribution of the self-reported book-reading data, arranged separately for

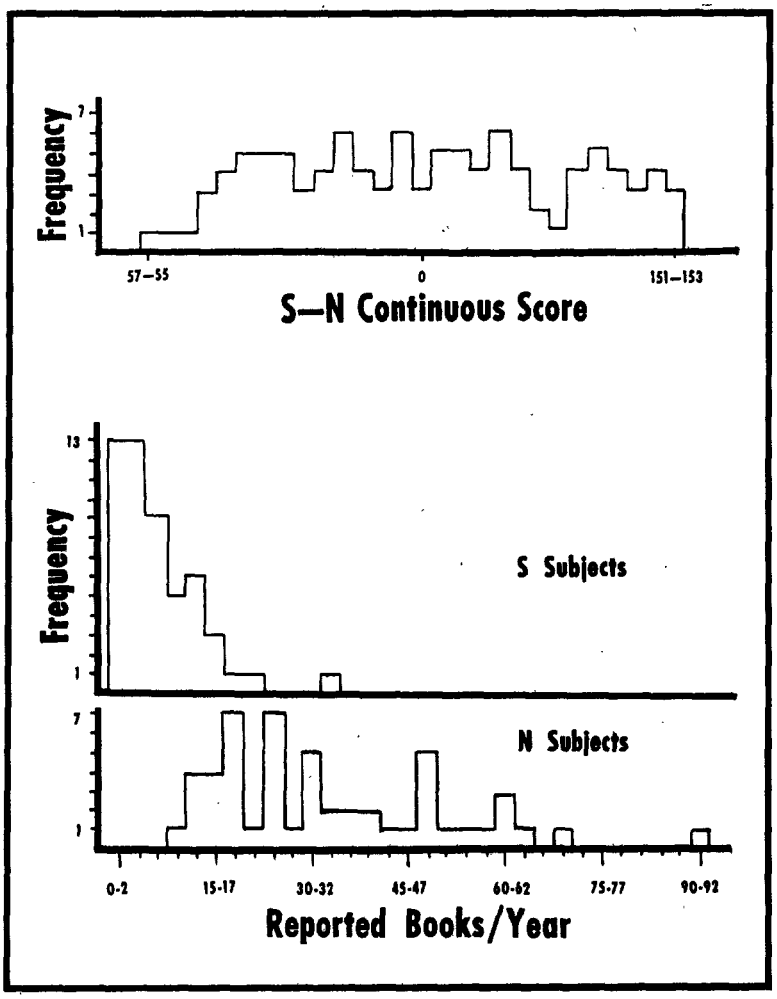

Figure 1. Frequency distributions of Sensing-Intuition (S–N) scores (N = 104), with class intervals of 2; frequency distributions of reported books read per year by Sensing (N = 52) and Intuitive (N = 52) subjects, with class intervals of 3.

subjects in the S category and those in the N category. It is interesting to note that no Ns reported book-reading frequency within the lowest three class intervals graphed, and no Ss reported frequencies in the top 19 intervals. Despite these disparities, it is apparent that the book-reading criterion would not distribute bimodally if one collapsed the two groups of subjects into a single distribution. The collapsed distribution would be jaggedly unimodal, skewed to the right (skew = 1.19), like the two distributions for S subjects (skew = 1.78) and N subjects (skew = 0.85) that it was composed of.

The two distributions for S-preference and N-preference subjects on this criterion differ most in kurtosis and in location. When a normal distribution's kurtosis is set at zero, the S-preference subjects' distributions' calculated kurtosis value is 4.48, indicating leptokurtosis, and the N-preference subjects' distributions' value is 0.21. The differences in kurtosis produce differences in variance between the S and N groups, which will be taken into account during the analyses of possible differences in location on the criterion variable.

Myers's (1962/1975) procedures were followed to group the book-reading data, yielding the function depicted in Figure 2 and Table 2. The one-way ANOVA of these data is significant, $F(5, 98) = 22.56, p < .0001, \eta^2 = .53$, as is the Levene's test (Glass, 1966), indicating unequal variances, $F(5, 98) = 9.04, p < .0001$, across groups. Because alpha may be disturbed by inequality of variance in nonnormal populations, the criterion variable was log transformed (Dunlap & Duffy, 1974) to normalize the data. The ANOVA of the transformed data was again significant, with increased variance explained, $F(5, 98) = 28.35, p < .0001, \eta^2 = .59$.

For both the original and the log-transformed data, Duncan's Multiple Range tests for unequal n indicate that the change in level at the midpoint is the only significant ($p < .05$) change between adjacent groups. As Table 2 indicates, the S–N distribution was not bimodal for the class intervals used in these ANOVAs, despite the change in criterion level at the S–N scale midpoint.

Visually, there appear to be differences in slope in the two halves of Figure 2, as well as differences in level. The slope values, .39 in the Intuition half and .05 in the Sensing half,

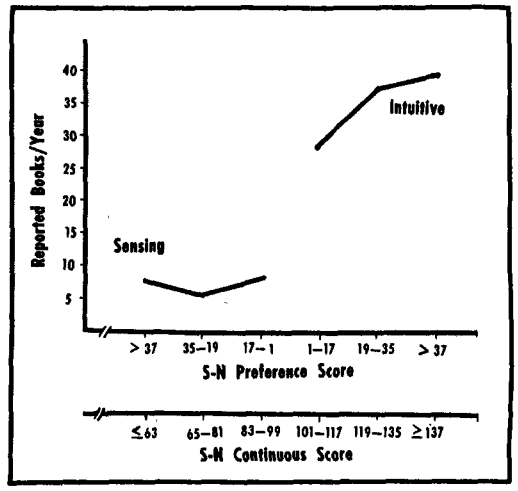

Figure 2. Reported books read per year as a function of Sensing and Intuition (S–N) preference scores or continuous scores. ($N = 104$.)

are not significantly different, however, as assessed by a two-tailed t test. For the 52 subjects in the Sensing half, the correlation between S continuous scores and the criterion ($r = .10$) is insignificant; for the 52 subjects in the Intuition half, the correlation between N continuous scores and the criterion ($r = .35$) is significant ($p < .05$), but the difference between the two correlations is not significant. Because the one-way ANOVA of Figure 2 data was significant, so is the overall ($N = 104$) correlation between ungrouped S–N continuous scores and the criterion ($r = .70, p < .001$).

The data were examined for evidence relevant to Mendelsohn et al.'s (1982) third typological criterion, predictor variable interactions. To obtain adequate cell n for effect estimation, the four bipolar MBTI variables were collapsed into dichotomous categories. Data in the resulting $2 \times 2 \times 2 \times 2$ factorial design were subjected to an unweighted means ANOVA. When the untransformed data were used, the only significant effect was the S–N main effect, $F(1, 88) = 99.25, p < .001, \eta^2 = 0.53$. The anticipated E–I × S–N interaction was not significant.

When the log-transformed criterion data were used, the S–N main effect was again significant, $F(1, 88) = 147.42, p < .001, \eta^2 = .63$; the E–I × S–N interaction was not significant; and an unexpected interaction, S–N × T–F, was significant, $F(1, 88) = 5.08, p < .05, \eta^2 =$

Table 2
Means and Standard Deviations on Reported Annual Book Reading, by Score Group

	MBTI[a] score for sensing subjects			MBTI[a] score for intuitive subjects		
Statistic	≤63	65–81	83–99	101–117	119–135	≥137
M	7.43	5.89	8.00	28.04	36.92	38.76
SD	9.19	5.64	5.31	14.54	20.97	18.21
N	14	18	20	22	13	17

[a] These Myers-Briggs Type Indicator (MBTI) scores are continuous scores.

.05. A simple effects analysis revealed that this interaction was produced by higher reported bookishness, $F(1, 88) = 4.80$, $p < .05$, in the SF group compared with the ST group; the two N groups were almost identical.

An effort was then made to examine the data for all possible two-way interactions when the six predictor groupings indicated in Figure 2 were used and when continuous scores were used. The criterion was used both in its raw metric and in the log-transformed units.

Of the two-way ANOVAs with six levels, only the analysis using the E–I and S–N scales yielded a cell distribution that would permit a reliable estimate of the interaction term; this term was not significant for either the original or the log-transformed criterion.

Ungrouped, continuous MBTI scores were then entered into the new SPSS (Hull & Nie, 1981) stepwise multiple regression program, and all six two-way interaction terms were included as predictors. Only the S–N scale contributed significantly to the prediction of either the original or the log-transformed criterion; no interaction terms contributed significantly. For the original criterion metric, R (or r) = .70, $F(1, 102) = 99.31$, $p < .001$, adjusted $R^2 = .49$; for the log-transformed criterion, $r = .74$, $F(1, 102) = 120.46$, $p < .001$, adjusted $R^2 = .54$. It is interesting to note that the S–N × T–F interaction that had appeared against the log-transformed criterion when the predictor scores were dichotomous categories did not appear when the predictors were expressed as continuous scores.

Behavioral Bookishness Criterion

Of the 50 Ns living in the county, 45 had a library card; of the 52 Ss, 20 had a library card. Table 3 arranges these data so that they are comparable to the data depicted in Figure 2. The overall $\chi^2(5, N = 102)$ is 28.30, $p < .0001$. Orthogonal coefficients were applied to the categories in Table 3 in such a way as to permit a contrast between the middle two groups, those with S or N scores nearest the midpoint. The resulting $\chi^2(1, N = 102)$ is 7.76, $p < .01$.

To check for possible interactions between the predictor variables and this dichotomous bookishness criterion, I conducted several logistic regression analyses. Log-linear models are suitable when criteria are dichotomous (Goodman, 1972). When the predictor model includes all interactions between all predictor variables, the log-linear model is equivalent to a logistic model (Kriska & Milligan, 1982).

Successive analyses were performed, with categorical predictors, with predictors grouped into the six class intervals used in Figure 2, and, finally, with continuous predictors. With categorical predictors, both the S–N scale, $\chi^2(1, N = 102)$ improvement = 27.22, $p < .0001$, and the E–I scale, $\chi^2(1, N = 102)$ improvement = 12.67, $p < .001$, were significant predictors, but no two-way or higher interaction terms contributed significantly. The anticipated E–I × S–N interaction was not significant when six class intervals were used, but when continuous predictors were used, the interaction was significant, $\chi^2(1, N = 102)$ improvement = 5.81, $p < .05$. No other interactions were significant.

Examination of the data indicates that the E–I and the S–N scales interacted complexly as a function of score intensity in ways that were not describable by the simple multiplicative interaction that had been predicted. The main implication of this weak interaction is, in this instance, that the categorical typology may mask interactions that are complexly de-

Table 3
Proportions of Sensing Subjects and Intuitive Subjects With Library Card, by Score Group

	MBTI[a] score for sensing subjects			MBTI[a] score for intuitive subjects		
Statistic	≤63	65–81	83–99	101–117	119–135	≥137
Proportion	.357	.389	.400	.818	1.00	.937
N	14	18	20	22	12	16

[a] These Myers-Briggs Type Indicator (MBTI) scores are continuous scores.

pendent on continuous score intensity, not categorical groupings.

Both the E–I and the S–N predictors remained highly significant with the six-group and ungrouped continuous scores in the logistic regression analyses. Table 4 exhibits the criterion proportions when the E–I scores were grouped into the six class intervals used earlier for the S–N scale. A midpoint discontinuity appears in these data; the orthogonal contrast between the two middle proportions yields a $\chi^2(1, N = 40)$ of 7.20, $p < .01$. There appears to be an association between library participation and E–I score extremity, but only within the Introversion half of the function; the Extraversion half is relatively flat.

Discussion

Empirical Findings: Sensing–Intuition

Although construct validation of the S–N scale was not the focus of the present investigation, these findings are in line with earlier studies of the correlates of this scale. The bookishness of the N-preference group on both criterion measures is compatible with the characteristically more academically capable, less practical, less stimulus-bound intellectual style described by earlier studies (Carlson, 1980; Carlson & Levy, 1973; Carlyn, 1977; McCaulley, 1981).

The I-preference group was more bookish than the E-preference group when library participation was examined. In the absence of corroborative self-report data, however, it is not clear that this finding should be taken to indicate that the I-preference group is more attracted to cognitively complex tasks than the E-preference group is. This difference may reflect frugality differences or the introvert's hesitance to ask others for favors, including book loans. The MBTI scales assess "broad band" variables that will occasionally introduce ambiguity as to what facet of the predictor was the operative one.

Two weak ($p < .05$) interactions appeared in the data, each on only one of the three variations examined for predictor class intervals. One interaction was not predicted, the S–N × T–F effect when dichotomous MBTI scores were used to predict self-reported book reading. The configuration was produced by differences between the ST group and the SF group. This finding is interpretable on a post hoc basis, relating to the reading difficulty level of the literary styles to which individuals with ST or SF preferences are theorized to be differentially attracted (see Helson, 1982; Myers & Myers, 1980). Direct data are, of course, essential to warrant such an interpretation.

The predicted form of the E–I × S–N interaction was not obtained. The complex interaction that was obtained appeared only when continuous scores were used to predict the library use criterion in an analysis that did not separate the categorical halves of the predictor variables. This finding is a weak one, but it probably suffices to demonstrate that categorical groupings are not invariably useful.

Perhaps a word should be said at this point about the marked variance differences that were found between the S and N groups on the self-reported book-reading criterion (see Figure 1). The theory behind the MBTI did not predict these variance differences; as with most theories, the focus is on central tendencies, not variances. It seems that the variance differences could most parsimoniously be attributed to a "floor" effect for the Sensing group. If the criterion were a hedonic scale of attractiveness of book reading for the sample, one would make efforts to extend the scale in

Table 4
Proportions of Extraverted Subjects and Introverted Subjects With Library Card, by Score Group

	MBTI[a] score for extraverted subjects			MBTI[a] score for introverted subjects		
Statistic	≤63	65–81	83–99	101–117	119–135	≥137
Proportion	.500	.476	.476	.734	.786	1.00
N	18	21	21	19	14	9

[a] These Myers-Briggs Type Indicator (MBTI) scores are continuous scores.

the aversive direction so that the pileup of Ss at the lowest values would no longer appear.

It would be expected that a pattern of results differing from the present one would appear if data were collected in a setting in which multiple cognitively complex leisure options existed. Book reading is virtually the only such leisure activity available in the isolated setting where the present data were collected. It is believed that the N-preference subjects' attraction to urban settings (McCaulley, 1978) derives partly from attraction to the urban array of cognitive alternatives. To the extent that an N-preference subject's valence for complexity is distributed among a variety of activities, the contrast between S-preference subjects and N-preference subjects on book reading alone would be reduced, compared with the present findings. Theoretically, however, a setting that presents both nonsocial (e.g., book reading) and social cognitive options would be optimal for revelation of any E versus I and E–I × S–N relationships to the cognitive criteria. Thus it could be speculated that in a setting characterized by cognitive variety, the magnitude of the S–N effect might be reduced, but the potential impact of E–I and E–I × S–N on bookishness might be more clearly revealed.

Theoretical Implications: Typological Differences

It would be safe to venture that most American behavioral scientists are strongly disposed to reject typological approaches (see Gatchel & Mears, 1982; Lidz, 1976, pp. 554–555; Mischel, 1968, 1977). Such systems somehow smack of dogmatism, rigidity, and omniscience. I differ with Mendelsohn and his coworkers when they state that "the concept of type is obviously an attractive one" (Weiss et al., 1982, p. 1183). The nonobvious nature of this observation is only exacerbated by the fact that, after finding no typological markers in an important data set and a replication of that set, the authors offer the following sweeping opinion: "It is our view that the discontinuities that justify categorical thinking will not likely be found using personality variables" (Weiss et al., 1982, p. 1188). It seems worthwhile to check at least a few more cases before developing such an opinion, at least in explicitly typological systems, in which considerable effort has been made to develop an instrument optimally sensitive at the midpoint,[5] where discontinuities are alleged to exist (see Myers, 1962/1975, pp. 89–98).

Curiously, although the MBTI has been favorably reviewed (Carlyn, 1977; McCaulley, 1981) and fairly widely used, most users direct their efforts at construct validation of the bipolar scales by using them as if they were continuous unipolar scales, reporting no effort to check for midpoint discontinuity. This deficit appears, it should be noted, in MBTI studies published by Mendelsohn himself (Mendelsohn, 1966; Mendelsohn & Geller, 1963, 1965, 1967; Mendelsohn & Kirk, 1962), though I. B. Myers had described, empiricized, and debated the first two typological criteria in 1962 (Myers, 1962, 1962/1975). This failure to examine typological criteria need not, however, be attributed to gullibility or sloth. The MBTI theory is novel in many ways other than the

[5] It was reported (Myers, 1962/1975) that this optimal sensitivity was established by examining disparate functions of criterion variables against the two halves of MBTI variables, not by bimodality in frequency distributions. The manual (Myers, 1962/1975, pp. 90–92) describes how the division point of the E–I scale was relocated for Form F because of the form of separate regressions of grades and IQ on the E half and the I half in large samples.

typological ways, and the test may serve as a practical assessment device simply by virtue of its presently established construct validity.

The present study presents evidence that, like the E–I measure (Myers, 1962/1975) and the T–F scale (Myers, 1962/1975; Stricker & Ross, 1964), the S–N scale relates discontinuously, in this case to two closely related cognitive criteria. The shape of the relationship seems to be similar to that reported by Webb (1964), although he does not present means or depict his regression. The E–I scale relates discontinuously to the behavioral criterion in the present study. Dichotomous functions are not always found when MBTI variables correlate significantly with criteria, however (Stricker & Ross, 1964). Myers (1962/1975, pp. 92–98) offered possible methodological reasons for Stricker and Ross's continuous functions. Clearly, however, more discontinuous empirical relationships are needed for each of the multiple criteria relevant to each of the four MBTI variables before the MBTI user is fully justified in alluding to persons falling into the 16 possible score patterns as persons with characteristic personality "types" (see Footnote 4). The present S–N data, which neatly display a change in level at the midpoint that is the only significant change between adjacent groups (see Figure 2), clearly provide incremental support for this typological approach.

The interpretation of more ambiguous data than these may necessitate further refinement of the criteria for discontinuity. Data may be found where there are significant changes at the midpoint but also at other points. When evidence for discontinuity consists of changes in slope in the two halves of the function, rather than changes in level, the criteria for discontinuity may become complex, as Thistlethwaite and Campbell (1960) noted. Some researchers may argue with the standard (Myers, 1962/1975) procedure of grouping the data into thirds in each half of the bipolar scale to reduce unreliability; smaller groupings would likely make any function more jagged and increase the likelihood of obscuring any midpoint discontinuity. At any rate, the details of the criteria for discontinuity warrant further explication because this criterion—not multimodality—is the one on which most proposed typologies will stand or fall.

The question of multimodality calls for further comment because the argument continues to surface that this criterion—definitive in biological taxons—is somehow importable to test proposed psychological typologies. A search of the psychological literature indicated that multimodal frequency distributions are found (Bash, 1955; Gray, 1948) so rarely (Lord, 1958; Myers, 1962/1975; Stricker & Ross, 1964) when they have been searched for in explicitly typological systems and appear (O'Connor, 1941, p. 110; Stukát, 1958, pp. 59–60) so unexpectedly in nontypological systems that their occurrence can safely be posited to be a random departure from a condition of ragged unimodality.

It might, however, be worth noting that MBTI score distributions are typically platykurtic (Myers, 1962/1975), that they tend to become increasingly platykurtic as the responding subjects are older and their scores more reliable (Carlyn, 1977; Myers, 1962/1975), and that the maximal negative value of the fourth moment of a distribution, the kurtosis index, is obtained when a distribution is bimodal (see Mood, 1950). Kurtosis reflects the height of the tails of a distribution; this height is maximal with bimodality. Empirical studies strongly suggest, however, that MBTI score distributions will not attain maximal platykurtosis.

It is tempting to speculate that because discontinuous functions against external criteria have appeared on several occasions when there was no bimodality for the MBTI predictor, perhaps one should require instead that the criterion distribution be bimodal. As the bottom portion of Figure 1 indicates, however, collapsing the S and N groups into a single distribution would produce a jagged distribution but not a bimodal one. Nevertheless, the conventional analyses for differences in location for the S group and the N group on the criterion were highly significant. One suspects that if the Ss and Ns clustered into two separate distributions on the criterion, the magnitude of the resulting statistical effect might be unprecedented in the behavioral sciences.

One can also consider the axiom offered by Mendelsohn et al. (1982), that multiple-variable typologies must yield interactive relationships with external variables. Scant evidence has been offered on this point by past MBTI research. Because the theory behind

the MBTI makes many explicit and implicit interactive predictions, it is hoped that future large-scale studies can undertake the most straightforward and thorough test for multiplicative or interactive relationships between categorical MBTI variables and criterion variables: a daunting (because of the needed sample size) 2 × 2 × 2 × 2 factorial ANOVA. Such an analysis may not be necessary when the hypotheses of an investigation focus only on certain subsets of the variables in question, as in some earlier studies (Carlson, 1980; Stricker & Ross, 1964). MBTI researchers have, however, been lamentably sparing in their use of factorial ANOVA in any form (e.g., Anast, 1966) or in their use of any configural application of the general linear statistical model. Although Mendelsohn is surely more knowledgeable about this issue than some, this limitation applies to Mendelsohn's analyses of a data set that included MBTI scores and frequency of visits to a college counseling center (Mendelsohn & Geller, 1963; Mendelsohn & Kirk, 1962). Students who displayed 1 of the 16 possible score patterns seemed to display a unique avoidance of the college counseling facility (Mendelsohn & Kirk, 1962). A factorial analysis of variance to check the apparent four-way interaction—or any other interaction—could not be executed, however, because the sample size was too small. This humble, familiar difficulty seems to have prevented testing many intriguing proposals about dispositional configurations in this explicit typology.

The problem is not always that an inconveniently large sample size is needed to estimate variable interactions, however. The significance levels of such interactions are sometimes not reported (although they can be calculated from data presented) in some large-scale studies. McCaulley (1978) and McCaulley and Natter (1974) composed the four E–I × S–N cells, for example, but evaluated them only with a univariate F that was not followed by pairwise statistical comparisons of the four cells. The factorial design is typically avoided. McCaulley (1981) made these comments: "The sixteen types differ, then, not only in the four preferences but also in the relationships postulated among them. The relationships are theoretical, not additive or multiplicative" (p. 303). This observation is reminiscent, both in spirit and content, to Block and Ozer's (1982) claim that "changes in the psychological meaning of a variable can occur as a function of the level of another variable in ways that may not be reflected by ANOVA interactions or moderated regressions" (p. 1173). Block and Ozer's argument is weakened, as Weiss et al. (1982) observed, by the fact that there are no merely statistical interactions in the data from which Block and Ozer argued. Oddly, McCaulley's claim is vitiated by the fact that there actually are significant multiplicative interactions in data she has gathered and reported in descriptive terms (McCaulley & Natter, 1974), though the reader must be prepared to do his or her own simple effects analyses to locate the significant configurations. I have calculated significant interaction effects for E–I × S–N scores on IQ, Preliminary Scholastic Aptitude Test scores, and Gates Reading Test scores from the data presented by McCaulley and Natter (1974, p. 143). Other ability measures reveal only main effects for the S–N scale and sometimes for the E–I scale. These patterns do not appear on tests that measure specific practical skills rather than general ability.

The form of the present data, however, only roughly parallels McCaulley and Natter's (1974) findings. The weakly significant interaction against the library use measure was obtained only with continuous scores, not with the dichotomous categories used by McCaulley and Natter and thus cannot, in the present case, be associated with the categorical typology. The significant S–N × T–F interaction was, on the other hand, only detectable with dichotomous categories, not with continuous scores. This interaction was not explicitly predicted. It was, however, in the direction usually found for ability and achievement measures when there is an S–N × T–F interaction (McCaulley & Natter, 1974, p. 144).[6] One should conclude that the interactions in the present data, though suggestive, may be fragile;

[6] Significant S–N × T–F interactions appear in McCaulley and Natter's (1974, p. 144) data for the 12th Grade Aptitude test average and the Mathematics portion of the Preliminary Scholastic Aptitude Test. Here SF-preference subjects exceed ST-preference subjects, but those with the NT preference exceed those with the NF preference. Such an interaction was not expected in the present data partly because the aptitude data in McCaulley and Natter's table that seem most relevant, Gates Reading Test scores, do not show this interaction.

they should not be trusted until they are replicated and so cannot be said to provide clear evidence that the third requirement for a typology offered by Mendelsohn et al. (1982) has been met.

It would, however, be worthwhile to pursue the data analysis methods modeled here with other, perhaps more compelling, criterion variables. The four variables on which the MBTI theory is based, as well as the three variables underlying the Jungian descriptions (Jung, 1921/1971) that the MBTI theory elaborates, are interesting, multifaceted constructs. But gathering together behaviors that seem to stick together and naming the cluster is a popular, almost pedestrian, activity that has long engaged the human observer and the student of factor analysis. Jung himself commented that his variables were merely organizations of observed facts (Jung, 1921/1971). The striking and unusual proposal concerning these variables is the allegation that they are bipolar, reflecting relatively stable, qualitatively different preferences at each pole. This bold hypothesis deserves not the parody it has received (e.g., Gatchel & Mears, 1982, p. 162), but rather further study and empirical investigation. The MBTI is the primary instrument that would facilitate such investigation, but the bipolar hypothesis seems unfortunately to have been unexamined in several extant MBTI data sets.

A second arresting feature of the typological theories, in both the original Jungian version and in the presently discussed extension, is the elaborate detail concerning putative interactions among the variables. One must hope that methods that can detect theorized configural patterns will be increasingly applied to MBTI data; such methods have rarely been used in the past. As Anderson (1972) observed in an analogous context, "Failure to uncover configural processes may reflect inadequate methodology, namely, the use of additive or linear models analyzed by regression-correlation techniques" (p. 93). With interaction-sensitive methodologies, scientific indications could eventually be developed that might suggest either that the typology "cleaves nature at its joints" or that it is simply conceptual baggage, redundantly attached to variables that would be maximally useful when employed additively, as if they formed a conventional unipolar predictor set. There seems to be little value in nihilistic pessimism about the wisdom of attempting to verify these typological proposals. One must, however, equip oneself with methods suited to the quest.

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