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STABILITY OF FACTORS ACROSS MATING PLANS

by

FRANKLIN WAYNE POLEY

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

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THE UNDERSIGNED CERTIFY THAT THEY HAVE READ, AND RECOMMEND TO THE FACULTY OF GRADUATE STUDIES FOR ACCEPTANCE, A THESIS ENTITLED "STABILITY OF FACTORS ACROSS MATING PLANS" SUBMITTED BY FRANKLIN WAYNE POLEY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE OF DOCTOR OF PHILOSOPHY.

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Abstract

This research was conducted to determine whether different segregating and non-segregating mating plans alter the structure of a factor. Two non-segregating mating plans, consisting of four pure strains and four F-1 hybrid groups were used with data obtained from a study on avoidance conditioning and a study on emotional behavior in mice. In addition, two segregating populations, consisting of four F-2 groups and four backcross groups were used with the avoidance conditioning data. Within each of the mating plans selected, data were rearranged in a number of ways. Examination of major loadings, hyperplane counts and invariance coefficients by Burt and Cattell methods showed that factors are stable or invariant across different mating plans. These results indicate that the differential effects of linkage, pleiotropy and assortative mating do not disrupt factor structure.

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Introduction

This research was conducted to answer the question whether genotype may influence factor structure. While genotype has been shown to influence the magnitude of factor scores (Royce, Carran & Howarth, 1970) its effect on the organization of behavior has yet to be studied empirically. This problem was approached in three ways: (1) Directly by visually comparing factor structures from different segregating and non-segregating populations, (2) Indirectly by comparing the adequacy of simple structure (through hyperplane count) in these populations, (3) Indirectly by comparing invariance coefficients of the populations.

The question of the effect of genotype on factor structure has both empirical and theoretical importance. The empirical issue relates to interpretability of factors. Royce (1966), in an extensive review of factor applications in comparative psychology, has suggested that factors of "autonomic balance" and "motor discharge" are invariant. However, the recognition of the same factor across a number of studies is a difficult task. Even within a species there is considerable confusion and this confusion may be due to the use of genetically varied populations. Thus Royce, Carran and Howarth (1970) factored across ten strains of inbred mice while McClearn and Meredith (1964) factored a population of four-way cross (F_2) animals derived from C57BL/Crgl, A/Crgl, DBA/2Crgl and C3H/Crgl strains. Authors of the latter study point out that "...the population sampled from must be sufficiently heterogeneous in order that substantial correlations may emerge. The utilization of a more or less highly inbred group of animals is not a profitable tactic in multivariate studies, therefore, because the process of inbreeding results in a progressive decline in the genetic component of variance." This recommendation is contradiction to the factor analytic study of Willingham (1956) which used only CFW strain mice and the study of Furchtgott and Cureton (1964) which used only mice from a 101 x C3H cross.

If these populations do in fact yield different factor structures it is important to be able to decide which population should be used in the final interpretation of factors. This leads to the criterion of simple structure as a means of obtaining psychologically meaningful, invariant factors.

The question of theoretical significance which is relevant to this research pertains to the relationship between genetic sources of covariation and phenotype covariation, reflected in factor structure. Recently, it has been suggested that the source of variability, especially the exact source of genetic variability, should be considered in the design of a factor analytic study (Poley & Royce, 1969). Failure to do so may produce factors confounded by significant loadings from genetic influences, particularly linkage and assortative mating. These factors would then describe genetic influences rather than psychological-organismic traits. Thus the confounding would occur in terms of identifying meaningful psychological constructs, although the genetic influences may be very real.

Hirsch (1967) has discussed a similar problem in the context of "correlational naivete". He points out that "in diploid organisms many correlations are going to be found that will mislead us into inferring dependence where there is actually biological independence."

In Hirsch's view, the major source of this confounding is in the fiction of random mating. Thus the founders of a population with a multitude of "biologically independent" behavioral characteristics will inevitably be correlated by chance, with respect to some of these characteristics. These correlations would eventually be removed by random mating, with the attainment of Hardy-Weinberg frequencies. But organisms tend not to mate randomly; and over a finite number of generations, little progress is made toward removing the "spurious" correlation. Hirsch comments: "Many of the trait correlations that distinguish racial, ethnic, and national groups can be of just this fortuitous nature, maintained by reproductive isolation and non-random idiosyncratic systems of mating. I consider this a most important result. Its full implications are going to take us a very long time to unravel."

McClearn (1967) also notes that chance conditions may produce correlations across a number of pure strains. For this reason he recommends the use of four-way cross (F_2) animals to test hypotheses about correlations, although the possible influence of linkage is recognized. McClearn suggests that eight-way cross populations would be preferable yet in multivariate research.

Several psychological studies have provided us with empirical evidence to support the reality of these hypotheses. Stockard, Anderson and James (1941) found that body type and temperament segregated independently in F_2 generations of dogs, contradicting the hypothesis of a biological relationship between these dimensions. Although it is possible that evolution could act upon a common physiological basis, the selection pressures in this case are probably imposed by man upon biologically independent characteristics. Brain cholinesterase level, in another line or research, was found to be correlated with learning. But Rosenzweig, Krech and

Bennett (1960) tested an F_2 population and the correlation was lost. A similar fate befell the correlation between alcohol dehydrogenase level and alcohol preference in mice, in a study by McClearn (1965).

Thompson (1957) has discussed the relationship between genes and factors through the common ground of correlation: "We may start merely with an empirical correlation and ask the question--what could this correlation mean in terms of genetics?" He discusses four varieties of 'communality': chromosome communality, gene communality, selection communality and environmental communality. These refer to linkage, pleiotropy, assortative mating and common environmental influences, respectively. Thompson considers these influences to be a plausible basis for factors since they may produce correlations of behavior. He comments that "we must find some methods for deciding which interpretation applies in the case of any particular factor or set of factors". That is, they would produce a relationship between otherwise independent behaviors. This is the problem discussed by Hirsch.

Genetic and environmental influences may also come to exert differential effects due to partitioning of variance. Several computational procedures of relevance to this issue have been developed. Falconer (1960) describes a method developed in quantitative genetics for partitioning the phenotypic correlation (r_p) into genetic correlation (r_A) and environmental correlation (r_E). The r_A component may be calculated from the formula

$$r_A = \frac{\mathrm{cov}_{xy}}{\sqrt{\mathrm{cov}_{xx}\,\mathrm{cov}_{yy}}}$$

where cov_{xy} is obtained from the product of the value of x in parents and the value of y in offspring; cov_{xx} and cov_{yy} are the parent-offspring covariances of each character separately. r_E is estimated directly from phenotypic correlations within pure strains or F_1's from the strains where these are available. Meredith (1969) has developed a method of "Within and Between Sets Factoring". Within-sets factors are obtained by a factor analysis of the correlation matrix calculated from within-cells deviations of inbred strains and (or) their F_1's. Between-sets factors are obtained by factoring the correlation matrix obtained from between-cells deviations. Thus a within-sets correlation is essentially equivalent to r_E while a between-sets correlation is essentially equivalent to r_A. Vandenberg (1966) has factor analyzed Thurstone's PMA scales based on MZ twin differences which reflect environmental influences alone and DZ twin differences which reflect genetic and environmental influences. Furthermore, Vandenberg (1966) points out that the number of significant roots of the equation $|C_{DZ} - C_{MZ}| = 0$ will reflect the number of independent genetic influences; C_{DZ} and C_{MZ} are the covariance matrices of fraternal and identical twin differences, respectively.

Method

Subjects - Data obtained from 320 mice (160 males and 160 females) were used in this study. All subjects were offspring from mating highly inbred strains of mice ordered from Jackson Laboratory. Four different mating plans were selected (Figure 1): pure strain animals, F_1 hybrids, F_2 or four-way cross animals and backcross animals obtained by crossing F_1 hybrids with pure strains. Within each of those mating plans, four different groups of subjects were selected each containing 20 subjects (10 males and 10 females). Within the limitations set by the chosen design, subjects were selected from a larger study conducted by J.R. Royce. Data from this research were used in the present study.

Apparatus - Analyses were based on 17 different measures from seven test situations. Tests include avoidance conditioning, open-field, straightaway, pole, cell, hole-in-wall and pipe. These have been described more fully elsewhere (Royce, Carran and Howarth, 1970).

Avoidance Conditioning - The fully automated avoidance conditioning apparatus has been described elsewhere (Yeudall, Royce and DeLeeuw, 1968). In summary, it consists of a shuttle box (3 1/2 in. wide x 1 5/8 in. high x 15 1/2 in. long) which is mounted inside an insulated chamber with a one-way mirror in the door. Photo-electric cells are mounted in such a way as to focus across the mid-line of the shuttle box. One speaker is located at each end. The chamber is illuminated by a six-watt fluorescent light and is ventilated by a small fan. The control unit located in a separated room allows for adjustable parameters.

MATING PLAN I

Pure Strain A x Pure Strain A
↓
Pure Strain Offspring Tested

SWR/J (N = 20)
C57BL/10J (N = 20)
A/HeJ (N = 20)
SJL/J (N = 20)

MATING PLAN II

Strain A x Strain B
↓
AB hybrids Tested

A/HeJ x SWR/J	(N = 20)
SWR/J x SJL/J	(N = 20)
ST/bJ x SJL/J	(N = 20)
ST/bJ x A/HeJ	(N = 20)

MATING PLAN III

Strain A x Strain B
↓
Hybrid AB x Hybrid AB
↓
F_2 Tested

(SWR/JX129/J) x (SWR/JX129/J)	(N = 20)
(129/JXA/HeJ) x (129/JXA/HeJ)	(N = 20)
(SWR/JXA/HeJ)x (SWR/JXA/HeJ)	(N = 20)
(BALB/CJXSWR/J) x (BALB/CJXSWR/J)	(N = 20)

MATING PLAN IV

Strain A x Strain B
↓
Hybrid AB x Strain B
↓
Backcross Tested

(SWR/JXBALB/CJ)XSWR/J	(N = 20)
(129/JxA/HeJ)XA/HeJ	(N = 20)
(BALB/CJX129/J)X 129/J	(N = 20)
(BALB/CJXSWR/J)X BALB/CJ	(N = 20)

FIGURE 1 Mating Plans and Specific Genotypes

Open Field - The open field used is a flat white plexiglass circle, four feet in diameter, divided by concentric circles painted with narrow black lines. The outermost region, bounded by a 12 inch high sheet metal wall and a 34 inch circle on the other side is divided into 16 equal areas by lines radiating outward. The next region, bounded on the inner side by a 20 inch circle and divided into eight equal portions. The center of the field with a six inch diameter is undivided. The field is housed in a structure of plywood (64 in. long x 52 in. wide x 60 in. high). The housing is fitted with a one-way window for observation and a suspended plexiglass start box. From the celing of the housing, a bank of fluorescent lights behind translucent paper provides uniform illumination at 130 foot-candles.

Straightaway - Straightaway consists of a runway (50 in. long x 1.5 in. wide) elevated 31 inches from the floor. The runway is divided by black lines into 11 interior sections each 3.8 inches long and two 2.3 inch sections at either end. Covering the runway is a transparent plexiglass strip attached to wire mesh for footage. The apparatus is housed in a large plywood structure (62 in. long x 14 in. wide x 56 in. high) with a one-way window. Illumination received from the surface of the runway is 20 foot-candles. Lighting is provided by fluorescent lamps behind translucent glass.

Pole - The pole apparatus consists of a brass rod (3/8 in. x 34 in.) with a 1 1/2 in. wire mesh ladder extending the length of the pole and over the top to form a platform (1 1/2 in. x 2 in.). The pole is enclosed in a plywood structure (51 in. x 20 in. x 16 in.). Subject is placed on the top of the pole and subsequently descends.

Cell and Hole-in-Wall - The cell, hole-in-wall tests are part of the same apparatus. This consists of a gray plexiglass box (12 in. long x 8 in.

wide x 3 in. high) divided into six compartments, each 4 in. x 4 in. x 3 in. Adjacent pairs of these compartments are separated by a black sliding door, covering a 1 1/4 in. square opening. Thus three subjects may be tested at one time. In the hole-in-wall test, subject is placed in one compartment with a transparent plexiglass covering and the door is opened to the other compartment with a black plexiglass covering. In the cell test, subject is allowed to move from the dark compartment to the light compartment. The apparatus is housed in a plywood structure.

Pipe - The pipe apparatus consists of two white opaque goal boxes (6 1/4 in. square x 4 in. deep) connected by a gray plastic tube 24 in. long with 2 1/8 in. inside diameter. Each goal box has a hinged, transparent lid perforated with air holes. On one side of each goal box a circular opening covered by a sliding opaque door leads to the pipe. The pipe is housed in a plywood box (30 in. wide x 43 in. long x 22 in. high) with a hinged door at the front and a one-way window mounted at each end. Subjects are tested in this apparatus on a food deprivation schedule and are required to move from one goal box to the other to obtain a food pellet.

Procedure - Measures described above are part of a large battery requiring a one month period for completion. In this test sequence, avoidance conditioning is the first test, beginning at 40 ± 3 days of age. This is followed by testing on individual emergence, activity wheels, open field, straightaway, pole, cell, hole-in-wall, pipe, circular activity with bell, and underwater swimming.

Variables chosen for the mouse emotionality analysis of the present study were selected because of the apparent invariance of the factors which they measure (Table 1) based on analyses for three consecutive years of

		YEAR 2 FACTORS			
		I	II	III	IV
YEAR 1 FACTORS	I	.33	-.47	.37	.09
	II	.21	.40	-.29	.66
	III	.41	.11	.51	.26
	IV	.46	.36	-.17	.80

		YEAR 3 FACTORS			
		I	II	III	IV
YEAR 2 FACTORS	I	.52	.15	.22	-.04
	II	-.20	.46	-.05	.39
	III	.33	-.35	.54	-.26
	IV	.10	.45	.26	.41

		YEAR 3 FACTORS			
		I	II	III	IV
YEAR 1 FACTORS	I	.50	-.21	.09	-.23
	II	.00	.49	.18	.21
	III	.28	.08	.67	.15
	IV	.00	.39	.19	.64

TABLE I Congruence Coefficients of Four Factors from Three Consecutive Years of Testing, 1967-1969 testing. Factor 1 has highest loadings from open field latency, open field activity, straightaway latency, straightaway activity and pole latency to leave top. It is interpreted as "Freezing" or "Motor Discharge". Factor 11 has highest loadings from straightaway, cell, pole, hole-in-wall, and pipe urination and sex. It is interpreted as "Territorial Marking". Factor 111 has highest loadings from five defecation measures (open field, straightaway, pole, cell, and hole-in-wall and two urination measures (straightaway, pole). It is interpreted as "Autonomic Reactivity". Factor 1V with loadings from pole latency to leave top, pole latency to descend and pole defecation is interpreted as "Acrophobia". Thus mouse emotionality analyses were based on 17 variables and four factors. Mating plans I and II (from Figure 1) were used in these analyses.

The avoidance conditioning analyses were based upon six measures obtained from three consecutive days of testing, with correct avoidances and intertrial activity recorded on each day. This yielded an avoidance conditioning factor and an intertrial activity factor. Analyses were conducted according to all four mating plans in Figure 1.

Analyses

All analyses employed Principal Components factoring. This method extracts factors in order of their contribution to variance. The method also uses ones in the principal diagonal of the correlation matrix. Other methods may employ squared multiple correlations, reliabilities or communalities. The number of components or factors was based upon considerations from previous research. Thus four factors were sought in the mouse emotionality problem corresponding to territorial marking, freezing, acrophobia, and autonomic balance; two factors were sought in the avoidance conditioning problem corresponding to avoidances and activity. However, factoring was terminated with six mouse emotionality factors and three avoidance conditioning factors in order to avoid the loss of factors due to possible reductions in their contribution to variance.

The use of the Principal Components method was justified on several grounds: (1) The previous study by Royce and Poley (1970) employed Principal Components factoring. The factors were initially identified on the basis of this analysis. (2) The communalities were found to be sufficiently high. For pure strains, F-1 and total (N=160) mouse emotionality analyses the communalities were 68.4%, 67.1%, and 64.3% respectively. For the four avoidance conditioning mating plans: pure strains, F-1, F-2 and backcross, the communalities were 77.4%, 78.3%, 83.1%, and 81.4%, respectively. The total (N=320) avoidance conditioning analysis yielded a communality of 82.7%. (3) There is a considerable amount of debate among factor analysts concerning the "best" factor analytic procedure. Conclusions for the present study were based upon comparisons across mating plans. Thus the major requirement was an adequate computerized program which would not selectively bias results for a given population.

Two analytic rotations to simple structure were conducted following the Principal Components solution. Varimax rotation to orthogonal simple structure was developed by Kaiser (1958). In this procedure, the final factor loadings maximize the function.

$$V = n \sum_{p=1}^{m} \sum_{j=1}^{n} (b_{jp}/h_j)^4 - \sum_{p=1}^{m} \left(\sum_{j=1}^{n} (b^2{}_{jp}/h^2{}_j) \right)^2$$

Thus factor loadings (b) will tend toward unity and zero. Promax rotation to oblique simple structure was developed by Hendrickson and White (1964). This procedure computes a transformation matrix, L, of an orthogonal factor matrix, C, such that $L = (C'C)^{-1}C'D$. The matrix D is established as a power of C.[1] In the present study, power two and power four were used.

Factoring and rotations were imposed upon 10 arrangements of the data within each mating plan. The first four arrangements consisted of factoring each of the four genotypes (with N = 20) separately. Thus in a non-segregating population (pure strains and F_1) the source of variation would be environmental only. In a segregating population (F_2 and backcross) variation would be both genetic and environmental. The second set of four arrangements consisted of "mixed groups" analyses (N = 20) whereby five subjects from each of the four genotypes were randomly combined in a group, with the restriction of balancing for sex. In all four mating plans, variation would then be both genetic and environmental. Arrangement number nine was Meredith "Within - Sets" factoring based upon deviations from cell means and representing environmental variation only but with N = 80. (Meredith "Between - Sets" factoring yielded singular matrices.) The final arrangement of each mating plan was obtained by combining all 80 subjects in a factoring. This represents both genetic and environmental variation. In addition to these arrangements a single factoring based upon total N = 320 was conducted for the avoidance conditioning problem and a single factoring based upon N = 160 was conducted for the mouse emotionality problem. The 21 factor matrices for mouse emotionality and 41 factor matrices for avoidance conditioning are described in Appendix A.

The employment of 10 different factorings within each mating plan permits a more general comparison of the effects of mating plans on factor structure. In addition it permits comparison of the arrangements which involve different combinations of genetic and environmental variation, within the mating plans.

The final set of analyses related to the question of how to describe and compare factor structure matrices. A matrix of numbers could be described in many ways. Three methods were selected here because they are important to the use of factors as constructs in psychological research. The first method involved visual examination and interpretation of factors in different solutions. Only matrices based on N = 80 were used since the comparison of all 62 matrices by this method is very awkward, if not impossible. The second, related method was an attempt to quantify Thurstone's (1947) notion of simple structure. Thurstone's criteria were as follows:

(1) Each row of the factor matrix should have at least one zero,

(2) If there are m common factors, each column of the factor matrix should have at least m zeros,

(3) For every pair of columns of the factor matrix there should be several variables whose entries vanish in one column but not in the other,

(4) For every pair of columns of the factor matrix, a large proportion of the variables should have vanishing entries in both columns when there are four or more factors.

(5) For every pair of columns of the factor matrix there should be only a small number of variables with non-vanishing entries in both columns. The complete set of Thurstone criteria is still difficult to quantify but Cattell (1966) has suggested that percentage of loadings in the hyperplane is a reasonable approximation. That is, the number of zero loadings (± .10 are taken as upper and lower limits by convention) is maximized in a given matrix. Eber (1966) has developed the Maxplane factor solution based on this criterion. Thus the second method used in this study was based upon a comparison of hyperplane counts.

The third method involved comparing invariance coefficients for different solutions. Invariance coefficients must be based upon a comparison of the matrix in question with a target matrix. Thus the matrix for each problem with the largest sample size (N = 320 for avoidance conditioning; N = 160 for mouse emotionality) was chosen for these purposes. This followed from the expectation that the large sample size would stabilize correlations and hence factor loadings. Two invariance coefficients which could be applied to oblique solutions were selected. Burt's (1948) congruence coefficient is based on the following formula:

$$r_c = ab/\sqrt{a^2 \quad b^2}$$

where a and b are corresponding factor loadings. Cattell's (1969) salient variable index begins by establishing a frequency table between factors, of positive salient, negative salient and hyperplane loadings. A perfect match, then, would produce entries in the principal diagonal only, for this 3 x 3 table. The S - index indicates the degree to which perfect matching is obtained.

In particular, assume that we have the following table between two factors:

		Factor B		
		PS	H	NS
Factor A	PS	F_{11}	F_{12}	F_{13}
	H	F_{21}	F_{22}	F_{23}
	NS	F_{31}	F_{32}	F_{33}

The final formula for the S-index is

$$S = \frac{F'_{11} + F'_{33} - F'_{13} - F'_{31}}{F'_{11} + F'_{33} + F'_{13} + F'_{31} + \frac{1}{2} \quad (F'_{12} + F'_{21} + F'_{23} + F'_{32})}$$

where $F'_{11} = F'_{33} = \frac{F_{11} + F_{33}}{2},$

$F'_{13} = F'_{31} = \frac{F_{13} + F_{31}}{2},$

$F'_{21} = F'_{23} = \frac{F_{21} + F_{23}}{2},$

and $F'_{12} = F'_{32} + \frac{F_{12} + F_{32}}{2}$

Results

Interpretation of Factors: Factor structure matrices for samples in this research with N = 80 are presented in Appendix B. Promax 4 loadings are reported, to be consistent with the factor solution of Royce and Poley (1970) which determined the choice of variables and factors in the present study. Only loadings ≥ .30 are shown.

In general, factors discovered in the Royce and Poley (1970) analyses are recovered by the present mouse emotionality analyses, regardless of genotype and regardless of whether the analysis is based on combined genotypes (allowing genetic and environmental sources of variation) or Meredith within-sets factoring (allowing environmental variation only).

Appendix B-1 presents the Royce and Poley (1970) factors based on N = 360. Factor 3 with a predominance of activity loadings is interpreted as "motor discharge." Factor 4 with a predominance of urination loadings is interpreted as "territorial marking." Factor 7 with a predominance of defecation loadings is interpreted as "autonomic balance" and Factor 8 with loadings from the pole apparatus is interpreted as "acrophobia." This appendix also shows the major loadings for the total N(160) of the present study. Although the present study used a portion of the data of the larger analysis, invariance still should not be taken for granted. Thus a close examination of the matrix for the present study is warranted and reveals that all four factors are recovered. Factor I is clearly motor discharge, Factor II is territorial marking, Factor III is autonomic balance and Factor IV is acrophobia. Factors V and VI are uninterpreted factors.

Concentrating on pure strain vs. F1 analyses in Appendix B-2, the four factors again appear for Meredith within-sets analyses. The territorial marking factor for pure strains is the only factor presenting some difficulty, with only two of the five urination loadings appearing. There is also some shift in order of factors. Acrophobia is Factor I of pure strains analysis but Factor IV of F-1 analysis while motor discharge is Factor IV of pure strains but Factor I of F-1 analysis. Analyses of Appendix B-3 are based on combining the four genotypes of each mating plan. Again, there is some variation in the order of factors but all four factors do appear in both pure strains and F-1 populations. Motor discharge is Factor I for both populations but Acrophobia appears as Factor II of pure strains and Factor IV of F-1's. Autonomic Balance is Factor III of pure strains but Factor II of F-1's. Territorial marking is Factor IV in the pure strain population and Factor III in the F-1 population. Thus all four factors are readily recognized by the usual method of inspecting major loadings, regardless of genotype. The one noticeable difference which does appear in these analyses is between Meredith within-sets factoring and factoring with combined genotypes. The former yields fewer major loadings on the whole, which may in fact make identification difficult as is the case with Factor III (Territorial Marking) of the pure strains analysis.

The avoidance conditioning factorings also indicate that factors are invariant across mating plans. With all subjects combined in a

	Segregating	Non-Segregating	
Mixed Groups (N=20)	31.5	29.7	30.6
Separate Groups (N=20)	26.2	30.5	28.4
	28.9	30.1	

Table 2

Average Hyperplane Counts of Groups with N=20 (Mouse Emotionality and Avoidance Conditioning) for Segregating and Non-Segregating Populations.

	Mouse Emotionality	Avoidance Conditioning
N=20	34.4	30.2
N=80 Combined Genotypes	40.2	37.0
N=80 Meredith Within-Sets	50.8	34.7
Total N	46.1	66.7

Table 3

Average Hyperplane Counts for Populations with Different Sample Sizes single analysis (Appendix B-4) there is a clear cut avoidance conditioning factor and an activity factor, although activity on day 1 of testing does not load on either factor. This general pattern appears through all analyses of segregating and non-segregating populations; and for both Meredith within-sets and combined groups analyses on these populations. A recurring effect, however, is that loadings on either the conditioning factor or activity factor are split and appear on a third factor.

<u>Hyperplane Counts:</u> Tables showing percentage of loadings in the ±.10 hyperplane are presented in Appendix C. From Appendix D-1 it may be seen that differences between genotypes (pure strains, F-1, F-2 and backcross) are negligible. In Table 2, the average hyperplane count for segregating populations (pure strains and F-1), combining mixed groups and separate groups analyses is 28.9% while the hyperplane count for non-segregating groups (F-2 and backcross) is 30.1%. Looking at this table the other way, mixed groups produce an average hyperplane count of 30.6%. Variation here is both genetic and environmental. Separate groups with variation of environmental origin only, produce an average hyperplane count of 28.4%.

Two influences, though of minor importance to the main objectives of this project, do have an influence on hyperplane count. The oblique rotations surpass the varimax orthogonal rotation in hyperplane count with Promax 2 surpassing Promax 4. Promax 2 (Appendix D-1) averages 32.9% while Promax 4 averages 30.7%. Varimax, however, averages only 27.0%. Another major influence on hyperplane count is sample size. There is also a suggestion in the mouse emotionality analyses that

	Segregating	Non-Segregating	
Mixed Groups (N=20)	.43	.48	.46
	.38	.38	.38
Separate Groups (N=20)	.50	.49	.50
	.38	.37	.38
	.42	.43	

Table 4

Average Invariance Coefficients of Groups with N=20 (Avoidance Conditioning Problem only) for Segregating and Non-Segregating Populations. (S-Index above dotted line; r-c below)

	Mouse Emotionality	Avoidance Conditioning
N=20	.23	.48
	.24	.38
N=80 Combined Genotypes	.23	.42
	.25	.37
N=80 Meredith Within-Sets	.25	.43
	.24	.37

Table 5

Average Invariance Coefficients for Populations With Different Sample Sizes. (S-index above dotted line; r-c below)

Meredith within-sets factoring (N = 80). The hyperplane counts are 50.8% vs. 40.2%. This does not hold up in the avoidance conditioning problem (34.7% vs. 37.0%) which may be due to the small size of the factor matrices in this problem (6 x 3) vs. the relatively large matrices (17 x 6) for mouse emotionality.

Invariance Coefficients: Invariance coefficients, like hyperplane counts, do not reflect any major differences between mating plans. Combining the averages of invariance coefficients (Table 4) gives .42 for segregating populations and .43 for non-segregating populations, in the avoidance conditioning problem. Mixed groups and separate groups analyses also do not differ with S-indices comparing .46 and .50 and congruence coefficients of .38 for both classes of analysis.

Table 5 also indicates that sample size has no effect on invariance coefficients. Two conditions only seem to alter the magnitude of the coefficients. Cattell's salient variable indices are larger than congruence coefficients for the avoidance conditioning problem (but not the mouse emotionality problem). Furthermore, invariance coefficients in general are larger for the avoidance conditioning problem than the mouse emotionality problem.

SUPPLEMENTARY ANALYSES

In order to counter any criticisms that the results obtained might be an artifact of the particular factor method used, two variations on Alpha factoring (Kaiser and Caffrey, 1965) were employed. It would seem unlikely that these methods would change the conclusions of the study, however, since there are no apriori grounds for expecting methods of factoring to be differentially biased by mating plans.

Since the major conclusions of the study were dependent upon factorings for the two mouse emotionality populations and four avoidance conditioning populations, these were selected for re-analysis. The method employed was Alpha factoring, iterating on communalities, with squared multiple correlations as initial communality estimates rather than ones. Factoring was terminated by two methods. The first method, concerned with providing comparability with the major analyses already summarized, terminated with six factors for mouse emotionality and three factors for avoidance conditioning. In the second method, factoring was terminated for eigenvalues greater than I.O.

The results of both variations are presented in Appendix E. It is clear that, for all analyses, the factors sought have re-appeared, although order of extraction and exact magnitudes of loadings have undergone minor change. This consistency occurs in spite of five changes in method: using different initial communality estimates, iterating in the reanalyses, using alpha factoring in addition to principal components, using different criteria for terminating factoring, and basing interpretation upon pattern coefficients on primaries vs. structure on reference axes. Although magnitudes of factor loadings have naturally varied in accordance with varieties in procedure, the pattern of loadings upon which conclusions were based, have not changed.

In no case are there less than two of the three major loadings required to identify the acrophobia factor, in the mouse emotionality analyses. For the other factors, three or more of the loadings required for identification appear. There is only one exception to this. The Autonomic-Balance factor for the F-1 population, with factoring terminated for eigenvalues greater than one, produces only two defecation loadings.

The changes which have occurred in communalities and eigenvalues as a result of the reanalysis are presented in Appendix F. As expected, overall communality estimates are lowered through Alpha factoring (the squared multiple correlation is the lower bound of the communality). Eigenvalues in Appendix F-2 show that Alpha factoring and Principal Components yield the same number of factors by the Kaiser-Guttman criterion (using only factors with eigenvalues greater than one)

In addition to the empirical support thus provided principal components, the following mathematical support is offered. The method of principal components is computationally similar to principal axes factoring (Harman, 1967, p. 136), The latter forms the basis for other methods such as Alpha, Canonical and Image factoring. The major difference relates to communality estimates. However, the method identifies proportionately more common factor variance among the first factors extracted; specific and error variance occur in greater proportion in later factors, with relatively small contributions to total variance. This sequence is also true of other methods of factoring, including Alpha factoring. Alpha factoring and principal components are expected to yield the same total number of factors (Kaiser, 1964). Furthermore, it must be recognized that it is impossible to accurately estimate communalities apriori (Harman, 1967, CH.5). It is possible to show mathematically that the squared multiple correlation is the lower bound for the communality (Dwyer, 1939) and, of course, 1.0 is the upper limit. The precise consequences of different communality estimates in empirical research have received very little attention to date.

Discussion

The main objective of this study has been to determine whether different mating plans (pure strains, F-1, F-2, backcross generations) exert a differential effect on the organization of factors. By three routes it has been determined that the factors studied in this research are highly stable or invariant across mating plans. The first method, involving the interpretation of factors in different matrices examines the major loadings and disregards low loadings. The second method, by hyperplane count disregards large loadings and focuses on zero loadings; thus it is a means of assessing simple structure. The third method, through coefficients of invariance which are mathematically related to correlation coefficients takes into account all of the factor loadings.

The general conclusion of invariance across genotypes would not be predicted from the theoretical writings of Hirsch (1967), McClearn (1967) and Thompson (1957). These papers discuss genetic theory which brings in the influence of covariation primarily through linkage, pleiotropy and assortative mating. Thompson (1957) also discusses "environmental communality." The disruption of factorial invariance would be expected on the basis of differential effects of these influences in different populations rather than in terms of a constant influence across populations (see Table 6).

The mechanism of linkage operates through meiosis or reduction division. Each body cell of an organism contains the diploid number of chromosomes characteristic of the species. That is, the chromosomes occur in pairs. In order to prevent this number from doubling each generation, reduction division or meiosis occurs, in

	Pure Strains		F-1		F-2		Backcross	
	Between	within	Between	within	Between	within	Between	within
Linkage	No	No	No	No	Yes	Yes	Yes	Yes
Pleiotropy	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Assortative Mating	Yes	No	Yes	No	No	No	No	No

TABLE 6

Differential Effects of Genetic Influences

on Four Mating Plans

the formation of gametes. During the process of meiosis, corresponding segments of homologous chromosomes are exchanged, providing genetic variability for the next generation. If two different genes on the same chromosome are in close proximity, they have a high probability of crossing over together. That is, they are linked, and the phenotypic expressions of these genes will covary. This influence would occur in the formation of gametes for an F-2 or backcross population but not in the formation of gametes for pure strains or F-1 populations from crossing pure strains. The homozygosity of pure strains assures that crossing over will not change the genetic constitution of a population. Thus linkage would exert its influence in a segregating F-2 or backcross population, but not in a non-segregating pure strain or F-1 population. "Across and within groups" types of analysis would not be expected to differ for any of the four populations, as a result of linkage.

Pleiotropy refers to the influence of a given gene upon two or more different characteristics. This could occur through a common biochemical pathway or several distinct pathways. Pleiotropy would exert its influence in both segregating and non-segregating populations. As a constant influence it should not disrupt factorial invariance. However, within-groups analyses for pure strain and F-1 populations would not manifest a pleiotropic effect on variance-covariance since there is no genetic variability. Only for between groups or across groups analyses would this influence appear. Segregating populations manifest genetic variability both between and within groups. Thus pleiotropy would again appear as a random influence.

Assortative mating, which is emphasized by Hirsch (1967), would originate in the natural population or base population from which the inbred lines are derived. Although assortative mating itself refers to covariation of phenotypes, the underlying genes would also be expected to covary. Consequently, fixation and loss of genes at the relevant loci would also be expected to covary. Thus the effects of assortative mating would continue in pure strain populations and F-1 populations. Segregating populations on the other hand should eliminate these effects due to the independent assortment of genes. As is the case with pleiotropic effects, assortative mating effects would be found in between groups analyses but not in within groups analyses for non-segregating populations. These effects would be absent in segregating populations, both for between and within groups analyses. The fourth class of influences referred to above, environmental communality, would not exert a differential effect since environment is held constant for all groups.

Although these influences do occur and might be expected to disrupt factorial invariance through their effects on covariation, factors appear to be constant across mating plans. One explanation of these results may be in terms of the magnitude of the influences. The present study was designed to examine the invariance of factors; and effects such as linkage and assortative mating may be too subtle to detect by the means of assessing factorial invariance. Furthermore, a factor is defined by loadings of a number of different variables. This statistical property would be expected to stabilize factors although occasional influences may add or delete a variable from a factor. A more speculative explanation of factorial invariance is in terms of the "super gene" concept. The super gene consists of a number of genes within a segment of chromosome, for which crossing over is prevented by a mechanism such as an inversion loop. Presumably evolution would produce such a structure because of the co-adaptive value of the individual genes within the loop or selection for genes which suppress crossing-over between loci. The phenotypic expression of this phenomenon may be factorial invariance.

The primary implication of this research for factor analytic studies is that factoring may be based upon any population, from the genetic standpoint, which produces sufficient variance to permit the calculation of stable correlations. Factoring may be conducted within a single strain (Willingham, 1956), across several strains (Royce, Carran & Howarth, 1970), or in a segregating population (McClearn & Meredith, 1964). Nevertheless, there is still little agreement in the factors identified by the rodent-factor studies conducted to date. Aside from differences caused by selection of variables, discrepancies may be due to sample size. The present research has shown that sample size has an important influence on hyperplane count. Meredith within sets factoring produces an extremely high hyperplane count and may be a useful technique in factor studies where some difficulty is encountered in obtaining simple structure.

FOOTNOTES

1. The matrix D is obtained from $D = | aij^{K+1} | / aij$ where aij is a loading in the original orthogonal matrix and (k + 1) represents raising these loadings to a specified power.

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APPENDIX A

FACTOR MATRICES EMPLOYED IN INVARIANCE ANALYSES

(Each solution is based on Principal Axes factoring with three rotations; Varimax, Promax 2, Promax 4; Three factors are extracted for the Avoidance Conditioning Problem based on 6 variables and Six for the Mouse Emotionality Problem based on 17 variables)

Source of Matrix	No. Matrices	No. Subjects
4 different genotypes combined in one analysis (pure strains; F1; F2; backcross) Avoidance Conditioning	1	320 (4 x 80)
Factoring within each Pure Strain Separately (Avoidance Conditioning)	4	20 in each analysis (10 male; 10 female)
Factoring within each F1 Separately (Avoidance Conditioning)	4	20 in each analysis (10 male; 10 female)
Factoring within each F2 group Separately (Avoidance Conditioning)	4	20 in each analysis (10 male; 10 female)
Factoring within each Backcross-group Separately (Avoidance Conditioning)	4	20 in each analysis (10 male; 10 female)
Meredith Within-Sets factoring for each of the 4 genotypes (Avoidance Conditioning)	4	80 in each analysis
Meredith Between-Sets factoring for each of 4 Genotypes (Avoidance Conditioning)	nil	Singular Correlation Matrices
Each Genotype (pure strains; F1; F2; backcross) factored separately (Avoidance C)	4	80 in each analysis

Source of Matrix	No. Matrices	No. Subjects
"Mixed Groups" analysis formed by combining 5 Ss from each of 4 groups in a given genotype. (Avoidance Conditioning) Pure Strain Samples	4	20 in each (5 males from group 1; 5 males from group 2; 5 females from group 3; 5 females from group 4)
"Mixed Groups" analysis F1 - population	4	20 in each
"Mixed Groups" analysis F2 population	4	20 in each
"Mixed Groups" analysis Backcross-population	4	20 in each
Mouse Emotionality Problem 2 different genotypes combined in one analysis (pure strains; F1)	1	160 (2 x 80)
Mouse Emotionality Problem Factoring within each pure strain separately	4	20 in each (10 male; 10 female)
Mouse Emotionality Problem Factoring within each F1 group separately	4	20 in each (10 male; 10 female)
Mouse Emotionality Problem Meredith Within - sets for each of the 2 genotypes	2	80 in each analysis
Mouse Emotionality Problem Meredith Between - Sets for each of the 2 genotypes	nil	Singular Correlation Matrices
Mouse Emotionality Problem Meredith Between - Sets for each of the 2 genotypes	nil	Singular Correlation Matrices
Each Genotype Factored separately (Pure strains; F1)	2	80 in each analysis

Source of Matrix	No. Matrices	No. Subjects
"Mixed Groups" analysis for pure strains	4	20 in each
"Mixed Groups" analysis for F1 groups	4	20 in each

		FACTOR				FACTOR					
	Variable	"3" M-D	"4" TERR	"7" A-B	"8" ACR	I MD	II TERR	III A-R	IV ACR	V	VI
1	Sex		-37				-48	-51			
2	Open field Latency	85				91					
3	Open Field Activity	-29				-56			-44	-43	
4	Open Field Defecation			58				70			
5	Straightaway Latency	84				90					
6	Straightaway Activity	-30									73
7	Straightaway Defecation			74				67			53
8	Straightaway Urination		55	35			57	54			
9	Pole Latency Leave Top	63			53	77			54		
10	Pole Latency Descend				81				83		
11	Pole Defecation			57	55			36	81		
12	Pole Urination		36	47			55				42
13	Cell Defecation			47				63		56	
14	Cell Urination		66				68				
15	Hole Defecation			45						78	
16	Hole Urination		63				69			38	
17	Pipe Urination		72				65				

ROYCE & POLEY (1970)

PRESENT STUDY (N = 160)

Promax 4 factor structure matrices from Royce & Poley (1970) and total N(160) for the present study, mouse emotionality problem (only loadings $\geq$ .30 shown.

APPENDIX B-1

	PURE STRAINS						F - 1					
	FACTOR						FACTOR					
	A-B	ACR	M-D	TERR			M-D	A-B	TERR	ACR		
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
1					-75			-46	-57			
2			84				92					
3	-56	-36	-67			36	-65			-42		
4	40		37		36	-44		79				
5	31	48	75				88					
6						74					56	47
7	53				53	46		72			49	
8	36			55	45			46	41		48	
9		88	37				80			42		
10		86								83		
11	47	71	48		32			33		79		
12			50	57							80	
13	87							78				
14				70	33				78			
15	79			37	40							86
16	38			79					71			31
17				55	69	47			59			

PROMAX 4 FACTOR STRUCTURE MATRICES FOR PURE STRAINS (N = 80) AND F - 1 (N = 80) FOUR GENOTYPES ARE COMBINED FOR EACH ANALYSIS.

APPENDIX B-2

	FACTOR						FACTOR					
	ACR	A-B	TERR	M-D			M-D	A-B	TERR	ACR		
VARIABLE	I	II	III	IV	V	VI	I	II	III	IV	V	VI
1						54		-30				
2		-43		34			87					
3				-40			-47					
4						-50		62				
5				50			84					
6						34						32
7		48						58				
8											51	
9	81						56					
10	73									65		
11	63									77		
12					50						54	
13		75						75			-32	
14			44						55			
15		79										44
16			61						69			
17				37	35				38			

PURE STRAINS F - 1

PROMAX 4 FACTOR STRUCTURE MATRICES FOR MEREDITH WITHIN-SETS ANALYSIS ON PURE STRAINS (N = 80) AND F - 1 (N = 80), MOUSE EMOTIONALITY.

APPENDIX B-3

VARIABLE	FACTOR			FACTOR			FACTOR		
	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1		75		82					85
2 Avoidances Day 2		87		81				72	30
3 Avoidances Day 3		79		73		-31		85	
4 Activity Day 1			99			93	83	-36	28
5 Activity Day 2	99				90		73		
6 Activity Day 3	99				81		82		-28

N = 320 PURE STRAINS COMBINED F - 1 COMBINED

PROMAX 4 FACTOR STRUCTURE MATRICES FOR TOTAL N = 320, PURE STRAINS COMBINED (N = 80), F - 1 COMBINED (N = 80) AVOIDANCE CONDITIONING PROBLEM.

APPENDIX B-4

	FACTOR			FACTOR			FACTOR		
VARIABLE	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1		67	-40	76			82		
2 Avoidances Day 2		90		87			81		
3 Avoidances Day 3		78	32	83			77		
4 Activity Day 1			88			91			92
5 Activity Day 2	99				50	47		91	
6 Activity Day 3	99				92			71	
	F - 2 COMBINED			BACKCROSS COMBINED			WITHIN-SETS PURE STRAINS		

PROMAX 4 FACTOR STRUCTURE MATRICES FOR F - 2 COMBINED (N = 80), BACKCROSS COMBINED (N = 80) AND WITHIN-SETS PURE STRAINS, AVOIDANCE CONDITIONING PROBLEM.

APPENDIX B-5

VARIABLE	FACTOR			FACTOR			FACTOR		
	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1			88		54	-48	68		
2 Avoidances Day 2		83			91		82		
3 Avoidances Day 3		80			81	30	80		
4 Activity Day 1	88	-31				86			88
5 Activity Day 2	58	42		98				59	46
6 Activity Day 3	81			98				92	
	WITHIN-SETS F-1			WITHIN-SETS F-2			WITHIN-SETS BACKCROSS		

PROMAX 4 FACTOR STRUCTURE MATRICES FOR WITHIN-SETS F-1, WITHIN-SETS F-2, WITHIN-SETS BACKCROSS, AVOIDANCE CONDITIONING PROBLEM.

APPENDIX B-6

PERCENTAGE OF VARIABLES IN THE ±10HYPERPLANE
MOUSE EMOTIONALITY PROBLEM

	Pure Strains				F1 Population			
	Source of Matrix	Varimax	Promax 2	Promax 4	Source of Matrix	Varimax	Promox 2	Promax
1	Mixed Sets - 1 (N=20)	30.4	39.2	40.2	Mixed Sets - 1 (N=20)	31.4	36.3	32.4
2	Mixed Sets - 2 (N=20)	32.4	33.3	24.5	Mixed Sets - 2 (N=20)	31.4	32.4	34.3
3	Mixed Sets - 3 (N=20)	26.5	38.2	32.4	Mixed Sets - 3 (N=20)	16.7	19.6	25.5
4	Mixed Sets - 4 (N=20)	31.4	37.3	35.3	Mixed Sets - 4 (N=20)	27.5	33.3	34.3
5	A/HeJ x A/HeJ(N-20)	35.3	40.2	33.3	SWRXSJL (N=20)	24.5	24.5	27.5
6	SJL X SJL (N=20)	30.4	32.4	29.4	ST X SJL (N=20)	26.5	42.2	36.3
7	C57 X C57 (N=20)	32.4	38.2	31.4	ST X A/HeJ (N=20)	23.5	29.4	32.4
8	SWR X SWR (N=20)	33.3	33.3	30.4	A/HeJ X SWR (N=20)	28.4	30.4	29.4
9	Four Strains Combined (N=80)	34.3	37.3	34.3	Four F-1 Combined N=80	44.1	49.0	42.2
10	Meredith Within-Sets (N=80)	52.0	54.9	53.9	Meredith Within-Sets N=80	45.0	52.0	47.0

TOTAL: N=160
VARIMAX: 44.1
PROMAX 2: 49.0
PROMAX 4: 45.1

APPENDIX C-1

PERCENTAGE OF VARIABLES IN ± .10 HYPERPLANE AVOIDANCE CONDITIONING PROBLEM

	Pure Strains				F1 Population			
	Source of Matrix	Varimax	Promax 2	Promax4	Source of Matrix	Varimax	Promax 2	Proma
1	Mixed Sets-1 (N=20)	44.4	61.1	50.0	Mixed Sets - 2 (N=20)	16.7	27.8	33.3
2	Mixed Sets - 2 (N=20)	27.8	33.3	22.2	Mixed Sets - 2 (N=20)	27.8	38.9	27.8
3	Mixed Sets - 3 (N=20)	5.6	5.6	5.6	Mixed Sets - 3 (N=20)	33.3	33.3	27.8
4	Mixed Sets - 4 (N=20)	27.8	33.3	16.7	Mixed Sets - 4 (N=20)	22.2	27.8	16.7
5	A/HeJ X A/HeJ (N=20)	27.8	22.2	33.3	SWR X SJL (N=20)	27.8	27.8	27.8
6	SJL X SJL (N=20)	22.2	27.8	27.8	ST X SJL (N=20)	16.7	33.3	27.8
7	C57 X C57 (N=20)	11.1	50.0	50.0	ST X A/He J (N=20)	38.9	38.9	38.9
8	SWR X SWR (N=20)	16.7	16.7	22.2	A/HeJ X SWR (N=20)	11.1	44.4	50.0
9	Four Strains Combined (N=80)	27.8	50.0	44.4	Four F-1 Combined (N=80)	27.8	33.3	27.8
10	Meredith within Sets (N=80)	33.3	44.4	38.9	Meredith Within Sets (N=80)	22.2	27.8	33.3

TOTAL: N=320
VARIMAX: 66.7
PROMAX 2:66.7
PROMAX 4: 66.7

APPENDIX C-2

PERCENTAGE OF VARIABLES IN ± .10 HYPERPLANE
AVOIDANCE CONDITIONING PROBLEM

	F2 Population				Backcross Population			
	Source of Matrix	Varimax	Promax 2	Promax 4	Source of Matrix	Varimax	Primax 2	Primax 4
1	Mixed Sets-1 (N=20)	27.8	38.9	22.2	Mixed Sets - 1 (N=20)	50.0	61.1	66.7
2	Mixed Sets - 2 (N=20)	33.3	27.8	22.2	Mixed Sets-2 (N=20)	22.2	27.8	27.8
3	Mixed Sets - 3 (N=20)	11.1	66.7	55.6	Mixed Sets - 3 (N=20)	5.6	5.6	16.7
4	Mixed Sets - 4 (N=20)	16.7	16.7	22.2	Mixed Sets - 4 (N=20)	11.1	50.0	50.0
5	(SWR X 129) (N=20)	16.7	27.8	27.8	(SWRXBALB) X SWR (N=20)	5.6	38.9	38.9
6	(129 X A/HeJ) (N=20)	16.7	27.8	22.2	(129 X A/HeJ) X A/HeJ (N=20)	27.8	33.3	27.8
7	(SWR X A/HeJ) (N=20)	16.7	5.6	5.6	(BALB X 129) X 129 (N=20)	33.3	50.0	44.4
8	(BALB X SWR) (N=20)	16.7	11.1	11.1	(BALB X SWR) X BALB (N=20)	44.4	38.9	33.3
9	Four F2 Combined (N=80)	50.0	50.0	50.0	Four Backcross Combined (N=80)	27.8	33.3	22.2
10	Meredith Within Sets (N=80)	38.9	44.4	44.4	Meredith Within Sets (N=80)	16.7	33.3	38.9

TOTAL: N = 320
VARIMAX: 66.7
PROMAX 2: 66.7
PROMAX 4: 66.7

APPENDIX C-3

			VARIMAX	PROMAX 2	PROMAX 4
AVOIDANCE CONDITIONING	PURE STRAINS	MIXED GROUPS	26.4	33.3	23.6
		SEPARATE GROUPS	19.5	29.2	33.3
		OVERALL AVERAGE	24.5	34.4	31.1
	F - 1	MIXED GROUPS	25.0	32.0	26.4
		SEPARATE GROUPS	23.6	36.1	36.1
		OVERALL AVERAGE	24.5	33.3	31.1
	F - 2	MIXED GROUPS	22.2	37.5	30.6
		SEPARATE GROUPS	16.7	18.1	16.7
		OVERALL AVERAGE	24.5	18.1	16.7
	BACKCROSS	MIXED GROUPS	22.2	36.1	40.3
		SEPARATE GROUPS	27.8	40.3	36.1
		OVERALL AVERAGE	24.5	37.2	36.7
MOUSE EMOTIONALITY	PURE STRAINS	MIXED GROUPS	30.2	37.0	33.1
		SEPARATE GROUPS	32.9	36.0	31.1
		OVERALL AVERAGE	33.8	39.4	34.5
	F - 1	MIXED GROUPS	26.8	30.4	31.6
		SEPARATE GROUPS	25.7	31.6	31.4
		OVERALL AVERAGE	29.9	34.9	34.1

AVERAGE HYPERPLANE COUNTS FOR DIFFERENT MATING PLANS AND ARRANGEMENTS OF DATA.

APPENDIX D-1

AVERAGE CONGRUENCE CO-EFFICIENTS (r - c) AND SALIENT VARIABLE INDICES (S)

MOUSE EMOTIONALITY PROBLEM (BASED ON ABSOLUTE VALUES)

PURE STRAINS	S	r - c	F - 1 POPULATION	S	r - c
	Promax 2	Promax 2		Promax 2	Promax 2
MIXED GROUPS -1 (N = 20)	.25	.22	Mixed Groups -1 (N = 20)	.24	.25
MIXED GROUPS -2 (N = 20)	.25	.26	Mixed Groups -2 (N = 20)	.22	.26
MIXED GROUPS -3 (N = 20)	.18	.24	Mixed Groups -3 (N = 20)	.24	.22
MIXED GROUPS -4 (N = 20)	.25	.28	Mixed Groups -4 (N = 20)	.23	.25
A/HEJ x A/HEJ (N = 20)	.26	.26	SWR x SJL (N = 20)	.20	.24
SJL x SJL (N = 20)	.24	.26	ST x SJL (N = 20)	.25	.24
C57 x C57 (N = 20)	.24	.23	ST x A/HEJ (N = 20)	.22	.24
SWR x SWR (N = 20)	.25	.19	A/HEJ x SWR (N = 20)	.21	.22
FOUR GROUPS COMBINED (N=80)	.23	.25	Four Groups Combined (N=80)	.23	.24
MEREDITH WITHIN SETS (N=80)	.25	.21	Meredith Within Sets (N=80)	.24	.26

APPENDIX D-2

AVERAGE CONGRUENCE CO-EFFICIENTS (r - c) AND SALIENT VARIABLE INDICES (S)
AVOIDANCE CONDITIONING PROBLEM (BASED ON ABSOLUTE VALUES)

PURE STRAINS	S	r - c	F - 1 POPULATION	S	r - c
	Promax 2	Promax 2		Promax 2	Promax 2
MIXED GROUPS -1 (N = 20)	.33	.33	Mixed Groups -1 (N = 20)	.61	.40
MIXED GROUPS -2 (N = 20)	.54	.38	Mixed Groups -2 (N = 20)	.50	.42
MIXED GROUPS -3 (N = 20)	.28	.37	Mixed Groups -3 (N = 20)	.39	.35
MIXED GROUPS -4 (N = 20)	.71	.41	Mixed Groups -4 (N = 20)	.42	.36
A/HEJ x A/HEJ (N = 20)	.41	.39	SWR x SJL (N = 20)	.51	.38
SJL x SJL (N = 20)	.60	.41	ST x SJL (N = 20)	.51	.34
c57 x c57 (N = 20)	.56	.39	ST x A/HEJ (N = 20)	.35	.35
SWR x SWR (N = 20)	.33	.33	A/HEJ x SWR (N = 20)	.57	.38
FOUR GROUPS COMBINED (N=80)	.34	.34	Four Groups Combined (N=80)	.66	.43
MEREDITH WITHIN SETS (N=80)	.28	.34	Meredith Within Sets (N=80)	.70	.42

APPENDIX D-3

AVERAGE CONGRUENCE CO-EFFICIENTS (r - c) AND SALIENT VARIABLE INDICES (S)

AVOIDANCE CONDITIONING PROBLEM (BASED ON ABSOLUTE VALUES

F - 2 POPULATION			BACKCROSS POPULATION		
	S	r - c		S	r - c
	Promax 2	Promax 2		Promax 2	Promax 2
MIXED GROUPS -1 (N = 20)	.43	.38	Mixed Groups -1 (N = 20)	.33	.33
MIXED GROUPS -2 (N = 20)	.56	.38	Mixed Groups -2 (N = 20)	.45	.37
MIXED GROUPS -3 (N = 20)	.33	.34	Mixed Groups -3 (N = 20)	.46	.41
MIXED GROUPS -4 (N = 20)	.53	.40	Mixed Groups -4 (N = 20)	.36	.36
(SWR X 129) (N = 20)	.44	.36	(SWR X BALB) x SWR (N=20)	.41	.38
(129 x A/HEJ) (N - 20)	.62	.39	(129 x A/HEJ) x A/HEJ (N=20)	.49	.40
SWR x A/HEJ (N = 20)	.65	.38	(BALB x 129) x 129 (N = 20)	.49	.37
BALB x SWR (N = 20)	.53	.37	(BALB x SWR) x BALB (N=20)	.33	.33
FOUR GROUPS COMBINED (N=80)	.30	.33	Four Groups Combined (N=80)	.37	.36
MEREDITH WITHIN SETS (N=80)	.42	.34	Meredith Within Sets (N=80)	.32	.36

APPENDIX D-4

			S - Index	r - c
CONDITIONING AVOIDANCE	PURE STRAINS	MIXED GROUPS	.47	.37
		SEPARATE GROUPS	.48	.38
		OVERALL AVERAGE	.44	.37
	F - 1	MIXED GROUPS	.48	.38
		SEPARATE GROUPS	.49	.36
		OVERALL AVERAGE	.52	.36
	F - 2	MIXED GROUPS	.46	.38
		SEPARATE GROUPS	.56	.38
		OVERALL AVERAGE	.48	.37
	BACKCROSS	MIXED GROUPS	.40	.37
		SEPARATE GROUPS	.43	.37
		OVERALL AVERAGE	.40	.37
MOUSE EMOTIONALITY	PURE STRAINS	MIXED GROUPS	.23	.25
		SEPARATE GROUPS	.25	.24
		OVERALL AVERAGE	.24	.24
	F - 1	MIXED GROUPS	.23	.25
		SEPARATE GROUPS	.22	.24
		OVERALL AVERAGE	.23	.24

AVERAGE INVARIANCE CO - EFFICIENTS FOR DIFFERENT MATING PLANS AND ARRANGEMENTS OF DATA

APPENDIX D-5

VARIABLE	FACTOR						FACTOR					
	TERR	M-D	A-B	ACR			M-D	TERR		A-B	ACR	
	I	II	III	IV	V	VI	I	II	III	IV	V	VI
1				-34					-45			
2		79					93					
3		-67							79			
4		31										
5		78		33			90					
6						64						39
7	32		30							64		
8	66									43		
9				64			68					
10				74							63	
11				31	50					42	74	
12					80					66		
13			88						56			
14	73							65				
15			62					38				62
16	69							99				35
17	49							29				

PURE STRAINS
6 FACTOR SOLUTION

F-1
6 FACTOR SOLUTION

PROMAX 4 MATRICES OF PATTERN ON PRIMARIES BASED ON AN ITERATED ALPHA FACTORING WITH VARIMAX ROTATION.

APPENDIX E-1

VARIABLE	FACTOR					FACTOR						
	TERR	M-D	ACR	A-B		M-D	TERR	ACR			A-B	
	I	II	III	IV	V	I	II	III	IV	V	VI	VII
1			-39						-45			
2		78				93						
3		-67							87			
4		31		37						99		
5		79				94						
6					47						34	
7	34										50	
8	68										38	
9			66			66		31				
10			66					60				
11			41		52			96			39	
12					60						68	
13				60					49	35		
14	69						75					
15				75								62
16	68						78					32
17	47						39					

PURE STRAINS

FACTORS WITH $\lambda > 1$

F-1

FACTORS WITH $\lambda > 1$

PROMAX 4 MATRICES OF PATTERN ON PRIMARIES BASED ON AN
ITERATED ALPHA FACTORING WITH VARIMAX ROTATION
(FACTORING TERMINATED $\lambda > 1$)

APPENDIX E-2

FACTOR

VARIABLE	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1	77			58				54	
2 Avoidances Day 2	87		32	90				76	
3 Avoidances Day 3	52			70		34		28	72
4 Activity Day 1			43		62				
5 Activity Day 2		72			61		100		
6 Activity Day 3		84			85		100		

PURE STRAINS
3 FACTOR SOLUTION

F-1
3 FACTOR SOLUTION

F-2
3 FACTOR SOLUTION

PROMAX 4 MATRICES OF PATTERN ON PRIMARIES BASED ON AN ITERATED ALPHA FACTORING WITH VARIMAX ROTATION (AVOIDANCE CONDITIONING)

APPENDIX E-3

FACTOR

VARIABLE	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1	61				78		55		
2 Avoidances Day 2	89				78		93		
3 Avoidances Day 3	74				57		66		
4 Activity Day 1		64						65	
5 Activity Day 2		79	48	43				60	
6 Activity Day 3			65	109				76	

BACKROSS
3 FACTOR SOLUTION

PURE STRAIN
FACTORS WITH $\lambda > 1$

F-1
FACTORS WITH $\lambda > 1$

PROMAX 4 MATRICES OF PATTERN ON PRIMARIES BASED ON AN ITERATED ALPHA FACTORING WITH VARIMAX ROTATION (AVOIDANCE CONDITIONING)

APPENDIX E-4

FACTOR

VARIABLE	I	II	III	I	II	III	I	II	III
1 Avoidances Day 1		54			68				
2 Avoidances Day 2		76			92				
3 Avoidances Day 3			72		65				
4 Activity Day 1				42					
5 Activity Day 2	99			122					
6 Activity Day 3	100			49					

F-2
FACTORS WITH $\lambda > 1$

BACKCROSS
FACTORS WITH $\lambda > 1$

PROMAX 4 MATRICES OF PATTERN ON PRIMARIES BASED ON AN ITERATED ALPHA FACTORING WITH VARIMAX ROTATION (AVOIDANCE CONDITIONING)

APPENDIX E-5

M. E. DATA

Var.	P-S_1	P-S_2	F-1_1	F-1_2
1	68	40	54	33
2	73	85	87	60
3	73	56	59	61
4	60	38	65	33
5	72	81	85	73
6	69	22	56	39
7	60	43	65	26
8	48	35	45	49
9	82	59	75	50
10	78	44	75	52
11	75	70	84	50
12	62	32	69	59
13	79	60	70	72
14	52	42	62	44
15	72	31	79	65
16	76	63	67	58
17	65	14	45	28

A. C. DATA

Var.	P-S_1	P-S_2	F-1_1	F-1_2	F-2_1	F-2_2	B_1	B_2
1	71	55	90	38	61	26	67	45
2	74	70	80	80	83	82	81	82
3	65	40	78	53	74	76	73	52
4	92	20	81	48	81	09	91	40
5	83	49	65	42	99	99	84	97
6	80	77	76	63	99	99	92	49

APPENDIX F-1

Communalities of Variables for Major Mating Plans Compared. The Subscripts refer to Principle Components (1) or Alpha Factoring (2). Solutions are based on Six Factors.

M. E. DATA

Factor	P-S_1	P-S_2	F-1_1	F-1_2
1	3.9	6.6	3.3	6.0
2	2.8	3.4	2.5	3.0
3	1.4	3.2	1.9	2.9
4	1.4	1.9	1.3	2.3
5	1.2	1.2	1.2	1.6
6	0.9	0.9	1.1	1.4
7	0.8	0.6	1.0	1.1

A.C. DATA

Factor	P-S_1	P-S_2	F-1_1	F-1_2	F-2_2	F-2_2	B_1	B_2
1	2.3	3.4	2.1	3.0	2.2	3.4	2.4	3.4
2	1.4	1.9	1.9	2.8	1.8	1.9	1.6	2.1
3	0.9	0.9	0.7	0.4	1.0	1.1	0.8	0.6

APPENDIX F-2

Eigenvalues of Factors for Major Mating Plans Compared. The Subscripts refer to Principle Components (1) or Alpha Factoring (2).

M.E. DATA

Factor	P-S$_1$	P-S$_2$	F-1$_1$	F-1$_2$
1	20.3	16.8	25.1	30.5
2	20.8	26.7	18.3	14.8
3	20.5	14.5	16.8	16.3
4	11.8	19.0	15.2	14.6
5	12.7	13.3	13.1	16.0
6	14.0	9.8	11.6	7.9

A. C. DATA

Factor	P-S$_1$	P-S$_2$	F-1$_1$	F-1$_2$	F-2$_1$	F-2$_2$	B$_1$	B$_2$
1	42.7	47.9	43.6	51.4	40.4	58.8	47.4	48.7
2	33.6	39.0	34.2	40.9	38.4	23.9	27.1	29.7
3	23.8	13.1	22.2	7.7	21.3	17.3	25.5	21.6

Appendix F-3

PERCENTAGE OF TOTAL COMPONENTS VARIANCE (1) AND TOTAL FACTOR VARIANCE (2) EXTRACTED BY SUCCESSIVE PROMAX 2 FACTORS.

APPENDIX G

MOUSE EMOTIONALITY AND AVOIDANCE CONDITIONING DATA PRESENTED IN THE SAME SEQUENCE OF GENOTYPES

The mouse emotionality sequence of data is as follows: Sex, open-field latency, open-field activity, defecation, straightaway latency, straightaway activity, straightaway defecation, straightaway urination, pole latency to leave top, pole latency to descend, pole defecation, pole urination, cell defecation, cell urination, hole defecation, hole urination, pipe urination. The avoidance conditioning sequence of data is as follows: correct avoidances Day 1, correct avoidances Day 2, correct avoidances day 3, activity Day 1, activity Day 2, activity Day 3.

SJL/J x SJL/J

2/4.9/70.0/2.5/1.1/98.0/1.5/1.0/40.9/21.7/1.0/0.0/3.5/1.0/4.0/0.5/0.0

2/7.3/80.0/6.0/3.3/127.0/3.0/0.5/100.7/18.4/2.0/1.0/1.5/0.0/3.0/0.5/0.5

2/7.4/36.0/4.5/5.7/78.0/3.5/2.0/44.1/18.0/1.5/0.0/3.5/0.5/1.5/0.0/0.0

2/9.8/41.0/2.5/3.1/72.0/2.0/0.0/102.2/22.2/0.0/1.0/5.0/0.5/2.0/0.0/0.0

2/13.0/62.0/4.0/4.5/122.5/5.0/1.0/10.4/15.2/0.0/0.0/1.0/6.0/1.5/0.5

A/HeJ x A/HeJ

2/38.2/30.0/5.0/17.7/49.5/1.5/0.0/232.5/44.3/3.0/0.5/4.0/0.0/3.5/0.0/0.5

2/12.5/26.0/1.5/10.5/19.5/2.5/0.5/104.5/43.4/6.0/0.5/6.0/0.0/5.0/0.0/1.0

2/12.3/25.5/2.5/15.1/34.5/2.0/0.5/228.4/106.1/0.5/0.0/8.0/0.0/5.5/0.0/0.0

2/11.3/25.0/3.0/18.7/40.0/3.5/0.5/446.7/51.9/3.5/0.5/5.5/0.0/5.5/1.0/0.5

2/9.6/52.0/4.5/17.9/70.0/1.5/0.0/50.6/480.1/2.0/0.5/6.5/0.5/3.5/0.0/0.0

C57/BL/10J x C57/BL/10J

1/4.3/86.5/2.5/6.6/126.0/1.0/0.0/24.8/8.5/1.0/0.0/3.0/0.0/5.0/0.0/0.0

1/4.0/110.0/3.0/6.2/143.0/1.0/0.5/59.5/92.5/0.5/0.0/6.0/0.0/2.5/0.0/0.0

1/5.4/111.0/2.5/7.1/126.5/1.0/0.0/908.3/1800.0/9.5/0.5/0.5/1.0/2.0/0.5/0.0

1/4.7/109.5/1.0/4.9/123.5/1.5/0.5/15.9/12.5/0.0/0.0/0.5/1.0/3.0/0.5/0.0

1/2.8/95.0/1.0/3.7/144.5/1.0/0.0/257.5/1800.0/5.0/0.0/0.0/0.0 1.0/0.0/0.0

SWR/J X SWR/J

1/16.5/76.0/3.0/8.8/78.5/4.0/0.5/14.4/15.3/0.5/0.0/0.5/0.0/2.0/0.0/0.0

1/9.6/139.0/4.5/5.9/108.0/1.5/0.5/12.3/16.8/1.0/0.0/5.5/0.0/3.5/0.0/0.0

1/15.4/88.0/2.0/6.4/138.0/1.0/0.5/11.6/13.5/1.5/0.5/6.0/0.5/3.5/0.5/0.5

1/3.6/100.0/1.5/1.4/137.0/1.0/0.0/13.9/13.6/1.0/0.5/1.5/0.5/2.5/0.0/0.5

1/3.2/92.0/1.5/5.9/96.5/3.5/0.0/26.3/10.9/3.0/1.5/3.5/0.5/4.5/0.5/0.0

SJL/J x SJL/J

1/5.6/66.5/7.0/3.9/93.5/2.5/0.0/54.9/19.0/3.0/0.0/9.5/0.5/8.5/1.0/0.0

1/2.6/116.0/6.5/2.9/97.5/4.0/2.5/26.6/14.1/3.0/0.0/7.5/0.0/7.5/0.5/0.5

1/5.1/73.5/3.5/4.9/101.5/4.0/1.5/28.8/19.9/3.0/0.0/5.5/1.0/5.0/1.0/1.0

1/12.9/63.0/1.0/3.9/87.5/4.5/0.5/133.8/24.6/2.0/0.5/3.5/1.0/5.5/1.0/0.5

1/4.9/92.5/2.0/4.3/93.0/3.5/2.5/81.9/22.0/3.0/0.0/2.5/1.0/3.0/1.0/0.5

A/HeJ x A/WeJ

1/30.0/35.0/4.5/16.8/65.0/1.5/0.5/46.0/281.6/2.5/0.0/3.0/0.5/1.5/0.5/0.5

1/15.8/44.0/4.0/12.5/62.5/2.0/0.0/69.2/49.2/1.5/0.0/2.5/1.0/1.0/0.0/0.0

1/25.8/19.5/6.0/149/56.5/2.5/0.5/219.9/44.7/1.0/0.0/3.0/0.0/3.0/0.0/0.0

1/12.3/53.0/2.0/13.6/70.0/2.5/1.0/273.3/19.8/2.5/0.0/2.0/0.5/2.0/0.5/0.0

1/14.5/40.0/4.5/ /8.6/82.0/0.5/1.0/34.3/47.7/2.0/1.0/5.0/1.0/4.5/1.0/0.5

C57/Bl/10J X C57/Bl/10J

2/2.1/106.0/1.5/9.6/113.5/0.0/0.5/71.1/15.7/0.5/0.0/2.5/0.0/0.5/0.0/0.0

2/4.2/103.5/2.0/6.9/71.0/0.0/0.5/25.9/109.9/0.5/0.0/1.0/0.0/0.0/0.0/0.0

2/9.4/74.5/0.5/8.7/75.0/1.0/0.0/547.1/29.1/4.5/0.0/1.0/0.0/0.5/0.0/0.0

2/7.3/107.0/1.0/7.3/130.5/0.0/0.0/269.4/17.4/2.5/0.0/0.5/0.0/1.0/0.0/0.0

2/5.1/107.0/1.5/5.8/139.5/0.0/0.0/55.0/275.1/1.5/0.0/0.0/0.0/0.0/0.0/0.5

SWR/J X SWR/J

2/4.4/68.0/2.0/5.9/68.5/6.0/0.0/92.2/28.1/3.0/0.0/5.5/0.0/4.0/0.0/0.5

2/11.7/83.0/3.5/4.2/156.0/2.5/0.5/13.3/10.5/1.5/0.0/2.0/0.5/3.0/0.0/0.0

2/22.4/126.5/3.5/3.8/97.0/2.0/0.0/21.6/9.3/2.0/0.0/0.5/0.0/2.5/0.0/0.0

2/7.9/154.5/2.0/2.7/155.0/3.0/0.0/2.2/7.6/1.5/0.0/3.5/0.0/2.5/0.0/0.0

2/7.9/88.0/2.0/6.4/138.0/1.0/0.5/10.5/16.7/0.5/0.5/5.0/0.5/6.0/0.5/0.0

SJL/J x SJL/J

1/7.5/57.0/3.0/7.5/67.0/3.0/2.0/39.7/16.5/2.0/0.5/6.5/2.0/3.0/1.0/1.0/

1/6.4/80.0/3.5/3.8/105.0/3.5/0.0/17.7/20.8/2.5/0.0/6.5/0.0/2.5/0.5/0.0

1/6.9/89.5/4.5/4.8/138.0/0.5/1.0/17.9/30.4/3.5/0.5/4.0/1.0/8.5/1.0/ 0.5

1/5.9/67.5/4.0/3.8/62.5/3.5/1.5/83.1/27.8/2.0/0.5/2.5/0.5/3.0/0.5/0.0

1/12.5/51.5 /4.0/4.9/60.0/5.0/1.0/280.5/35.0/6.5/0.0/3.0/0.5/3.0/1.0/1.0

A/HeJ X A/HeJ

1/43.1/17.0/3.5/28.3/33.0/2.0/1.5/672.6/548.3/12.0/0.5/6.5/1.0/5.5/0.5/0.5

1/13.9/26.5/4.5/11.2/52.0/2.0/1.0/45.7/49.9/3.0/0.5/11.5/0.5/4.0/0.5/0.0

1/9.8/19.0/3.5/5.0/65.0/1.0/1.0/89.3/114.4/3.5/0.0/9.0/0.0/9.0/1.0/0.0

1/11.9/18.0/2.5/15.9/31.0/2.5/1.0/87.2/409.2/4.5/0.5/7.0/0.5/6.5/1.0/0.0

1/11.0/28.0/5.0/14.1/48.5/2.5/0.5/31.8/52.1/2.0/0.5/7.5/0.5/7.0/0.0/0.5

C57/B1/10J X C57/B1/10J

2/3.0/134.0/1.5/2.6/154.5/0.5/0.5/32.6/8.7/0.0/0.0/3.5/1.0/3.0/0.5/0.0

2/5.9/109.0/1.0/7.1/109.0/0.0/0.0/32.9/8.3/0.5/0.0/0.0/0.0/0.0/0.0/0.0

2/5.9/109.5/1.0/5.7/140.0/0.5/0.0/78.8/12.1/0.0/0.0/1.0/0.0/2.0/0.0/0.0

2/3.4/71.5/0.5/3.3/117.5/1.0/0.0/24.9/104.2/0.5/0.0/1.0/0.0/3.0/0.0/0.0

2/2.1/115.5/2.0/5.6/140.5/1.5/0.0/20.6/18.7/0.0/0.0/4.0/0.0/0.5/0.0/0.0

SWR/J X SWR/J

2/23.5/35.5/4.0/5.9/56.5/0.5/0.0/4.5/11.4/ 0.5/0.0/3.5/0.0/3.5/0.0/2.0

2/10.1/109.5/5.5/5.3/116.0/2.0/0.5/36.0/23.7/0.0/0.0/3.0/0.0/2.5/0.0/0.0

2/13.0/120.0/1.5/6.4/139.0/1.0/0.5/20.2/53.7/2.5/0.5/3.0/0.0/2.5/0.5/0.0

2/16.1/138.0/2.5/3.2/154.5/1.0/0.5/38.5/9.3/0.0/0.5/1.0/0.5/1.0/0.0/0.0

2/15.3/118.5/3.5/5.5/118.5/1.5/0.0/13.5/13.2/0.5/0.0/5.5/0.5/2.5/0.0/0.0

SJL/J X SJL/J

2/3.4/103.5/2.0/5.1/83.0/2.5/0.0/44.3/3.5/0.5/3.0/0.5/2.5/0.5/1.0

2/8.2/64.0/2.5/1.5/80.5/1.0/1.0/16.2/13.8/0.5/0.5/5.5/0.5/2.5/1.0/0.5

2/5.4/95.0/2.0/10.9/62.0/2.0/0.5/49.4/15.0/0.5/0.0/4.5/0.0/2.0/0.0/0.0

2/6.5/96.5/1.0/2.8/100.0/1.0/1.0/123.5/22.0/1.0/0.5/3.5/0.0/3.0/1.0/0.0

2/4.3/110/0/2.5/1.8/134.0/2.5/1.5/55.3/17.6/2.5/0.5/2.5/0.5/2.0/0.5

A/HEJ X A/HeJ

2/18.5/54.0/6.0/10.3/75.5/1.5/0.5/201.5/60.6/0.5/0.5/1.5/0.0/3.0/0.0/0.0

2/10.5/35.0/4.5/11.3/88.0/1.0/0.0/15.2/340.9/2.0/0.0/3.0/0.5/3.5/0.0/0.5

2/19.6/33.0/6.5/11.5/79.0/1.5/0.0/198.9/45.4/0.5/0.5/2.5/0.5/5.5/0.0/0.0

2/13.1/36.5/4.5/11.4/60.0/1.5/0.0/135.5/948.9/4.0/0.0/3.5/0.0/2.5/0.5/0.0

2/11.3/30.5/6.5/13.0/80.0/0.0/0.0/153.5/47.1/4.0/0.5/3.5/0.0/2.5/0.5/0.0

C57/Bl/10J X C57/Bl/10J

1/4.4/98.0/2.5/10.3/108.0/1.0/0.0/901.7/1800.0/5.0/0.0/0.0/0.0/0.0/0.0/0.0

1/3.9/89.5/7.5/6.9/89.5/1.0/1.0/35.2/18.0/3.0/0.0/3.0/0.0/2.5/0.0/0.0

1/5.6/57.0/2.0/8.7/82.0/2.0/0.5/61.5/10.8/0.0/0.0/2.5/0.0/1.0/0.0/0.0

1/5.3/132/0/0.5/5.0/199.5/1.5/0.0/1350.0/146.2/6.0/1.0/2.0/0.0/2.0/0.0/0.0

1/6.3/83.0/4.5/4.7/173.0/0.0/0.5/30.6/12.7/0.0/0.5/0.5/0.5/1.5/0.5/0.0

SWR/J X SWR/J

1/10.9/97.5/1.0/5.5/149.0/2.0/0.5/6.6/13.6/1.0/0.0/6.5/1.0/5.0/0.0/0.5

1/9.1/111.0/3.0/3.1/102.5/0.5/0.5/2.9/11.9/1.5/0.0/2.5/0.5/4.5/0.0/0.0

1/10.4/83.0/3.5/6.7/152.5/2.0/0.5/55.1/12.0/2.0/0.5/3.5/0.0/2.5/0.0/0.0

1/11.9/149.0/2.0/10.9/103.0/1.5/0.0/27.2/11.7/2.0/0.5/3.5/0.0/2.5/0.0/0.0

1/13.9/94.0/2.0/8.7/101.0/4.0/0.0/3.5/0.0/0.0/4.5/0.5/5.5/0.0/0.0

ST/BJ X A/HeJ

2/13.6/40.0/2.5/4.9/78.5/1.5/0.5/46.9/37.4/3.0/0.5/1.0/0.0/2.0/0.0/0.0

2/16.4/26.5/1.5/7.2/70.5/2.5/0.5/315.1/72.6/4.5/1.0/3.0/0.0/3.0/0.0/0.5

2/17.8/29.0/3.5/3.2/77.0/3.0/1.0/508.4/18.7/5.0/1.0/3.0/0.0/4.5/0.0/0.5

2/6.6/68.5/3.5/2.9/126.5/1.5/0.0/1000.4/344.7/4.0/0.0/4.0/0.0/3.0/0.0/0.0

2/8.1/54.0/4.0/7.2/65.5/3.5/0.0/57.8/52.8/3.5/0.0/8.0/0.0/6.5/0.0/0.0

ST/BJ X SJL/J

2/6.6/109.5/2.5/3.5/121.0/2.0/1.0/51.6/12.3/0.5/0.0/2.5/0.0/1.5/0.0/0.0

2/11.1/42.5/2.0/11.9/47.0/2.0/0.5/50.1/85.3/1.5/0.0/3.0/0.0/1.5/0.0/0.5

2/5.9/52.0/4.0/11.7/52.5/0.0/0.0/136.1/417.3/1.0/0.0/1.5/0.0/3.0/0.0/0.0

2/6.3/28.0/2.5/11.5/50.0/0.5/0.0/570.6/1220.7/5.5/0.0/2.0/0.0/2.5/0.0/0.0

2/16.7/59.0/3.0/11.9/43.0/0.5/0.0/42.4/17.6/0.5/0.0/2.5/0.0/0.5/0.0/0.0

A/HEJ XSWR/J

1/11.7/59.0/3.0/7.3/96.5/1.0/0.5/48.6/15.7/0.5/0.0/5.0/1.0/2.5/0.5/0.5

1/3.8/52.0/1.5/7.1/101.5/0.5/0.5/24.7/23.9/0.5/0.0/2.0/0.0/2.0/0.0/0.0

1/9.0/53.0/1.5/8.9/95.5/1.0/1.0/31.0/21.3/0.5/0.0/3.5/0.0/1.5/1.0/0.0

1/20.1/6.5/1.5/12.4/31.0/2.0/0.0/299.6/49.2/1.5/0.0/1.5/0.0/1.5/2.0/3.0/1.0/0.5

1/14.5/35.0/4.0/19.7/47.5/2.0/0.5/61.9/37.5/0.0/0.0/4.0/0.5/3.0/0.0/0.0

SWR/J X SJL/J

1/9.8/71.5/2.0/4.9/90.5/7.0/1.0/14.4/24.9/0.5/0.5/4.0/0.5/3.0/0.0/0.5

1/8.3/78.0/2.5/4.6/118.0/3.0/2.5/34.8/16.5/1.5/1.0/1.5/1.0/2.0/0.0/0.0

1/6.9/84.5/5.5/4.8/131.5/4.0/1.0/28.1/2.0/0.0/6.5/0.5/4.0/0.5/1.0

1/24.1/88.0/2.5/6.4/117.0/2.5/0.5/27.5/14.6/3.0/0.5/2.5/0.0/2.0/0.0/0.0

1/7.4/78.5/5.0/5.7/78.0/1.5/0.0/17.2/19.2/1.0/1.0/1.5/0.0/1.0/0.5/0.0

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ST/BJ X A/HeJ
1/8.1/54.0/4.0/7.2/65.5/3.5/0.0/57.8/52.8/3.5/1.0/8.0/0.0/6.5/0.0/0.0
1/13.7/65.5/4.0/6.0/79.0/2.0/1.5/27.5/93.3/2.0/1.0/3.5/1.0/2.5/1.0/0.5
1/10.9/61.5/4.5/8.6/56.0/1.5/1.0/31.3/75.0/1.0/0.5/3.5/1.0/3.0/1.5/1.0
1/10.9/73.0/4.5/10.1/57.5/5.5/0.0/93.1/162.4/5.0/0.5/7.0/0.5/3.0/1.0/0.0
1/13.4/54.0/4.5/9.8/52.0/2.5/0.5/98.5/25.9/1.0/0.5/2.5/0.5/3.0/0.0/0.0
ST/BJ X SJL/J
1/6.5/86.5/0.5/5.8/119.5/0.5/0.5/4.4/10.4/0.5/0.0/2.5/0.0/4.5/0.0/0.0
1/10.7/86.0/4.5/4.9/132.5/1.0/0.5/30.2/12.2/1.0/0.0/6.5/0.0/0.0/0.0/0.0
1/22.1/3.0/1.5/8.5/17.0/0.0/1.0/1800.0/1800.0/2.5/0.5/0.5/0.0/1.5/0.0/0.0
1/120.0/0.0/0.5/180.0/0.0/0.0/0.0/1800.0/1800.0/0.0/0.0/1.0/0.0/2.0/0.0/0.0
1/8.3/58.0/1.5/5.4/136.0/2.0/0.0/282.4/14.3/0.5/0.0/2.5/0.0/3.0/0.0/0.0
A/HEJ XSWR/J
2/9.0/53.0/1.5/8.9/94.0/1.0/1.0/31.0/21.3/0.5/0.0/2.5/0.0/1.5/1.0/0.0
2/9.1/59.5/2.0/4.1/141.0/1.0/0.5/18.9/31.1/0.0/2.0/0.5/1.0/0.0/0.5
2/17.9/60.0/1.5/10.5/103.5/0.5/0.5/46.5/18.4/1.0/0.0/2.5/0.5/1.5/0.5/0.0
2/15.1/55.0/4.5/16.9/111.0/0.5/0.0/44.9/26.1/0.5/0.0/2.5/0.0/2.5/0.5/0.0
2/5.1/54.5/4.0/12.5/90.5/1.0/0.5/27.9/26.4/0.0/0.0/2.5/0.5/1.0/0.0/0.0
SWR/J X SJ/LJ
2/6.6/57.0/2.5/4.2/99.5/3.0/1.0/52.2/25.2/1.5/0.5/1.5/0.5/1.5/0.5/0.0
2/10.9/94.5/2.0/6.0/113.5/0.5/2.0/28.8.17.9/0.5/1.0/3.5/0.5/1.5/1.0/0.5
2/4.5/71.0/1.5/3.2/81.0/0.5/0.5/10.6/12.4/0.5/0.0/3.0/0.5/2.0/0.5/0.5
2/9.9/82.0/3.0/10.2/126.5/25.0/0.0/8.0/16.9/0.5/0.0/2.5/0.0/2.0/0.0/0.0
2/2.9/116.5/2.0/2.5/104.5/3.0/0.0/8.0/16.9/0.5/0.0/2.5/0.0/2.0/0.0/0.0
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ST/BJ X A/WeJ

1/15.6/82.0/3.0/6.6/54.5/3.0/0.0/37.6/28.8/2.0/1.0/2.5/0.0/1.5/0.0/0.0

1/9.9/53.0/3.5/9.5/56.0/3.0/0.5/337.1/32.2/2.0/0.5/3.5/0.5/7.5/0.5/0.5

1/54.1/10.0/3.5/13.6/48.0/4.5/0.5/98.6/47.5/3.5/0.0/4.5/0.5/4.5/1.0/1.0

1/18.4/83.5/4.5/5.4/105.5/3.5/0.5/74.9/35.9/5.5/0.0/7.5/0.5/4.5/0.5/0.0

1/3.4/66.5/4.5/5.7/127.0/5.0/0.5/272.6/41.9/2.5/0.5/5.0/0.5/4.0/0.5/0.0

ST/BJ X SJL/J

1/5.3/82.0/4.5/5.4/37.5/1.0/2.0/19.9/11.5/1.0/0.5/7.0/1.0/5.5/1.0/0.5

1/10.7/75.0/8.0/12.7/93.5/3.0/0.5/4.9/9.4/0.0/0.5/5.5/0.5/4.0/1.0/0.0

1/4.2/68.0/9.0/12.0/69.5/5.5/4.5/115.6/15.3/1.5/0.5/ /7.5/0.5/7.5/1.0/0.0

1/5.8/76.5/2.0/5.3/120.5/1.5/1.5/14.1/13.1/0.5/0.5/1.0/1.0/2.0/1.0/0.5

1/6.9/95.5/4.0/7.1/78.5/1.0/2.0/20.9/19.3/0.0/0.0/6.5/0.5/2.5/1.0/1.0

A/HeJ X SWR/J

2/11.2/46.5/2.0/9.4/47.0/1.5/0.0/16.6/15.7/0.0/0.0/3.5/1.0/7.0/1.0/0.0

2/6.5/90.0/2.0/5.8/67.5/0.5/1.0/227.4/30.2/0.5/0.0/2.0/0.5/4.0/0.5/0.5

2/11.7/67.5/1.0/3.0/118.0/0.5/0.0/12.5/13.9/0.0/0.0/1.5/0.5/2.5/1.0/0.0

2/6.4/101.0/0.5/3.9/84.0/0.5/0.5/9.6/19.1/0.0/0.5/1.0/0.0/0.5/0.0/0.0

2/8.9/88.0/2.0/4.7/127.0/3.0/0.0/8.2/12.9/0.5/0.0/2.0/0.0/0.5/0.0/0.5

SWR/J X SJL/J

2/6.6/103.0/2.0/2.7/116.5/5.0/0.5/11.5/12.3/ 2.5/0.0/3.5/0.0/4.5/0.5/0.5/

2/9.9/74.0/4.5/5.6/108.5/3.5/0.5/36.7/3.5/0.0/2.0/0.0/1.0/0.0/0.5

2/7.6/87.0/3.5/3.5/100.5/2.0/0.0/43.1/19.6/1.0/0.5/5.5/0.5/3.5/0.0/1.0

2/5.9/98.0/4.0/2.8/128.5/2.5/1.0/41.5/15.8/2.0/0.0/3.5/0.5/3.0/0.0/0.5

2/15.6/72.5/4.5/ /4.0/119.5/1.5/1.5/19.5/12.2/3.0/0.5/3.5/0.5/5.0/0.5/0.0

ST/BJ X AHEJ

2/8.9/59.0/1.5/3.3/84.0/1.0/0.0/16.5/29.9/0.5/0.0/3.0/0.0/2.0/0.5/0.0

2/16.9/49.5/1.5/9.4/57.0/1.0/0.0/36.3/108.8/1.0/0.5/1.0/0.0/2.5/1.0/0.0

2/18.1/37.0/3.0/12.6/42.5/0.5/1.5/48.4/33.1/0.5/0.5/3.0/0.0/3.0/0.0/0.0

2/8.4/62.5/4.0/10.9/48.0/3.0/0.0/55.8/28.7/2.0/0.5/4.5/0.0/2.5/0.0/0.5

2/11.9/41.5/4.0/22.1/63.5/4.5/0.5/7.0/22.3/1.5/0.0/3.5/0.0/4.0/0.5/0.0

ST/BJ X SJ/LJ

2/11.9/79.0/1.0/4.9/81.0/0.5/0.0/266.9/566.9/4.5/0.0/3.0/0.0/2.0/0.0/0.0

2/8.7/79.0/1.5/5.8/115.5/0.5/0.0/50.6/14.7/1.5/0.0/5.0/0.5/5.5/0.5/0.0

2/7.4/98.0/0.5/4.4/127.0/2.0/0.0/76.8/26.5/1.0/0.0/3.5/0.0/2.5/0.0/0.0

2/7.1/124.0/4.0/5.4/162.5/1.0/0.0/12.1/12.1/0.0/0.0/4.0/0.5/4.5/0.0/0.0

2/10.3/107.0/2.5/3.4/98.5/4.0/0.5/109.5/16.1/1.0/0.5/2.0/0.0/1.5/0.0/0.0

A/HeJ X SWR/J

1/16.4/54.0/2.5/6.3/98.0/2.0/0.5/161.9/51.9/0.0/0.0/2.5/0.0/1.0/0.5/0.5

1/15.5/78.5/4.5/9.0/74.0/0.0/0.0/39.6/26.6/0.0/0.0/3.0/0.0/1.5/0.5/0.0

1/12.2/48.0/5.0/7.7/65.5/0.0/0.0/89.0/23.5/2.0/0.0/0.5/0.0/0.5/0.5/0.0

1/18.2/49.5/4.5/6.9/68.0/0.5/0.5/86.7/25.9.0.0/0.0/4.0/0.0/4.5/1.0/0.5

1/3.9/119.0/3.0/10.1/65.0/0.5/0.5/18.2/12.9/0.5/0.0/1.5/1.0/1.5/0.0/0.5

SWR/J x SJ/LJ

1/8.%/113.5/2.0/5.3/134.5/0.0/0.0/121.6/26.8/2.0/0.0/4.0/0.0/1.5/0.0/0.0

1/9.4/66.5/3.0/4.5/81.5/2.5/1.0/3.9/11.8/1.0/0.0/3.0/1.0/1.5/0.0/0.0

1/5.8/78.0/1.5/4.2/95.5/1.5/1.5/13.2/12.9/0.5/0.0/1.5/1.0/2.0/0.5/0.0

1/5.9/70.5/0.5/5.4/94.5/1.5/0.5/3.8/9.9/0.0/1.0/1.5/0.0/1.0/0.5/1.0

1/7.8/88.5/1.0/4.3/120.5/0.0/0.0/8.9/18.1/1.0/0.5/5.0/0.5/3.0/0.0/0.5

Pure Strains						F-1						F-2						Backcross					
03	14	12	029	003	015	06	07	14	000	000	000	00	02	00	068	017	017	02	05	04	104	043	033
23	23	13	035	000	002	00	00	00	003	003	002	04	05	10	075	025	034	01	03	05	052	043	080
17	06	24	058	006	002	11	15	18	082	057	070	18	11	09	140	029	053	04	04	10	204	028	055
13	15	19	095	003	015	12	18	21	058	008	001	13	16	13	068	014	036	05	12	17	093	075	167
00	00	02	017	000	001	07	16	17	072	006	040	18	14	23	095	075	049	04	15	20	046	057	030
19	19	18	042	043	055	25	08	14	040	001	011	09	15	16	081	013	085	20	14	16	026	029	006
12	16	13	046	054	056	04	09	17	001	002	002	13	11	17	135	100	032	02	10	09	006	006	025
04	03	01	066	028	026	04	07	14	000	000	000	09	11	**25**	026	006	010	02	07	08	089	184	243
13	22	19	159	091	094	04	14	16	119	016	029	08	16	17	028	020	029	02	05	12	018	004	040
04	03	01	066	028	026	01	11	20	015	000	019	13	00	06	016	000	008	04	13	20	073	009	019
01	24	12	058	009	015	06	15	11	100	028	023	02	04	13	053	014	005	03	09	04	086	015	003
02	11	16	063	050	038	06	15	11	100	028	023	01	15	10	044	025	041	07	22	18	038	058	069
08	11	23	054	027	095	00	02	00	115	013	007	20	18	23	071	002	039	02	00	04	026	030	047
00	09	20	060	039	069	15	21	22	074	009	016	07	09	13	064	021	049	06	11	05	090	074	027
12	07	11	016	019	019	15	17	17	011	009	011	10	23	06	042	006	021	03	03	01	028	001	000
01	15	17	073	016	009	17	12	11	060	006	014	14	18	20	033	037	018	04	13	20	170	005	014
03	03	04	086	035	075	10	20	23	055	025	013	15	19	19	073	003	016	00	09	15	002	005	000
09	14	19	073	016	009	10	16	18	131	006	025	07	17	19	090	014	043	09	15	18	094	023	043
16	16	23	006	008	007	03	21	18	001	000	000	02	02	08	102	030	026	00	09	15	002	005	000
10	15	20	006	009	023	21	21	20	048	005	014	13	10	11	063	040	024	10	16	18	039	026	030
04	04	02	021	001	004	04	01	03	192	020	027	04	11	02	132	082	072	03	16	20	029	008	005
19	18	10	126	024	018	09	19	21	113	047	010	21	15	19	101	044	024	03	21	19	149	058	031
13	01	01	077	001	000	08	17	22	087	070	036	08	17	13	024	030	034	08	14	18	142	024	016
01	03	00	071	001	009	06	07	09	074	022	045	02	10	11	067	084	140	00	13	09	036	013	058
02	01	02	100	001	000	12	15	07	295	028	033	10	22	20	042	010	008	01	07	11	088	010	028
00	01	01	060	009	000	00	00	00	008	000	000	12	06	09	040	005	001	12	24	00	096	026	000
05	06	07	010	008	014	02	07	14	126	013	071	07	10	19	078	103	096	08	06	19	006	000	008
03	05	17	000	000	000	04	15	18	001	006	008	10	19	17	070	022	013	20	23	22	041	018	050
00	01	01	025	016	009	08	11	21	001	000	019	00	05	07	023	017	067	17	23	21	004	002	006
02	06	06	026	047	030	05	02	17	213	030	173	03	00	02	043	024	005	21	18	15	005	008	003
11	01	11	042	011	010	12	15	12	076	023	020	00	10	16	061	022	025	04	05	10	086	010	018
00	04	17	045	018	005	15	18	18	010	029	003	02	01	00	062	002	011	14	13	13	080	001	048
01	03	03	043	017	040	09	19	22	018	014	004	08	05	03	086	018	051	03	04	02	062	025	013
02	01	04	056	000	002	12	18	14	003	004	003	01	04	06	077	027	077	10	05	11	086	012	060
01	06	14	064	012	013	17	19	18	003	000	007	03	12	16	117	048	101	07	12	10	062	032	023
05	09	10	005	009	004	22	22	21	050	043	009	66	17	05	041	055	034	10	19	19	235	019	018
11	13	19	061	030	019	20	21	05	076	000	002	05	04	20	086	015	009	06	05	17	021	003	000
20	19	19	071	045	050	15	18	22	078	001	006	14	13	22	080	021	009	10	20	25	016	039	008
10	11	13	117	022	029	11	07	15	071	002	005	07	10	12	056	019	041	20	22	21	149	086	053
13	21	21	111	035	004	15	17	21	026	004	002	03	10	16	078	016	009	13	17	20	102	019	038
02	02	08	081	009	005	16	18	24	087	013	034	17	22	21	035	024	017	05	14	09	014	123	114

Pure Strains						F-1						F-2						Backcross					
02	20	15	122	005	001	03	05	15	097	038	073	09	23	19	035	050	022	04	09	19	102	200	505
12	07	08	078	005	008	10	21	12	101	101	064	03	04	13	104	070	057	07	00	06	113	010	012
06	17	12	123	033	059	00	02	04	026	001	000	12	15	12	091	035	074	06	07	08	069	028	027
01	08	14	073	003	007	00	00	02	074	012	050	09	12	21	147	046	085	02	08	16	109	046	061
05	12	17	042	012	014	03	05	11	106	014	025	06	06	08	120	032	021	06	02	22	009	001	004
01	10	21	035	020	015	05	21	18	056	041	135	19	16	17	127	094	042	09	19	24	019	015	019
13	14	22	082	047	046	00	05	05	053	000	011	06	02	04	032	003	010	11	16	19	089	000	016
12	19	23	038	046	020	05	18	19	070	023	100	03	14	12	020	018	001	05	15	21	000	000	003
00	16	03	028	001	003	06	04	18	051	001	033	00	03	00	072	009	000	15	23	24	070	068	010
10	24	17	069	009	023	12	10	21	015	007	015	06	08	11	093	013	040	03	09	11	051	044	023
03	10	16	063	020	054	11	13	15	006	005	005	04	16	18	057	033	041	18	20	20	007	001	003
23	20	24	034	002	001	10	22	25	015	001	009	11	19	21	134	072	071	02	03	14	036	029	001
10	10	70	010	000	000	13	21	19	018	005	002	01	11	19	038	012	014	13	01	00	036	005	008
08	14	18	049	012	020	06	11	20	060	002	000	07	16	11	083	060	015	13	03	06	052	000	018
09	12	16	006	141	036	14	06	19	084	000	039	10	22	21	063	041	129	20	19	19	078	010	005
09	12	16	006	008	036	13	18	17	098	000	003	02	04	07	026	006	003	20	21	22	076	201	060
15	23	24	100	029	100	12	11	20	086	003	008	02	09	06	154	054	010	19	20	23	008	119	001
01	01	01	072	111	052	16	10	17	094	009	005	04	24	19	214	123	189	14	20	23	034	045	063
11	23	17	098	003	033	13	22	13	064	004	000	12	20	17	081	040	028	16	23	20	108	103	110
02	17	15	063	006	012	22	20	22	106	044	040	12	24	21	169	341	151	02	14	17	196	040	053
10	06	06	044	002	003	11	15	20	146	020	046	10	19	20	080	096	094	13	14	15	144	109	083
08	12	14	061	003	000	20	19	17	099	038	070	14	13	21	098	085	063	18	14	15	060	005	013
12	25	04	059	000	009	14	16	22	137	051	066	09	12	14	065	019	031	01	06	07	045	021	042
05	24	01	022	000	000	03	18	18	030	018	037	14	20	12	041	008	063	08	13	22	082	090	100
10	10	20	022	007	009	03	19	11	008	003	000	05	05	10	171	042	068	05	19	17	053	035	047
00	00	00	019	002	000	05	12	16	001	000	000	03	04	06	111	045	032	10	08	20	046	021	037
02	05	15	000	000	000	10	15	14	003	000	000	12	14	10	078	065	047	16	22	24	063	061	109
00	04	01	052	014	000	04	19	28	032	002	003	01	00	00	002	001	000	17	23	20	207	090	159
00	00	02	014	000	005	01	16	16	119	009	011	13	22	23	005	001	014	16	21	22	099	017	073
02	11	15	075	013	037	20	18	16	023	018	006	03	11	12	032	028	021	06	21	15	053	076	072
00	02	12	016	000	010	19	20	18	037	008	002	12	14	17	086	057	092	06	21	15	053	076	072
01	06	03	059	022	014	15	13	12	007	006	000	01	00	01	049	014	021	15	23	19	079	100	092
04	03	08	084	029	068	11	25	21	125	195	053	06	12	11	045	010	014	07	07	09	059	030	040
01	05	14	065	005	004	16	16	22	004	001	003	02	07	12	107	046	083	04	14	18	068	043	033
00	00	19	065	046	025	11	17	19	072	010	010	04	07	07	038	024	018	10	18	18	017	015	012
10	19	21	065	046	025	11	05	13	079	005	016	05	13	20	168	102	133	17	22	22	553	337	049
19	20	22	066	042	038	07	11	18	077	022	018	11	18	20	100	019	053	15	15	16	033	012	002
02	03	11	100	007	017	11	11	18	073	000	002	06	14	20	116	006	009	14	19	17	022	085	029
16	24	21	077	018	022	05	15	22	079	002	019	05	17	21	077	044	083	03	19	17	012	039	022