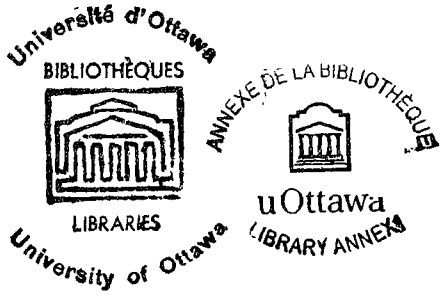
C 5P-2

THE EFFECTS OF DENOTATIVE AND CONNOTATIVE LINGUISTIC MEANING AND WORD CONCRETENESS ON THE HABITUATION OF THE SKIN CONDUCTANCE RESPONSE: EXTRAVERSION AND NEUROTICISM AS SUBJECT VARIABLES

by Ernest C. Desjardins

Thesis presented to the School of Graduate Studies of the University of Ottawa as partial fulfillment of the requirements for the degree of Doctor of Philosophy



Ottawa, Canada, 1976

© E.C. Desjardins, Ottawa, Canada, 1976

UMI Number: DC53892

INFORMATION TO USERS

The quality of this reproduction is dependent upon the quality of the copy submitted. Broken or indistinct print, colored or poor quality illustrations and photographs, print bleed-through, substandard margins, and improper alignment can adversely affect reproduction.
In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

UMI®

UMI Microform DC53892
Copyright 2011 by ProQuest LLC
All rights reserved. This microform edition is protected against unauthorized copying under Title 17, United States Code.

ProQuest LLC
789 East Eisenhower Parkway
P.O. Box 1346
Ann Arbor, MI 48106-1346

ACKNOWLEDGMENTS

This research was prepared under the supervision of William F. Barry, Ph.D., Professor, Faculty of Psychology of the University of Ottawa. The writer gratefully wishes to acknowledge his advice and encouragement, which spanned the more than three years during which this research was in preparation. Thanks are also extended to Henry P. Edwards, Ph.D., Professor and Dean, Faculty of Psychology of the University of Ottawa, for his many insightful comments on the ideas expressed in this thesis. The writer would also like to thank Lawrence T. Dayhaw, D.Ps.Ed., Professor, Faculty of Psychology of the University of Ottawa, for his contribution to the experimental strategy employed in the present research, and to Neil H. Timm, Ph.D., of the University of Pittsburg, for his suggestions concerning the multivariate analysis of the physiological measures.

Thanks are also in order for Mrs. Ann Hurd, programming consultant at the University of Ottawa, and Mr. Desmond Walsh of the Faculty of Education of the University of Ottawa, for their continuing assistance with the many programs required to analyze the data in the present experiments. The writer would also like to thank Mr. Edwin Achorn for the design and construction of the automated components used in the habituation experiments and Mr. Robert Spratt for his technical assistance.

ACKNOWLEDGMENTS

A special note of thanks is extended to Helen Laporte, Aurelda Michaud, and Celia McInnis for the reduction, coding and key punching of the psychological and physiological variables analyzed in the present research. Finally, the writer would like to thank Mrs. M. Sader and Mrs. I. Lawrence of the Ottawa Civic Hospital School of Nursing, who graciously allowed the writer to enter the various classrooms and solicit subjects.

CURRICULUM STUDIORUM

Ernest Desjardins was born July 28, 1937, in Portsmouth, New Hampshire, U.S.A. He received the Bachelor of Arts and the Bachelor of Philosophy degrees from the University of Ottawa in May of 1965, and the Master of Psychology degree in May of 1970.

ABSTRACT OF

The Effects of Denotative and Connotative Linguistic Meaning and Word Concreteness on the Habituation of the Skin Conductance Response: Extraversion and Neuroticism as Subject Variables[1]

One psycholinguistic experiment (N=104 subjects) and two skin conductance habituation experiments (n=48 subjects each experiment) investigated the hypothesis deduced from Sokolov's matching theory for the habituation of the orienting response, that habituation may be related to the meaning (meaningfulness) of the orienting stimulus. Following Pavio's (1971) analysis of linguistic meaning an operational strategy was conceptualized for the independent measures which distinguished denotative linguistic meaning, connotative linguistic meaning, and word concreteness. It was, therefore, further hypothesized that habituation to a word stimulus may be related to the denotative meaning, the connotative meaning, and the concreteness of the word stimulus. Alternative sets of contrary predictions were formulated for the three hypotheses based on (a) Sokolov's matching assumption, and (b) Pavio's implicit-arousal assumption advanced for linguistic meaning. Three classes of skin conductance habituation measures (phasic

---

1 Ernest C. Desjardins, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1976, xxx-548 p.

response, latency of phasic response, and tonic measures) were analyzed using an appropriate multivariate statistical model (repeated measures designs). The results of the two habituation experiments provided consistent support for the arousal hypothesis for two of the three classes of skin conductance measures. No support was found for Sokolov's matching hypothesis in either of the two experiments for any of the dependent measures.

An analysis of the interrelationships between the various skin conductance measures indicated that they were all significantly intercorrelated. These results replicated and extended the findings of previous workers to include the class of tonic skin conductance measures.

The relationships between the extraversion and neuroticism variables and the skin conductance habituation measures were also investigated employing univariate and multivariate correlational models (N=96 subjects). The results indicated that the extraversion variable was significantly and inversely related to tonic skin conductance and two separate estimates of spontaneous skin conductance activity. The neuroticism variable did not significantly correlate with any of the skin conductance measures. The present results were interpreted as providing support for Eysenck's (1967) prediction that skin conductance habituation measures are related to extraversion and not neuroticism.

TABLE OF CONTENTS

Chapter		page
	INTRODUCTION.	xxv
I.-	REVIEW OF THE LITERATURE.	1
	1. The Phenomenon of Physiological Response Habituation to Repeated Stimulation	1
	2. Habituation Theory and Stimulus Variables	6
	A. Sokolov's Theory for Habituation of the Orienting Response	7
	B. Experimental Evidence Bearing on the Predictive Validity of Sokolov's Theory	14
	C. An Analysis of Linguistic Meaning	26
	D. Linguistic Meaning and Habituation	43
	3. Habituation Theory and Subject Variables	46
	A. Eysenck's Personality Theory and Habituation	47
	B. Experimental Evidence Bearing on the Predictive Validity of Eysenck's Theory for Habituation Outcome	53
	4. Methodological Problems in Habituation Experiments	68
	5. Summary and Statement of the Null Hypotheses	83
II.-	EXPERIMENTAL METHODOLOGY.	91
	1. The Psychological Experiment	91
	A. The Two Subsamples of Subjects	91
	B. The Psychological Instruments	92
	C. The Linguistic Stimuli	101
	D. The Psychological Experiment	106
	E. Statistical Procedures for the Linguistic Measures	111
	2. The Habituation Experiments	112
	A. The Subjects in Habituation Experiments I and II	113
	B. The Construction of the Linguistic (Visual) Stimuli	113
	C. The Physiological Instrumentation and Apparatus	114
	D. The Habituation Experiments I and II	125
	E. The Quantification of the Electro-dermal Measures	131
	F. Statistical Procedures for the Skin Conductance (Dependent) Measures	154

Chapter page

II.- 3. The Statistical Null Hypotheses 168
A. The Multivariate (MANOVA) Null Hypotheses 168
B. The Correlational (Univariate) Hypotheses 172

III.- REPORT OF RESULTS. 175
1. The Selection of the Independent Measures of the Study 175
A. The Linguistic Measures of the Study 176
B. The Intercorrelations Between the Linguistic Measures 176
C. The Reliability of the Linguistic Measures 179
D. The Selection of the Word Stimuli for Habituation Experiments I and II 181
2. The Skin Conductance Habituation Measures 193
A. The Effects of Denotative and Connotative Linguistic Meaning on SC Habituation: Experiment I 193
B. The Effects of Word Concreteness and Connotative Linguistic Meaning on SC Habituation: Experiment II 247
C. The Physiological (Dependent) Measures of the Study 295
D. The Correlations Between the Physiological (Dependent) Measures 299
E. The Reliability of the Physiological Measures 308
3. The Evaluation of the Null Hypotheses 310

IV.- DISCUSSION OF RESULTS. 315
1. The Linguistic Measures of the Study 315
2. The Skin Conductance Habituation Measures and Sokolov's Theory 321
3. The Relationships Between the Dependent (Habituation) Measures 344
4. The Relationship of Extraversion and Neuroticism to the Skin Conductance Measures 360
5. Suggestions for Future Work 366

SUMMARY AND CONCLUSIONS. 372

REFERENCES 376

Appendix page

1. IMAGERY RATING SCALE. 394

2. WORD ASSOCIATION TEST 398

3. THE SEMANTIC DIFFERENTIAL RATING SCALES 403

4. WORD CONCRETENESS RATING SCALE. 410

5. WORD FAMILIARITY RATING SCALE 413

6. ORDER FOR THE ADMINISTRATION OF THE PSYCHOLOGICAL TESTS AND THE NUMBER OF SUBJECTS IN EACH GROUP. 417

7. THE RAW DATA FOR THE LINGUISTIC (INDEPENDENT) MEASURES OF THE STUDY 419

8. THE SCL_{max}, SCL_{min}, AND SCR_{max} SCORES FOR THE RANGE CORRECTION PROCEDURES FOR THE TONIC AND PHASIC SKIN CONDUCTANCE MEASURES IN HABITUATION EXPERIMENTS I AND II. 461

9. THE SUBJECT NUMBER (REAL) USED TO ASSIGN SUBJECTS RANDOMLY TO ONE OF THE FOUR CONDITIONS, AND THE SCORING CODE NUMBERS USED FOR THE SCORING OF THE POLYGRAPH RECORDS IN EXPERIMENT I AND EXPERIMENT II. 465

10. THE RAW DATA FOR THE PHYSIOLOGICAL (DEPENDENT) VARIABLES IN HABITUATION EXPERIMENTS I AND II. 467

11. CRITICAL VALUES FOR THE FOUR MULTIVARIATE TEST CRITERIA WILKS (Λ), ROY (θs), LAWLEY-HOTELLING ($U^{(s)}$), AND PILLAI ($V^{(s)}$), FOR THE HYPOTHESES (H_A, H_B, H_{AB}) IN THE PRESENT HABITUATION EXPERIMENTS 517

12. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE MEANINGFULNESS (m) SCORES BETWEEN SUBSAMPLE I AND SUBSAMPLE II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI. 519

Appendix page

13. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE IMAGERY (I) SCORES BETWEEN SUBSAMPLE I AND SUBSAMPLE II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI. 522

14. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE DENOTATIVE LINGUISTIC MEANING SCORES (m+I) BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI. 525

15. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE CONNOTATIVE LINGUISTIC MEANING (SD) SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI 528

16. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE FAMILIARITY SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI 531

17. A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE CONCRETENESS (A-C) SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI. 534

18. LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING MEANINGFULNESS (MEAN) SCORES (m) FOR SUBSAMPLES I AND II COMBINED 537

19. LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING IMAGERY (MEAN) SCORES (I) FOR SUBSAMPLES I AND II COMBINED . 540

20. LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING FAMILIARITY (MEAN) SCORES (f) FOR SUBSAMPLES I AND II COMBINED. 543

21. THE EYSENCK PERSONALITY INVENTORY (FORMS A AND B). 546

LIST OF TABLES

Table page

1. Studies Investigating the Relationship Between the Extraversion and Neuroticism Dimensions and Habituation Outcome. 63

2. List of Two-Syllable Word (Noun) Stimuli Selected from the Dictionaries of Pavio (1968), Heise (1965), and Nobel (1960) 104

3. The Skin Conductance (Dependent) Measures and Their Correlates in Habituation Experiments I and II 151

4. The Descriptive Statistics for the Six Linguistic Measures in Subsamples I and II Combined . 177

5. Intercorrelation Matrices for the Six Linguistic Measures in Subsamples I and II and Subsamples I and II Combined. 178

6. A Comparison of the Means ($\bar{X}_1$, $\bar{X}_2$) and Standard Deviations (SD_1, SD_2) for the Six Linguistic Measures in Subsample I and Subsample II . . . 180

7. List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Denotative Linguistic Meaning (Mean) Scores (m+I scores) for Subsamples I and II Combined 184

8. List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Connotative Linguistic Meaning (Mean) Scores (SD scores) for Subsamples I and II Combined 186

9. List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing (Mean) Concreteness Scores (A-C) for Subsamples I and II Combined. 188

10. The Linguistic Stimuli for the Four Cells in Habituation Experiment I (High and Low Denotative, and High and Low Connotative Linguistic Meaning) 190

Table page

11. The Linguistic Stimuli for the Four Cells in Habituation Experiment II (High and Low Word Concreteness, and High and Low Connotative Linguistic Meaning). 191

12. Summary of the Experimental Designs Indicating the Final Words Selected for Habituation Experiments I (Denotative and Connotative Linguistic Meaning), and II (Word Concreteness and Connotative Linguistic Meaning) . . . 192

13. Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_1), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli . 196

14. Multivariate Analysis of Variance for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . . 198

15. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, LAT_1, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B) 199

16. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli 200

17. Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_2), for Three Trial Blocks, to High and Low Denotative (HDen, (LDen) and High and Low Connotative (HConn, (LConn) Linguistic Meaningful Stimuli. 202

18. Multivariate Analysis of Variance for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . . 204

LIST OF TABLES

Table page

19. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, LAT_2, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative (B) Linguistic Meaning. . . 205

20. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. 206

21. Mean Scores for the Dependent Measures, Skin Conductance Level (SCL), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 208

22. Multivariate Analysis of Variance for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli . . . 210

23. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCL, for Three Trial Blocks for the Main Effect, Denotative Linguistic Meaning (A). 211

24. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli 212

25. Mean Scores for the Dependent Measures, Skin Conductance Response (SCR), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 214

LIST OF TABLES

Table page

26. Multivariate Analysis of Variance for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. 216

27. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B) 217

28. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli 218

29. Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval (SCR-TISI), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 220

30. Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . . 222

31. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR-TISI, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B) 223

32. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. 224

Table page

33. Mean Scores for the Dependent Measures, Skin Conductance Level-Range Corrected (SCL-RAN), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. . . 226

34. Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. 228

35. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCL-RAN, for Three Trial Blocks for the Main Effect, Denotative Linguistic Meaning (A). 229

36. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . 230

37. Mean Scores for the Dependent Measures, Skin Conductance Response-Range Corrected (SCR-RAN), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli . . 232

38. Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli 234

39. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR-RAN, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative Linguistic Meaning (B) 235

40. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . 236

Table page

41. Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval-Range Corrected (SCR-TISI-RAN), for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 238

42. Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. . 240

43. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative Linguistic Meaning (B). 241

44. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli. 242

45. Summary of the Multivariate Analyses of Variance for the Dependent Measures in Experiment I, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli 244

46. Summary of the Analyses of Simple Contrasts (Roy's Criterion) for the Dependent Measures in Experiment I, for Three Trial Blocks, for the Main Effects, Denotative and Connotative Linguistic Meaning. 245

47. Summary of the Generalized Discriminant Function Analyses for the Dependent Measures in Experiment I, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli, Indicating the Contribution of the Three Trial Blocks to the Rejection of the Hypothesis. . . . 246

Table page

48. Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_1), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. . 248

49. Multivariate Analysis of Variance for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli . 250

50. Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_2), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. . 252

51. Multivariate Analysis of Variance for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli . 254

52. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, LAT_2, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B). 255

53. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli 256

54. Mean Scores for the Dependent Measures, Skin Conductance Level (SCL), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 258

55. Multivariate Analysis of Variance for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli . 260

Table page

56. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCL, for Three Trial Blocks for the Concreteness X Connotative Meaning Interaction (AXB). 262

57. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 263

58. Mean Scores for the Dependent Measures, Skin Conductance Response (SCR), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. . 265

59. Multivariate Analysis of Variance for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 267

60. Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval (SCR-TISI), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 269

61. Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 271

62. Mean Scores for the Dependent Measures, Skin Conductance Level-Range Corrected (SCL-RAN), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 273

Table page

63. Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Word Concreteness, and High and Low Connotative Linguistic Meaningful Stimuli. . 275

64. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCL-RAN, for Three Trial Blocks for the Main Effects, Connotative Linguistic Meaning (B) and the Concreteness X Connotative Meaning Interaction (AXB). 277

65. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 278

66. Mean Scores for the Dependent Measures, Skin Conductance Response-Range Corrected (SCR-RAN), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 280

67. Multivariate Analysis of Variance for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Word Concreteness, and High and Low Connotative Linguistic Meaningful Stimuli. . 282

68. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR-RAN, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B). 283

69. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 284

Table page

70. Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulis Interval-Range Corrected (SCR-TISI-RAN), for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. . . 286

71. Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 288

72. Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B) 289

73. Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli. 290

74. Summary of the Multivariate Analyses of Variance for the Dependent Measures in Experiment II, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli 292

75. Summary of the Analysis of Simple Contrasts (Roy's Criterion) for the Dependent Measures in Experiment II, for Three Trial Blocks, for the Main Effects, Word Concreteness and Connotative Linguistic Meaning, and the Concreteness X Connotative Meaning Interaction (AXB) 293

76. Summary of the Generalized Discriminant Function Analysis for the Dependent Measures in Experiment II, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli, Indicating the Contribution of the Three Trial Blocks to the Rejection of the Hypothesis. 294

Table page

77. The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the First Trial Block and the Four Correlates of the Dependent Measures in Experiments I and II Combined. . . . 296

78. The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the Second Trial Block in Experiments I and II Combined 297

79. The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the Third Trial Block in Experiments I and II Combined 298

80. Intercorrelation Matrix (Pearson Correlations) of the Dependent Measures for the First Trial Block in Experiments I and II Combined 300

81. Intercorrelation Matrix (Pearson Correlations) of the Dependent Measures for the Second Trial Block in Experiments I and II Combined 301

82. Intercorrelation Matrix (Pearson Correlations) of the Dependent Measures for the Third Trial Block in Experiments I and II Combined 302

83. Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the First Trial Block in Experiments I and II Combined 303

84. Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the Second Trial Block in Experiments I and II Combined 304

85. Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the Third Trial Block in Experiments I and II Combined 305

86. Canonical Correlation Analysis Between the E and N Variables in the First Set, and the SCL-TB_1, SCL-TB_2, and SCL-TB_3 Variables in the Second Set. 306

87. Canonical Correlation Analysis Between the E and N Variables in the First Set, and the $Spont_1$ and $Spont_2$ Variables in the Second Set 307

Table page

88. Estimates of the Intrasession Reliability Coefficients for Adjacent Trial Blocks for the Physiological Measures in Experiment I and Experiment II. 309

89. The Evaluation of the Multivariate Null Hypotheses for Denotative Linguistic Meaning (Ho 1.1 to 1.8), Connotative Linguistic Meaning (Ho 2.1 to 2.8), and Word Concreteness (Ho 3.1 to 3.8) for the Dependent Measures in Experiments I and II. 311

90. The Evaluation of the Correlational (Univariate) Hypotheses Between the Extraversion (Ho 4.1 to 4.10) and Neuroticism (Ho 5.1 to 5.10) Variables and the Physiological Measures in Experiments I and II Combined. 313

LIST OF FIGURES

Figure page

1. Schema for the Orienting Reflex. 10

2. Mean Latency of Skin Conductance Response (LAT_1) to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 197

3. Mean Latency of Skin Conductance Response (LAT_2) to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 203

4. Mean Skin Conductance Level to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 209

5. Mean Skin Conductance Response to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 215

6. Mean Skin Conductance Response-Total Interstimulus Interval to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 221

7. Mean Skin Conductance Level-Range Corrected to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli . . . . . .

8. Mean Skin Conductance Response-Range Corrected to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 233

9. Mean Skin Conductance Response-Total Interstimulus Interval-Range Corrected to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 239

LIST OF FIGURES

Figure page

10. Mean Latency of Skin Conductance Response (LAT_1) to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 249

11. Mean Latency of Skin Conductance Response (LAT_2) to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 253

12A. Mean Skin Conductance Level to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 259

12B. The Interactions Between Word Concreteness and Connotative Linguistic Meaning for SCL-TB_1, SCL-TB_2, and SCL-TB_3 261

13. Mean Skin Conductance Response to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 266

14. Mean Skin Conductance Response-Total Interstimulus Interval to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli . . 270

15A. Mean Skin Conductance Level-Range Corrected to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 274

15B. The Interactions Between Word Concreteness and Connotative Linguistic Meaning for SCL-RAN-TB_1, SCL-RAN-TB_2, and SCL-RAN-TB_3 276

16. Mean Skin Conductance Response-Range Corrected to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli. 281

17. Mean Skin Conductance Response-Total Interstimulus Interval-Range Corrected to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli 287

INTRODUCTION

Over the past decade and a half a great deal of interest has been shown in the phenomenon of habituation. While it is critical to distinguish behavioral habituation (learning or adaptation) from physiological response habituation (extinction), as Peeke and Hertz (1973, p. ix) have recently indicated, the research described in this paper will be restricted to the latter phenomenon.

Clearly, the most important impetus for the investigation of physiological response habituation has come from the Soviet Union. The theoretical and experimental work of the neo-Pavlovian psychologist, E. N. Sokolov, has in particular generated a great deal of interest among Western Psychophysiologists. Sokolov has advanced a theory for the habituation of the orienting response which is based primarily on a neurophysiological matching assumption. He observed, while working in his own laboratory, that any change in a previously habituated stimulus caused the orienting response to return (dishabituation). He, therefore, inferred that something must have been recorded in the nervous system which served as a frame of reference against which to compare any new afferent signals. This "neuronal model," he hypothesized, was used as a kind of biological filter to prevent "familiar" stimuli as opposed

to "novel" stimuli from triggering the orienting response. Thus when a mismatch is present the orienting response is elicited, and when the mismatch ceases the OR components habituate.

Sokolov's theory, then, was stated in relatively clear and simple terms and directly suggested a number of physiological defining operations which could be used to provide empirical tests of his theory. The Russian research style has, until very recently, demonstrated a classic disinterest in the study of individual differences. Consequently, most of the parametric studies investigating various aspects of his theory have been done outside the Soviet Union. Western psychophysiologists responded appropriately to the challenges implied in Sokolov's theory, and in the past fifteen years more than 100 habituation studies have been reported in the various psychological and psychophysiological periodicals.

The earlier work was devoted to directly testing or "replicating" many of Sokolov's (1960, 1963a) claims. Thus the earlier work attempted to distinguish orienting from defensive responses, or to investigate the effects of changes in "the intensity, the quality, the duration, and the order of presentation of the stimuli" (Sokolov, 1960, p. 205). By the early 1970s it was becoming increasingly obvious that Sokolov's model-mismatch theory

could not account for many of the empirical findings reported in the literature. In 1973, O'Gorman, a psychologist working at the University of New England in Armidale, Australia, published a very important theoretical work reviewing virtually all the stimulus change studies up to that time and directly challenged the validity of the matching assumption. O'Gorman's critique of Sokolov's theory was all the more incisive because some of his own earlier work apparently supported Sokolov's theoretical position.

The research reported in these pages takes its inspiration from the work of Sokolov (1960, 1963a, 1963b, 1969), O'Gorman (1973), Bernstein (1969, 1973), Eysenck (1967), and many others. It specifically investigates the hypothesis drawn from Sokolov's own work, that habituation may be related to the meaning (meaningfulness) of the orienting stimulus. It also investigates Eysenck's (1967) hypothesis that individual differences in habituation may be related to the personality variable, extraversion.

The reader will undoubtedly observe that the present report of research is considerably more extensive than the usual dissertation manuscript. There are, however, good reasons for this, because the present experimental work differs from most other habituation studies

in at least two important ways. A great deal of effort was extended in the present research to provide adequate operational measures for the independent variables of the study. This was judged to be of critical importance because Sokolov and his coworkers have not suggested any defining operations for the psychological aspects of his theory.[1] How would Sokolov, for example, define in psychological terms "meaning," "novelty," "familiarity," "image," etc.? While at a conference with other prominent neuropsychologists, Sokolov (1960) was asked to define the term novelty.

> Sokolov: But the factor of novelty should be explained. What is meant by "novelty"? Novelty is the noncoincidence between the stimulation and the elaborated neuronal model (Sokolov, 1960, p. 205).

Thus Sokolov, when asked for an essentially psychological definition, responded exclusively in physiological terms. Eysenck (1966) pointed out a full decade ago that Russian psychologists typically shroud their theories in physiological terms. There are cultural and ideological reasons, obviously stemming from the Pavlovian and neo-Pavlovian

---

1 This issue is taken up in considerable detail in Chapters I and IV. The one partial exception to this statement may be found in Sokolov's information theory interpretation of the OR. This approach, however, has been criticized by a number of workers on the basis that his "entropy" model addresses only the structural or physical aspects of the orienting stimulus (see the text).

research idioms which would explain Sokolov's (1960) response. But this does not assist in the development of the psychological aspects of his theory which are clearly just as important as the physiological considerations.

The present research differs in another important way from most other habituation studies. The complex problems of the physiological dependent measures indexing habituation and their statistical treatment were extensively treated in Chapters I, II, and IV. These problems can no longer be treated, en passant, by serious workers in this area because, as Koriat, Averill and Malstrom (1973) have correctly indicated, they represent theoretical as well as methodological issues.

The first chapter presents a review of the relevant theoretical and experimental work which moved the writer to formulate the hypotheses and predictions of the study. A separate section is included in Chapter I which introduces the most important ongoing methodological problems common to habituation experiments.

Chapter II describes in detail the psychological experiment which was carried out to define the independent measures of the study and the two habituation experiments. Fairly extensive analyses of the procedures employed to quantify the physiological (dependent) measures and their statistical treatment are given in Chapter II, and represent

a further elaboration of these issues which were introduced in Chapter I.

Chapter III reports the results of the statistical analyses obtained on both the linguistic (independent) measures and the skin conductance habituation measures. There are nearly 90 tables reported in Chapter III. However, the reader need not despair because appropriate summary tables are reported at the end of each habituation experiment.

The results of both the psychological experiment and the habituation experiments are discussed in Chapter IV.

CHAPTER I

REVIEW OF THE LITERATURE

This chapter presents a review of the most important theoretical and experimental work which provided the basis for the problems to be investigated in this paper. The chapter is divided into five sections. The first section gives a general introduction to the habituation literature. Section two offers a critical analysis of Sokolov's mismatch theory, and identifies the major hypotheses and predictions of interest to the present study. Section three examines the relationship between personality variables and habituation outcome and, in particular, reviews the theoretical and experimental work addressed to Eysenck's theory. Section four introduces the most important methodological problems common to habituation experiments. A summary and statement of the null hypotheses are given in the final section of this chapter.

1. The Phenomenon of Physiological Response Habituation to Repeated Stimulation

A good deal of evidence is now available to support the phenomenon of decreased physiological response to repetitions of the same stimulus (Gastaut, 1957; Hermandez-Peon, 1960; Pribram, 1967; Sharpless & Jasper, 1956;

Sokolov, 1960, 1963a, 1963b, 1969; Thompson & Spencer, 1966). In their review of the early habituation literature, Thompson and Spencer (1966) point out that a number of similar definitions of habituation have been proposed. More recently, Groves and Thompson (1970) define habituation simply as "decreased response to repeated stimulation" (p. 419). Furthermore, they suggest that the most popular analogues used to signify both the physiological and psychological aspects of the process are habituation or extinction, and learning or adaptation, respectively

Relatively few well-elaborated theoretical constructs have been brought forth to explain habituation. The most comprehensive of the current habituation theories are those offered by Sokolov (1963a) and Thompson (Groves & Thompson, 1970; Thompson & Spencer, 1966). Lynn (1966) has provided an excellent critical review of the earlier habituation literature, particularly as it has relevance for Sokolov's theory, while Graham (1973) has most recently provided a critical comparison of the habituation theories proposed by Sokolov and Thompson.

Lynn (1966, pp. 33-61) distinguishes one- and two-stage models of the habituation process. The one-stage models posit the generation of an inhibitory process in the stimulated neurons (particularly the cortex) which eventually extinguishes the response. Lynn rejects

one-stage models on the basis that much of the experimental evidence cannot be adequately incorporated into such a model. One-stage models cannot account for the return of a habituated response (dishabituation) when the eliciting stimulus is changed (Sokolov, 1960). Neither can a one-stage model account for the data reported by Sharpless and Jasper (1956) which indicates that habituated stimuli continue to elicit evoked potentials in the cortex long after the autonomic components of the orienting reaction are habituated.

Two-stage models posit one-stage during which there is an analysis of the stimulus, and a second stage during which a response is either activated or blocked. Apart from the fact that the two-stage theories differ with respect to the assumptions about the most important inhibitory mechanisms, e.g., the cortex (Sokolov, 1960), the pons (Moruzzi, 1960), the hippocampus (Grastyan, 1960), and the neo-cortex (Jouvet, 1961), Sokolov's theory differs in other important ways.

Sokolov's theory for habituation of the orienting reaction has a number of important advantages over the other theories reviewed by Lynn. Firstly, Sokolov's theory is parsimonious, relatively complete, and clearly stated. Secondly, many of the concepts are expressed in operational terms which allow researchers to experimentally "test"

various aspects about the predictive validity of his theory. Finally, the theory addresses itself to some of the psychological aspects of the habituation process (e.g., what kind of stimuli, under what conditions, give what kind of habituation or dishabituation).

Graham (1973) arrived at a similar conclusion following her critical review of the ANS habituation literature, in terms of its supportive relevance for the theories of Sokolov (1963a) and Thompson (Groves & Thompson, 1970; Thompson & Spencer, 1966).

Thompson's dual-process theory of habituation posits two hypothetical processes, habituation (response decrease) and sensitization (response increase). These two relatively independent processes are hypothesized to interact in the central nervous system, determining the final physiological and behavioral outcome. Groves and Thompson argued that Sokolov's "stimulus-model comparator theory" could not adequately incorporate the experimental data from the "stimulus intensity effect" and the "incremental stimulus intensity effect" studies.[1] The experimental evidence

---

1 Strong stimuli (stimulus intensity effect) have been found to consistently prolong habituation (O'Gorman, 1973). Groves and Thompson argued that a strong stimulus should produce a well-consolidated neuronal model, thereby predicting shorter (rapid) habituation. The incremental stimulus intensity effect refers to the low-level final response, which is observed when the stimulus intensity is gradually increased over trials. This contrasts to the high-level final response which is observed when a high intensity stimulus is given on all trials, or when a much higher stimulus intensity is applied after habituation to a lower intensity stimulus (Davis & Wagner, 1969; Groves & Thompson, 1970).

cited in support of their theory is drawn primarily from experiments on the hind limb flexion reflex of the acute spinal cat and the acoustic startle response of the intact rat (Groves & Thompson, 1970).

Graham (1973) refutes these arguments on the basis that Sokolov's matching theory is addressed to an orienting response (OR). Startle responses would be defined in Sokolov's system as defensive responses (DR). Secondly, she points out that any decreasing response to graded increasing intensity stimuli can easily be accounted for in a theory that posits a habituation generalization hypothesis (i.e., Sokolov's). Further, she argues that: (1) a spinal reflex model for habituation will probably never be able to account for the habituation and dishabituation to complex kinds of stimulus conditions; (2) the "sensitization" part of Thompson's theory adds nothing to its predictive power; and (3) no quantitative functions are available for many of the essential concepts (e.g., generalization of habituation, sensitization, decay of sensitization). She concluded her critical remarks as follows:

> A more fundamental question is whether any model of spinal reflex behavior will prove adequate to account for behavior in the adult human. Thompson's theory does not predict differences in the rate of habituating ANS responses either as a function of the type of response involved or as a function of

> stimulus characteristics other than frequency or intensity. In contrast, Sokolov's stimulus-model-comparator theory is primarily concerned with the problem of specifying stimulus conditions which elicit and lead to habituation of a particular type of response, the orienting reflex. These conditions require a nervous system capable of responding to the amount of information provided by very complex stimulus variations (p. 211).

Thus it appears that Sokolov's theory for habituation of the orienting reaction has not been seriously contested on the basis of the data brought forth by Thompson and his coworkers. For the reasons stated above, Sokolov's theory has generated among western psychophysiologists what is fast becoming an "enormous literature." It will now be necessary to carry out a more comprehensive critical analysis of Sokolov's theory in order to develop the hypotheses of interest to the present study.

2. Habituation Theory and Stimulus Variables

Sokolov's theory, more than any other, is addressed essentially to those stimulus conditions which may activate or extinguish the orienting response. This section of the chapter will present an analysis of Sokolov's theory, as well as a review of many experimental studies which have tested various inferences following from his theory. This analysis will provide the basis for the statement of the major hypotheses to be investigated in the present experiments, and will allow the writer to offer alternative sets

of contrary predictions concerning habituation outcome. The first set of predictions will follow from Sokolov's hypothesis, and the second set of predictions will follow from an alternative hypothesis which was recently suggested in the literature.

A. Sokolov's Theory for Habituation of the Orienting Response

Sokolov (1960, 1963a, 1963b) defines the OR as an integrated functional system of reactions, motor (EMG response), autonomic ("GSR," heart rate, vasomotor, and pupillary), sensory (lowering of sensory thresholds), and central (EEG changes), to a "novel" stimulus which facilitates in the organism the optimum conditions for the reception and retention of a stimulus. Its purpose is to increase the functional efficiency of the nervous system so that the stimulus can be processed by the organism in the most efficient manner. The repeated presentations of a stimulus of mild or moderate intensity will eventually lead to the habituation of the physiological response components (Sokolov, 1960, 1963b). Furthermore, Sokolov (1960, 1963a, 1963b) has repeatedly stated that any perceived change will cause the OR to reappear (dishabituation). Sokolov has reported no parametric evidence to substantiate these claims. However, his experimental work and writings

provide the major "evidence" upon which his habituation theory was originally founded.

Sokolov (1960, 1963b) further distinguishes the OR from the adaptive response (AR) and the defensive response (DR) on the basis of differences with respect to the quality, intensity, and modality of the stimulus. The OR is nonspecific with regard to the quality, intensity, and modality of the stimulus. The adaptive response depends on the quality and modality of the stimulus. Lights, for example, will continue to evoke a constriction in the pupil of the eye. The DR depends upon the intensity of the stimulus. A painful electric shock will consistently elicit a physiological response which is difficult, if not impossible, to extinguish. Habituation, then, is the second "property" (Sokolov, 1963b) which distinguishes the OR from adaptive and defensive responses.

Sokolov's (1960) neuropsychological theory for habituation of the OR may be summarized as follows: Incoming sensory stimuli pass up the afferent sensory pathways to the cortex, and at the same time excitatory impulses are sent by the afferent collaterals to the reticular formation. When the reticular formation is activated by both the afferent collaterals and the cortex, the orienting reaction is activated. With repeated presentations of the novel stimulus, a neuronal model is

traced in the cells of the cortex. "The model postulates a chain of neural cells which preserve information about the intensity, the quality, the duration, and the order of presentation of the stimuli" (Sokolov, 1960, p. 205). If, on the other hand, the initial stimulus matches a model already elaborated in the cortex, inhibitory impulses are sent down to the afferent collaterals in time to block the nonspecific input to the reticular formation. The OR does not take place and the habituated stimulus instead elicits an inhibitory conditioned response (Figure 1, Sokolov, 1960, p. 216).

In his earlier (1960) and more recent (1969) formulations, Sokolov has, in particular, addressed his theory to those stimulus conditions which may activate or extinguish the orienting reaction. The stimulus "property" which was originally conceptualized to elicit the OR was "novelty."

> According to our hypothesis the orienting reflex is evoked when the neuronal model set up in the brain does not coincide with all the parameters of the stimulus. The orienting reflex is produced not only by the stimulation itself, but by impulses arising as a result of non-coincidence between a certain cortical pattern (the model) and the applied stimulation.
> . . . . . .
> Sokolov: But the factor of novelty should be explained. What is meant by "novelty"? Novelty is the noncoincidence between the stimulation and the elaborated neuronal model (1960, p. 205).

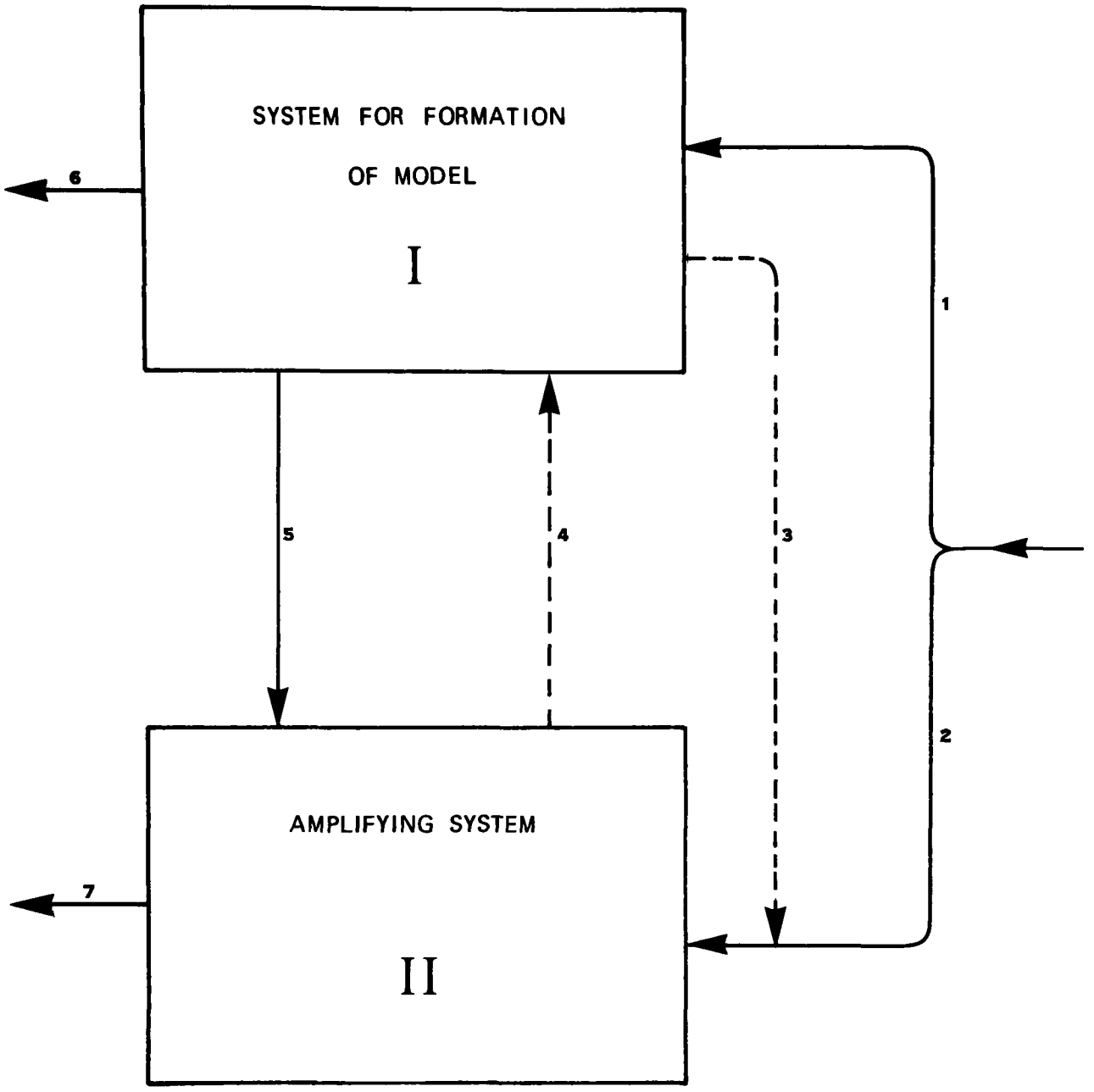


Figure 1 – Schema for the orienting reflex. I. Modeling system. **II.** Amplifying system. **1** = specific pathway from sense organs to cortical level of modeling system; **2** = collateral to reticular formation (represented here as an amplifying device); **3** = negative feedback from modeling system to synaptic connection between collaterals from specific pathway and R.F.; **4** = ascending activating influences from the amplifier (R.F.) upon modeling system (cortex); **5** = pathway from modeling system to amplifying system (this is the pathway through which the impulses signifying concordance are transmitted from the modeling system to the amplifying system); **6** = to the specific responses caused by coincidence between the external stimulation and the neuronal model elaborated in the cortex; and **7** = to the vegetative and somatic components arising from the stimulation of the amplifying system (R.F.).

However, even in his earlier (1960) work Sokolov clearly favored a more cognitive or information theory interpretation of the habituation process as well as the "novelty" interpretation.

> Brazier: Professor Sokolov, would you be more satisfied if this were put into the language of information theory rather than Gestalt? When bits of information come through to the brain, there will be an orienting reflex.
> Sokolov: Yes, that's right, although I have no actual measurement of the amount of information. It should be measured.
> Brazier: Yes, but this would bring in the concept of probability of the nervous system's having experienced this before. The less probable the stimulus the more information will come through.
> Sokolov: That is right.
> Pribram: First, a set must be established out of which events are to be selected, "setting the stage," as it were. The second step does not occur until after the first. In a sense, this goes beyond information theory, because it sets the limits on the number of alternatives out of which selection can then be made. Only then does information measurement begin.
> Sokolov: But information theory can be used in all cases where the stimuli can be characterized by their probability of occurence. When a stimulus is repeated, the probability of its occurrence is increased, and therefore the amount of information it conveys is decreased (p. 206).

In a more recent publication, Sokolov (1969) continues to develop this same line of thinking. The OR is conceptualized as a system of hypotheses, or predictions, about the orienting stimulus, its probability of occurrence and its meaning. The neuronal model preserves information about the meaning of a previously experienced

stimulus, allowing the subject to compare this with the meaning of afferent signals actually operating. It follows, then, that the duration of habituation is related to the degree of mismatch between the hypothesized meaning and the actual meaning of a stimulus.

> One of the essential features of the neural model is that it anticipates the future significance of afferent impulses based on the past flow of impulses. Nervous impulses which anticipate the meaning of a stimulus are used by the nervous system in two ways: first to arouse a positive conditioned response while a stimulus is in operation; second, to inhibit impulses approaching the centers which carry out the orienting reflex. Impulses which anticipate the meaning of afferent signals are constantly being checked against afferent signals which are actually operating. The discrepancy signal that appears is proportional to the difference between the extrapolated and the actual meaning of a signal (Sokolov, 1969, p. 683).

It is clear that Sokolov conceptualizes the OR primarily as a response to a lack of stimulus information. Its purpose is to secure additional information about the stimulus. Once the lack of clarity has been eliminated, and the stimulus has been identified, the OR habituates.

> Since the orienting response depends upon the entropy of the entire system of hypotheses, what group a stimulus is assigned to is inconsequential. What is important is the fact of recognition. However, the moment a new stimulus is presented, there is less probability that it will pertain to the previous neural model; for a period of time, then, all the hypotheses are equally probable. In this case the amount of entropy increases and the orienting response is elicited, terminating only when the new stimulus has been recognized (Sokolov, 1969, p. 689).

There is, therefore, a good deal of consistency between the earlier (novelty interpretation) and the more recent (meaning or information theory) versions of Sokolov's theory. A careful consideration of both versions indicates that his theory is predicated firmly upon a matching assumption. Two inferences immediately follow: (1) the OR is a response to a lack of stimulus information (signals of mismatch between the stimulus and the neural trace); and (2) the OR habituates once the stimulus has been identified (signals of mismatch disappear).

It is now possible to challenge the primary assumption upon which Sokolov's theory is founded, as well as some of the inferences and predictions which follow from his theory. The writer will argue that Sokolov's theory has failed to adequately consider both (1) individual differences about other aspects of the orienting stimulus, and (2) individual differences in the subject's physiological response (responsiveness). In order to do this, the writer will appeal to the experimental work which has been done, principally outside of the Soviet Union. As indicated above, Sokolov and his coworkers have not published any parametric data to support his theory.[2]

---

2 This statement is restricted to the English translations of his work readily available to Western workers.

B. Experimental Evidence Bearing on the Predictive Validity of Sokolov's Theory

Although there are a great many studies published in the habituation literature, only a selective review will be offered here. There are three related classes of habituation studies providing data that have a particular relevance for the ideas developed in this paper. They are as follows: (1) the stimulus change studies; (2) the stimulus significance studies; and (3) the information theory studies.

A critical evaluation of virtually all the relevant stimulus change studies has recently been reported by O'Gorman (1973). He reviewed the findings of over 30 stimulus change studies which tested various aspects of Sokolov's (1963a, 1963b) prediction that any perceptible change in the stimulus conditions will bring about the dishabituation of the OR components. Studies examining the effects of changing (1) the intensity of the stimulus, (2) the duration of the stimulus, (3) the elements of a compound stimulus, and (4) the order of presentation of the stimulus, were reviewed. In addition, some studies were reviewed which tested Sokolov's hypothesis that the magnitude of the OR is proportional to the amount of stimulus variation (that is, the larger the stimulus change, the larger the physiological response).

The generally inconsistent or negative findings led him (O'Gorman, 1973) to conclude that "the OR is less sensitive to variation in stimulus conditions than originally implied by Sokolov" (p. 467). Only those studies which produced an increase in the intensity of the stimulus, or a change in the modality of stimulus presentation, gave consistent results. Moreover, a number of studies suggested that some subjects who were clearly aware of the stimulus-change conditions (assessed by post-experimental questionnaire) did not demonstrate dishabituation.

These findings embarrass Sokolov's theory of habituation, particularly because he has repeatedly predicted that any perceived change in the stimulus conditions will bring about the return of the OR (Sokolov, 1960, p. 203; 1963a, p. 283; 1963b, p. 561). O'Gorman (1973) raises the question whether the data from the stimulus change studies reviewed by him require a matching assumption at all. He succinctly points out that the hypothetical matching process implies that the nervous system is responding to the differences between stimuli rather than to the energy properties of the stimulus (p. 468). Finally, making reference to some of his own earlier work (1972), O'Gorman suggests that perhaps future studies would do well to investigate both the energy properties of the orienting stimulus, as

well as differences in the subjects' responsiveness within the various OR component systems.

There have been a few stimulus change studies which followed O'Gorman's 1973 review. Mino and Miyata (1975) studied the effects of the range of stimulus change on the habituation of the skin resistance response (SRR) in three different but related experiments. Their results indicate that differential dishabituation did not occur as a function of the independent variable manipulations. They concluded that their findings in general were inconsistent with predictions following from Sokolov's theory.

Edwards (1974, 1975) reported the results of two studies which investigated the effects of change in stimulus intensity and recency (change in the interstimulus interval). In the first study, both intensity and recency were manipulated. The results did not support a neural model-mismatch theory of habituation. He concluded that a change in one stimulus parameter will not always bring about dishabituation. In the second study, the results of reducing the stimulus intensity after 4, 8, 15, 22, and 30 trials was investigated. (His 1974 results suggested that greater dishabituation takes place when the stimulus is changed after only four trials.) The results indicated that when the stimulus intensity was reduced in the earlier trials (1 - 10), the magnitude of the skin conductance

response (SCR) decreased; in the middle trials (15 - 30) the SCR increased; and, finally, in the later trials (after 30) a reduction in stimulus intensity produced a decreasing response. Edwards (1975) suggested that these results are "puzzling for theoretical analyses" (p. 13). He questioned whether a stimulus-specific model-mismatch theory could account for his habituation data.

Consistent with O'Gorman's conclusions, Ginsberg and Furedy (1974) found that predictable dishabituation could be obtained when the stimulus modality was changed (visual to auditory and vice versa), but only for the SRR component and not for the vasomotor component.

Finally, Jackson (1974) reported the results of two within subjects and one between subjects experiments, which investigated the effects of an increase in stimulus intensity on the skin conductance (SC) and heart rate (HR) responses. The results of the within subjects experiments indicated that SC increased directly with stimulus intensity, and the HR response was tri-phasic (decrease, increase, and decrease) to an increase in stimulus intensity. The between subjects experiment indicated that after the SC response had been habituated to a 0 db stimulus, a test stimulus (increase on the tenth trial) would bring about an increase in SC, while habituation to an 80 db stimulus produced a decrease in SC on the test trial. Her results indicate a

direct relationship between stimulus intensity and habituation for the conditions of increasing stimulus intensity.

The results of those stimulus change studies which followed O'Gorman's 1973 critical review, then, for the most part, support his own conclusions. The new findings provide only limited support for Sokolov's theory (e.g., Ginsberg & Furedy, 1974; Jackson, 1974). On the other hand, there are many experimental findings which cannot be accounted for by a stimulus-model-comparator theory. In addition, the results of studies which have manipulated the stimulus attribute "significance," also provide a singular challenge for Sokolov's theory of habituation.

For a number of years Bernstein and his coworkers (Bernstein, 1969; Bernstein, Taylor, Austen, Nathanson & Scarpelli, 1971; Bernstein, 1973; Bernstein, Taylor & Weinstein, 1975) have been challenging the idea that habituation can be adequately explained through the medium of an automatic reflexive-type mechanism (Sokolov, 1963a). They have designed a number of experiments, the results of which suggest that the perceived significance of the evoking stimulus can more reliably predict habituation outcome than a mismatch hypothesis which focuses on the familiarity-novelty differences in the orienting stimulus.

Bernstein (1969) was able to demonstrate that a stimulus change on a test trial can be correctly perceived

and reported by subjects without ensuing dishabituation. He speculated that, perhaps, a two-stage process was involved during which, first, the matching procedure took place followed by an evaluation of the significance of the stimulus information. An OR would then be evoked only if the stimulus change was perceived as significant.

Bernstein et al. (1971) reported experimental evidence to indicate that when a stimulus "apparently moves" towards a subject, longer dishabituation occurs than when a stimulus "apparently moves" away from a subject. They interpreted these results to suggest that the apparent movement towards the subject is more significant than apparent movement away from the subject.

In response to O'Gorman's (1972) earlier criticism of Bernstein's (1969) "significance hypothesis," Bernstein (1973) investigated the effects of "significant" stimuli on nonspecific electrodermal fluctuations (NSFs).[3] O'Gorman (1973) had previously argued that a simpler explanation than the significance hypothesis is that subjects not responding to a stimulus change exhibit lower levels of NSFs which, in turn, reflects the predominance of inhibitory vs. excitatory processes in the nervous system. Bernstein (1973) countered by providing experimental evidence to suggest that when an

---

3 NSFs are the same as spontaneous electrodermal responses, which are distinguished from stimulus specific responses.

orienting stimulus is perceived as significant, the number of NSFs is greater than when the stimulus is not perceived as significant. He concluded that the number of NSFs themselves reflect central judgments about stimulus significance. Furthermore, he strongly criticized the relatively arbitrary Soviet distinction between "nonsignal" stimuli, which allegedly are free from central evaluation, and "signal" stimuli, which come under central-cortical evaluation. He points out that there are no dichotomous data to support such a concept.

> "Signal" and "indifferent" ORs are recognized essentially in that the former take "longer" to habituate. There is no critical value separating them. There is also no provision for dichotomous processes mediating these two "types" of OR. If there is no provision made initially for a central evaluation of significance in the integrated cortical-subcortical processes presumably responsible for the OR, where and how does such an evaluation break into the circuitry, once an experimenter creates "signal" value? The present writer suggests that there is no dichotomy; that every stimulus is internally judged at least potentially significant at the time it elicits an OR; that, for various reasons, some stimuli or conditions continue to be judged significant for a longer time than do others, and therefore continue to elicit ORs for a longer time. Thus a single continuous process is suggested in which significance judgments are always made, rather than a dichotomous one in which they suddenly intrude (Bernstein, 1973, pp. 152-153).

Additional evidence has been most recently reported by Bernstein et al. (1975) which provides further support for the significance hypothesis. They reported data which indicate that there is longer SCR habituation to high

significance-stimulus conditions than to physically identical stimulus conditions which do not possess high significance. Once again, they argue that their SCR habituation data reflect the central evaluation of the significance of all incoming stimuli.

The overall evidence from the series of studies reported by Bernstein and his coworkers suggests quite strongly that central judgments about the significance of the orienting stimuli play an important role in predicting habituation outcome. It also underscores, as Bernstein has repeatedly stated, the importance of cognitive, affective, and motivational variables for habituation outcome. Attempts to reliably predict habituation using an information theory model have also been done, and shed some light on Sokolov's theory.

It was pointed out above that Sokolov's theory predicts a direct relationship between habituation and the uncertainty of the orienting stimulus. Lovibond (1969) tested this hypothesis and found that skin conductance habituation was related to the degree of uncertainty in the reinforcement schedule applied to the orienting stimuli. He interpreted this as offering some support for Sokolov's information theory analysis of OR habituation.

Orr and Stern (1971) investigated the effects of three different levels of stimulus uncertainty on the EEG

and skin conductance responses. Their results indicated that uncertainty had no significant effects on either of the OR components.

O'Gorman (1971) objected to the fact that, in both the Lovibond (1969) and the Orr and Stern (1971) studies, reinforced stimuli were used. He followed up on these two earlier studies by investigating the effects of manipulating the information value (uncertainty) of the stimulus (non-reinforced) on the skin resistance response and the finger pulse volume response.[4] His findings suggest that skin resistance habituation is a direct linear function of the information value (uncertainty) of the orienting stimuli. The vasomotor response was not significantly affected by the independent variable manipulations.

Velden (1974) reported the results of a study designed to provide a more precise empirical test of Sokolov's entropy model interpretation of the OR. Employing a rigorous information theory analysis to define the information value of each word in a short (German) sentence which was used as the orienting stimulus, he tested five

---

4 The information value (uncertainty) of a stimulus is defined in information theory as the probability of stimulus occurrence (Shannon, 1948). The higher the probability of stimulus occurrence, the lower the information value (uncertainty). The lower the probability of stimulus occurrence, the higher the information value (uncertainty). (Also see Sokolov, 1960, p. 206.)

hypotheses inferred from Sokolov's entropy model. The results of the data analyses performed on the phasic change scores and the tonic skin resistance levels offered very little support for any of the hypotheses. He concluded that his results reject an OR construct which assumes a relationship between the uncertainty of the stimulus conditions and the strength of the OR. He further speculated that his data favor a (delayed) "information processing" hypothesis, which implies a relationship between the magnitude of the OR and the information conveyed by an event.

The weight of the evidence from the information theory studies, then, indicates only limited support for Sokolov's entropy model interpretation of the habituation process. Furthermore, as Velden (1974, p. 683) has most recently stated, Sokolov's entropy model interpretation of the OR addresses itself only to the structural parts of the orienting stimulus and no provision is made for the "motivational" aspects of the stimulus.

The experimental findings from the three groups of studies reviewed above cannot, for the most part, be accounted for by Sokolov's theory. The overall evidence is simply not consistent with inferences following from any of the formulations of Sokolov's theory. The highly probable conclusion is that variables other than a simple mismatch between the structural aspects of the orienting

stimulus and a neuronal model have a significant part to play in determining and predicting habituation outcome. This conclusion becomes especially tenable when workers manipulate the more complex stimulus conditions. The writer concludes that the consideration of other variables (cognitive, affective, and motivational) may well lead to a more reliable prediction of habituation outcome, than a model-mismatch theory addressed primarily to the structural aspects or the uncertainty of the orienting stimulus.

The present study will test an additional hypothesis deduced from Sokolov's theory for habituation of the orienting reaction. The major hypothesis to be advanced in the present research is that individual differences in habituation may be related to individual differences in the meaning (meaningfulness) of the orienting stimulus. It can be recalled that this hypothesis was specifically stated in one of Sokolov's (1969, p. 683) own texts. However, even if Sokolov had not suggested such an hypothesis, it still could have been inferred from his mismatch theory on logical grounds.

His theory clearly indicates that a high meaningful stimulus would be expected to have produced a well-elaborated neuronal model in the nervous system, and hence the matching process (stimulus identification) would take place relatively quickly. While, on the other hand, a low

meaningful stimulus would not be expected to have produced a well-elaborated neuronal model, and hence the matching process would take place relatively slowly. Sokolov's mismatch hypothesis, then, would predict relatively more habituation in response to a high meaningful stimulus, and relatively less habituation in response to a low meaningful stimulus.

On the other hand, the studies reviewed above indicate that there is now sufficient evidence to question the validity of the matching assumption. The experimental evidence suggested that a stimulus evoked response (OR) may not necessarily be a function of the differences between stimuli (a mismatch), but may be a function of the arousal or energy properties of the stimulus. The predictions about habiutation outcome to high and low meaningful stimuli made on the basis of an arousal hypothesis would be contrary to those which follow from a mismatch hypothesis. Thus it could be argued that a high meaningful stimulus would produce relatively less habituation, and a low meaningful stimulus relatively more habituation, because the arousal value of the high meaningful stimulus is greater.

An arousal hypothesis, then, would predict relatively less habituation in response to a high meaningful

stimulus, and relatively more habituation in response to a low meaningful stimulus.

Word stimuli will be used to test the hypotheses and predictions advanced in the present study, primarily because most of the psychological research has been restricted to the investigation of linguistic meaning. Extensive research over the years into the problem of linguistic meaning has produced a number of instruments which may be used to reliably index word meaning, although a good deal of theoretical controversy about the "meanings of meaning" remains. The next subsection of this chapter, then, will be devoted to a review of the relevant linguistic meaning literature.

C. An Analysis of Linguistic Meaning

The difficult tasks of providing an adequate theoretical analysis as well as operational indices of "meaning" have plagued many workers over the years. Part of the difficulty stems from the fact that meaning as a theoretical construct overlaps with a number of other psychological processes of interest, e.g., perception, memory, learning, and language. Pavio (1971), commenting on the apparent dilemma, suggests that meaning is both the most basic problem but, which at the same time, depends upon the other psychological processes. He illustrates this difficulty

by giving the example of the interrelationship between meaning and memory.

> Whatever its other defining characteristics, meaning implies at the very least that there is information in memory storage that contributes to a sense of familiarity when one is presented with a meaningful "stimulus" (pp. 39-40).

A second consideration underscoring the problem of an adequate psychological analysis of meaning is the distinction between the meaning of an object and some symbolic representation of the object. There are obvious differences, for example, between (1) a real, live Nazi (soldier) in the flesh with full dress uniform, (2) the word "Nazi," and (3) the swastika symbol. This suggests that depending upon whether one is confronted with the real object, a verbal sign, or a nonverbal sign, a different kind, level, or modality of meaning is conveyed.

However, as Creelman (1966), in her extensive review has pointed out, the systematic exploration of the different kinds of meaning in general has been largely ignored. For reasons which are not readily apparent, most of the psychological literature has been restricted to linguistic meaning. Understandably, then, the linguistic meaning literature is quite vast, as Hall (1971), Pavio (1971), Creelman (1966), and others have made quite clear. For obvious reasons, therefore, the review presented here will remain firmly rooted to the task.

Two questions guided the present writer in his review of the linguistic meaning literature. The first question asked whether there are different kinds of linguistic meaning for which adequate theoretical and operational treatments are currently available. The second question asked if there are other verbal attributes which, strictly speaking, may not be analyzed under a meaning construct, but which may bear some relationship to the linguistic measures, and which may have some relevance for habituation outcome.

The various approaches to the problem of linguistic meaning have traditionally conceptualized and defined meaning as some kind of (implicit) response to a word stimulus. These have typically included verbal associative responses, conditioned (nonverbal) responses, and imaginal responses (evoked imagery). In addition, at least two other approaches to word meaning can be identified.

Skinner's (1957) functional behavioristic approach to linguistic meaning, in contrast to the "implied response" approaches, emphasizes the investigation of those overt behavioral conditions under which the word occurs. The meaning of the word is to be found by specifying those conditions which give rise to the response (word). Other variables are not important. Brown (1958) argues for an analysis which conceptualizes linguistic meaning as

a behavioral disposition. Implicit response theories of linguistic meaning place the mediating response inside the organism where it cannot be identified. He suggests that psychologists would do better to concentrate on the behavior itself, rather than on implied responses (images or associations).

These two latter approaches need not be of more concern in this paper because neither has led to a systematic treatment of linguistic meaning which clearly demonstrated either theoretical or operational advantages over the more traditional approaches. Furthermore, Pavio (1971) has rather effectively dealt with Skinner's objections to the traditional reaction theory approaches, by pointing out that the Skinnerian theoretical analysis uses covert verbal behavior, images, and emotional responses as explanatory concepts. Brown's critique of the imagery construct is also refuted by Pavio who suggests that Brown may have confused the logical definitions of linguistic meaning with the major psychological reactions to words which mediate language behavior and linguistic meaning. At any rate, this continuing theoretical controversy need not be of further interest here.

The present writer will, in substance, follow the exposition of linguistic meaning offered by Pavio (1971, pp. 39-86) with the qualifiaction that much of the original

research will be cited and elaborated upon when necessary. Pavio (1971) not only provides one of the most comprehensive and critical reviews currently available in this difficult area, but also advances a somewhat original and innovative approach to the problem of linguistic meaning. The writer will, therefore, draw rather heavily upon some of the theoretical distinctions as well as the linguistic measures considered by Pavio.

The verbal-associative approaches to linguistic meaning represent one of the oldest and richest traditions in experimental psychology. Ebbinghaus (1885) published his classical list of nonsense syllables in an effort to provide a technique for the experimental investigation of memory. He assumed that these stimuli would elicit a relatively consistent number of associations because they were presumably devoid of meaning. Glaze (1928) was able to demonstrate the contrary by calculating the percentage of subjects who reported that a nonsense trigram (consonant-vowel-consonant) elicited some association. This was termed the association value of the stimulus.

A number of studies followed which replicated and extended the work investigating the association value of nonsense syllables (Krueger, 1934; Witmer, 1935). Hull (1933), reporting a slightly different approach, calculated the number of associations elicited for each stimulus-

syllable across subjects. It was not, however, until 1952 that Nobel extended the approach to real words by defining linguistic meaning in terms of associated content.

The original study (Nobel, 1952) was generated from the theoretical perspective that associated content is an index of meaning. Meaningfulness was formerly defined as a relationship between stimulus and response (S means R), by utilizing the Hullian (1943) construct of habit strength. Nobel postulated that meanings increase as a simple linear function of the number of S-multiple-R connections acquired in the subject's history. An index of linguistic meaning "m" was operationally defined as the average number of continued written associations made by subjects within a sixty-second interval.

Nobel constructed a list of 96 two-syllable words which yielded a psychological performance scale of m values ranging from 0.99 to 9.61. The words were systematically selected from the Thorndike-Lorge (1944) tables in such a way as to represent most of the letters in the alphabet for the initial letter and an extreme frequency of usage. These were supplemented with 18 artificial words in order to ensure a low m extreme on the scale.

A number of other associative approaches to linguistic meaning have been advanced, extending the work of Nobel and his coworkers. However, Pavio (1971,

pp. 47-48), after a partial overview of the research, concluded that there is a good deal of theoretical overlap. That entire area of research, then, defines linguistic meaning as some kind of associative phenomenon which results in observable and quantifiable response data.

A second approach to the study of linguistic meaning as an implicit response draws on the early conditioning theories. This approach is predicated upon the hypothesis that a response which is initially given to the object itself is transferred to the word by the process of classical conditioning. The best elaborated example using this approach is Osgood's (1953) theory.

Osgood and his coworkers have hypothetically defined linguistic meaning as a representational mediation process. The implicit response is representational in the sense that it is part of the original response pattern brought about by the original stimulus (significate). It is mediational because it produces overt responses which may be quite different from the original response. The word (sign), then, represents the original stimulus-object and produces some "replica" of the overt behavioral response as a mediation process. The proposition is stated formally by Osgood, Suci and Tannenbaum (1957) as follows:

> A pattern of stimulation which is not the significate is a sign of that significate if it evokes in the organism a mediating process, this process (a) being some fractional part of the total behavior elicited by the significate and (b) producing responses which would not occur without the previous contiguity of non-significate and significate patterns of stimulation (p. 7).

Strictly speaking, Osgood's theory need not be restricted to affective meaning, but may also include other meanings of "meaning" (Osgood et al., 1967, p. 9). However, in actual practice, Osgood has restricted his research efforts to the investigation of affective (connotative) linguistic meaning. He and his coworkers have developed the Semantic Differential (SD) as an instrument to define and measure "semantic meaning."

The semantic differential scales were developed by applying factor analytic techniques to a large number of bipolar adjective ratings which were given to a number of word stimuli. The meaning of a word was then operationally defined by its hypothetical position in multidimensional semantic space.

The original (two) factor analyses (Osgood & Suci, 1955) reliably yielded three factors. The first factor was termed "evaluative" (E) because it loaded most highly on such scales as good-bad, beautiful-ugly, and nice-awful. The second factor to emerge from the analyses was labelled "potency" because it loaded highly on the strong-weak,

heavy-light and hard-soft scales. The third factor was identified as an "activity" factor because it loaded heavily on the active-passive and fast-slow scales. These three factors taken together accounted for over 50% of the total variance in the scores, while the evaluative factor taken alone accounted for over 70% of common factor variance, underlining the heavy evaluative element in the SD scales.

A number of subsequent factor analytic studies have, for the most part, replicated the earlier results of Osgood and his associates (DiVesta, 1966; DiVesta & Walls, 1970; Heise, 1965). One notable exception to the above findings was reported in Pavio's (1968) factor analysis. The three SD factors did not emerge clearly from Pavio's statistical analysis. However, the reason for this, as he himself has stated (1971, p. 83), may lie in the fact that not enough of the SD scales were included in the analysis. In his factor analysis of 30 variables, Pavio (1968) only included the three pivotal scales from the semantic differential (good-bad, hard-soft, active-passive).

A third approach to linguistic meaning as an implied response traditionally has defined meaning as evoked imagery. Pavio (1971) has reviewed some of the earlier work which focused on the problems stemming from the conceptualization of linguistic meaning as some kind of imagery response. The earlier controversies centered around questions about

(1) whether images can be abstract, (2) which comes first, the meaning or the image, (3) the problem of imageless thought, or (4) whether meaning is better considered an "organismic disposition" or an implicit response.[5]

Pavio (1971, pp. 50-59) has advanced a dual-process theory of meaning which posits both nonverbal imagery and words (imaginal and verbal symbolic processes) as major psychological reactions of objects, events, and language (words). It differs from the other contemporary approaches to meaning because it assigns to the imagery concept a major mediating role within the context of an associative model.

The theory postulates three hypothetical levels of associative meaning (representational, referential, and associative) which correspond to three different kinds of stimulus information processing, representational, referential associative, and associative chaining. Representational

---

5 Some of the specific details of the controversies are as follows: (1) An image is of a specific object (i.e., particular), whereas an abstract concept is general (i.e., universal). (2) Experimental findings are contentious about which comes first (Pavio, 1971, p. 42). (3) Many subjects report "cognitive processing" without the use of images. (4) The functional-behavioristic objection that psychology should deal only with overt behavior (response) and not attempt to penetrate the "little black box." (5) Pavio offers a tentative answer to these objections aimed at the imagery construct by proposing that (a) one may have a schematic image of an abstract concept, or (b) that the abstract referents may be "concretized" and an image can then be made to one or more of the concretized referents. In order to grasp the full significance of these statements it will, however, be necessary to examine Pavio's theory more closely.

meaning refers to concrete images and words (auditory-motor responses) that are stored in long-term memory and available for use. This level of meaning would be indexed by familiarity or recognition responses.

Referential meaning implies a connection (association) between the imaginal and verbal representations corresponding to the same referent. For referential meaning, the association stays close to the referent for both symbolic representations. The object may evoke its verbal label (word) and the word can evoke the object image. Referential meaning is indexed by the imagery value of verbal stimuli and the codeability of objects.

Associative meaning refers to chains of associations between words, images or both (i.e., word-word associations, word-image associations, or image-image associations). Associative meaning, then, implies associative connections between different referents or conceptual categories. Theoretically, it is possible to have chains of associations (of both symbolic modalities) organized in a complex or hierarchical fashion. In spite of this, however, most operations available only index verbal associations (Nobel's m).

The abstractness-concreteness of meaning is also conceptualized by Pavio (1971) within the context of his theory. Concreteness is formally defined by its "directness

of sensory reference." The underlying assumption is that the concreteness of an object or word is determined primarily by its ability to elicit a concrete image as an associative reaction, rather than a verbal associative reaction. The imaginal symbolic processes, then, become functional primarily with concrete stimuli and tasks, while verbal symbolic processes become functional with both concrete and abstract stimuli. Analyzed in terms of the levels of meaning, referential meaning pertains primarily to objects, pictures, and concrete words, and associative meaning refers to both concrete and abstract stimuli.

This distinction is not absolute and the concreteness dimension cannot be fully equated with the levels of meaning. An abstract stimulus may indirectly evoke an image to one of the concrete verbal associates of that abstract stimulus. Pavio (1971) gives the example of the abstract word "religion" which may evoke the image of a church, while a picture of a particular church may elicit the verbal associate "religion." However, both modalities of symbolic representation are most likely to have been mediated by the word associate "church."

> The analysis, therefore, does not imply an absolute difference in the nature of the symbolic associative reactions that can occur to concrete and abstract terms, but only that there are differences in the probabilities involved--images are more likely to be directly evoked by concrete rather than abstract words (Pavio, 1971, pp. 60-61).

There are other verbal attributes which have some relevance for an analysis of linguistic meaning and are related (correlated) to some of the linguistic measures discussed above. In order to complete this analysis of linguistic meaning, then, it will be necessary to examine the intercorrelations between those linguistic measures which have relevance for the present study.

Nobel (1952) reported a correlation of .92 between rated familiarity (f)[6] and m. Nobel interpreted this correlation as suggestive that both m and f are joint functions of the frequency of occurrence of a given stimulus in the subject's experiential past. Similar results were reported by Hall (1967) who obtained a correlation (r) of .88 between rated number of associations and f, and Underwood, Ekstrand and Keppel (1965) reported a correlation of .85 between f and Thorndike-Lorge frequency. Frincke (1968) also reported similar findings resulting from a factor analytic study. He found that m, familiarity, and frequency all loaded highly on a factor which he identified as a "meaningful-familiarity" factor.

In contrast to these findings, Pavio (1968) reported low correlations between m and frequency (.21) and m and rated familiarity (.23). He interpreted these

---

6 The familiarity of the word is rated on a 5-point (never-very often) rating scale (see Appendix 5).

results obtained on his own list of 96 nouns (in contrast to Nobel's list of words) as suggesting that both frequency and associative experience are necessary causal factors explaining the (low) correlations between m and the familiarity measures. Thus the high meaningful word is not necessarily highly familiar. Some low frequency words (e.g., mare) produce as many associates as high frequency words (Pavio, 1971, p. 82). This interpretation by Pavio is consistent with the hypothetical role that both images and words play as mediators of linguistic meaning in his theoretical model.[7]

Based on the analysis of linguistic meaning formulated by Pavio, one would expect high and positive intercorrelations between rated imagery (I), rated concreteness (A-C), and Nobel's association measure (m). Pavio, Yuille and Madigan (1968) reported correlations of .83 between I and A-C, .72 between I and m, and .56 between A-C and m. Although the interpretation of the differences between the individual correlations is more difficult and problematic for theoretical analysis, Pavio (1971)

---

7 That is, his theory would predict that the relationship between familiarity measures and m scores cannot be explained by a single causal factor. By inference, then, one would expect moderate to low correlations between familiarity and m scores. This follows, provided the list of words used to calculate the correlations between the measures contains a representative sample of words which are relatively low frequency and high m (e.g., "mare" eliciting the high frequency associate "horse").

speculates that they support his position that imagery is a primary causal factor responsible for the relatively higher number of associations given to concrete nouns. Furthermore, the moderate correlations between m and I (r = .72) and m and A-C (r = .56) are consistent with the hypothesis that abstract terms attain their meaning primarily from intraverbal experience, while concrete terms get their meaning from both verbal (word-word associations) and sensory (imaginal) experience.

In spite of these interesting and original formulations set forth by Pavio, a substantial degree of controversy remains. Although Pavio (1968), in his factor analysis, could not identify a "meaningful-familiarity" factor, at least one other worker has identified such a factor. Frincke (1968) reported a factor analysis of nine verbal attributes which yielded two clearly identifiable factors. The first was labeled "meaningful-familiarity" and the second "imagery-concreteness." In view of these discrepant findings, Hall (1971) concludes as follows: "Pavio's (1968) findings notwithstanding, we believe that the two attributes of the isolated verbal item that are primarily related to learning are (1) meaningfulness-familiarity, and (2) concreteness-imagery" (p. 77).

The theoretical exposition of linguistic meaning outlined above suggests that at least two kinds of linguistic

meaning can be identified and reliably indexed. They are denotative (cognitive) meaning indexed by the I and m measures and connotative (affective) meaning indexed by the semantic differential scales. Furthermore, it also follows that the measures of denotative and connotative linguistic meaning will be found to be relatively independent (uncorrelated).

> Thus a gap is filled for the semantic differential factors can be regarded as exhausting the major portion of connotative meaning, whereas imagery-concreteness may be viewed as defining intensity of denotative meaning. The underlying psychological processes appear also to differ, connotative meaning involving affective (e.g., pleasant-unpleasant) and motor (e.g., active-passive) components, whereas denotative meaning involves cognitive imagery and (as indicated by the moderate loading of m on the imagery-concreteness factor) verbal associative processes (Pavio, 1971, p. 84).

The writer concludes that there does not seem to be any compelling evidence at this time to recommend the selection of either the I or m measure, one over the other, to index denotative meaning. Therefore, denotative linguistic meaning will be operationally defined by using both the I and m measures in the present study.

Connotative linguistic meaning will be operationally defined by using 10 of the semantic differential scales which loaded highly on the evaluative factor. The writer, then, will restrict his interpretation of connotative meaning in the present study to include only "evaluative"

or affective meaning. The writer takes the position that the term "connotative" meaning can be used with qualifications because (as indicated above) in the original factor analyses more than 70% of the common factor variance was accounted for by the E factor.

Finally, because of the inconsistent correlations reported between the familiarity and m measures, the linguistic attribute familiarity (f, Nobel, 1953) will also be one of the measures obtained on the words to be used in the present study. This will allow the experimenter to examine the correlations between f and the other linguistic measures, and compare these results with those discussed above.

No source could be found in the published literature which simultaneously provided normative data for all the linguistic attributes of interest to the present study for the same list of words (i.e., I, m, f, SD, and A-C). This suggests that the first major experimental task in the present study will be to construct a list of words which provides values for all five linguistic measures. This will be treated in considerable detail in Chapter II. It will be necessary now to restate the major hypothesis and predictions advanced in Section 2B above in terms of the specific modalities of linguistic meaning.

D. Linguistic Meaning and Habituation

The major hypothesis of interest to the present study is that individual differences in habituation may be related to individual differences in the meaningfulness of the orienting stimulus. The analysis of Sokolov's theory as well as the analysis of linguistic meaning, both of which were provided above, will now allow for the statement of three operational hypotheses (1, 2, 3) and three related sets of contrary predictions (1A, 1B; 2A, 2B; 3A, 3B).

The prediction A series follows from Sokolov's mismatch hypothesis. The prediction B series represents a further specification of the general arousal hypothesis (outlined above) which is now applied to meaningful linguistic stimuli. Thus the general arousal response hypothesis becomes an "implicit arousal-response hypothesis" which is an extension of the linguistic meaning analysis also provided above, and assumes that when a word is presented, imagery activity, verbal associative activity, and conditioned affective response activity take place. It is further assumed that these arousal responses mediate the meaning(s) of the word stimulus and bring about (cause) a physiological response pattern (to repeated stimulation) which is consistent with and proportional to the implicit cognitive and affective responses to the word.

The hypotheses and corresponding sets of predictions are stated as follows:

Hypothesis 1. Individual differences in habituation to word stimuli may be related to individual differences in the denotative meaning of the word stimuli.

Prediction 1A (Mismatch Hypothesis). There will be significantly more habituation in response to a high denotative linguistic meaningful stimulus and significantly less habituation to a low denotative linguistic meaningful stimulus.

Prediction 1B (Arousal-Response Hypothesis). There will be significantly less habituation in response to a high denotative linguistic meaningful stimulus and significantly more habituation to a low denotative linguistic meaningful stimulus.

Hypothesis 2. Individual differences in habituation to word stimuli may be related to individual differences in the connotative meaning of the word stimuli.

Prediction 2A (Mismatch Hypothesis). There will be significantly more habituation in response to a high connotative linguistic meaningful stimulus and significantly less habituation to a low connotative linguistic meaningful stimulus.

Prediction 2B (Arousal-Response Hypothesis). There will be significantly less habituation in response to a high connotative linguistic meaningful stimulus and significantly more habituation to a low connotative linguistic meaningful stimulus.

Hypothesis 3. Individual differences in habituation to word stimuli may be related to individual differences in the concreteness of the word stimuli.

Specific predictions stemming from the concreteness dimension are more difficult to make because word concreteness could not be fully equated with the modalities of meaning defined above. Neither is there anything present

in Sokolov's theory that would directly predict differential habituation to high and low concrete words. There is, however, some indirect evidence which can form the basis for tentative differential predictions about the habituation to high or low concrete words. The high correlations reported between C and I (.83), and the moderate correlations between C and m (.56) (Pavio et al., 1968) suggest that habituation predictions made on the basis of the concreteness dimension may be similar to those made on the basis of denotative linguistic meaning. Secondly, some experimental evidence (Pavio & Simpson, 1968) suggested that under imagery task instructions, abstract words produce greater pupillary response (longer habituation) than concrete words. This is consistent with Pavio's theory because it is much more difficult to generate images to abstract words than to concrete words. It seems reasonable, therefore, that greater psychological and physiological demands are made upon the subject when requested to generate an image to an abstract versus a concrete word, and one would predict greater physiological response to the abstract word. However, the interesting question remains about what happens to habituation to high and low concrete words under typical habituation task instructions, which usually forbid any predetermined cognitive or motor task instructions. The following tentative

predictions based on the concreteness dimension can be made:

> Prediction 3A (Mismatch Hypothesis). There will be significantly more habituation in response to a high concrete word stimulus and significantly less habituation to a low concrete word stimulus.
>
> Prediction 3B (Arousal-Response Hypothesis). There will be significantly less habituation in response to a high concrete word stimulus and significantly more habituation to a low concrete word stimulus.

Thus far the writer has been concerned with the possible effects of stimulus variables on habituation. It will now be necessary to review the most relevant research which has investigated the effects of various subject variables on habituation.

3. Habituation Theory and Subject Variables

Much of the work which has investigated the relationship between habituation and subject variables has been concerned with studying the effects of various personality variables on habituation outcome. Eysenck (1967), more than any other worker, has attempted to provide a firm theoretical link between his personality dimensions (Extraversion (E), Neuroticism (N)), and the available neurophysiological models (theories). This would hypothetically allow him to account for the differences within each personality dimension, as well as the statistical

independence of the two dimensions (Eysenck & Eysenck, 1963; Farley, 1967) in terms of biological substrata.

A. Eysenck's Personality Theory and Habituation

Eysenck (1967, p. 80) and Gray (1967) have concluded that the Russian personality dimension of "strength of nervous system" is similar to the extraversion personality dimension. Both theoretical systems have postulated an excitation-inhibition balance as a hypothetical construct to account for differences in personality. In Pavlov's (1927) system the "weak nervous system" individual in whom cortical excitatory processes dominate is similar to the Eysenckian introvert, and the "strong nervous system" individual in whom cortical inhibitory processes dominate is similar to the Eysenckian extravert.

Eysenck (1967, pp. 230-233) postulates the existence of two relatively independent cortical-subcortical loops to explain the psychological aspects, as well as the independence of the extraversion and neuroticism dimensions. The first is a cortico-reticular loop which includes afferent sensory pathways to the cortex, afferent collaterals to the reticular formation, and ascending pathways from the reticular formation to the cortex. It can be seen that this is virtually identical to the model proposed by Sokolov (1960) to explain habituation phenomena (see

Figure 1, p. 10). Eysenck (1967), then, appeals directly to Sokolov's model to find a physiological basis for the E dimension.

> It is one thing to have available neural substrata for arousal and inhibition, but it is quite another to integrate these into some form of model adequate for the explanation of the behavioral phenomena relating to extraversion and introversion. Perhaps the model suggested by Sokolov (1960) and Voronin and Sokolov (1960) for the orienting reflex may serve as a more general theoretical structure for the integration of physiological and psychological effects (p. 249).

Accepting the hypothetical link between Eysenck's E dimension and the Russian dimension of strength, it can be hypothesized that the introvert will demonstrate significantly longer habituation than the more cortically inhibited extravert. Eysenck (1967) concludes on this subject:

> Experimental work linking the orienting reflex with individual differences is curiously lacking, particularly in view of Pavlov's frequent observations and statements that the weak nervous system is particularly liable to display persistent orienting reflexes (pp. 251-252).

The second loop is a visceral brain-reticular formation loop which includes the visceral brain (hippocampus, amygdala, angulum, septum, and hypothalamus [MacLean, 1958, 1960]), afferent collaterals from the visceral brain to the reticular formation, and ascending pathways from the reticular formation to the cortex. Eysenck hypothesizes that this loop is concerned with

emotion and provides the physiological basis for the neuroticism dimension.

> It is this loop that is concerned with emotion, and in its application to personality differences, with neuroticism/emotionality. It follows that cortical arousal can be produced along two quite distinct and separate pathways. It can be produced by sensory stimulation or by problem-solving activity of the brain, without necessarily involving the visceral brain at all; in this case we have no autonomic arousal, but possibly quite high cortical arousal. A scientist sitting quite immobile and to all appearances asleep, but thinking profoundly about some professional problems, might illustrate this state of affairs; there is considerable cortical arousal but little autonomic activity (p. 232).

Thus Eysenck, drawing primarily on the work of Gellhorn (1961), Gellhorn and Loofbourrow (1963), Papez (1937), and MacLean (1958, 1960), argues for the partial independence of cortical "arousal" which is under the control of a cortico-reticular system and affects differences on the E personality dimension, and autonomic "activation" which is under the control of a cortico-hypothalamic system and affects differences on the N personality dimension. The differential behavioral effects observed for the E and N dimensions are hypothetically linked to differential thresholds in the activity of the ascending reticular activating system and the hypothalamus, respectively. In adopting this position, Eysenck clearly takes issue with Duffy's (1962) earlier proposal for a single activation dimension and, in particular, points

out the difficulty for such a theory when attempting to find the necessary physiological substrata to account for the existence of two orthogonal (independent) psychological factors (E and N).

Gray (1970) has more recently offered suggestions for the psychophysiological modification of Eysenck's (1967) theory of introversion-extraversion. After reviewing the conditioned fear literature and re-reviewing some of the studies investigating the physiological basis of the E dimension, Gray concludes that Eysenck's hypothesis of greater conditionability for the introvert should be replaced with the hypothesis that introverts are more susceptible to punishment and frustrative nonreward. Furthermore, the results of experimental work which demonstrated that both sodium amytal and lesions in the frontal cortex effect an increase in extraverted behavior are interpreted by Gray to suggest that a frontal cortex-medial septal-hippocampal system lies at the basis of the E dimension. Gray, therefore, suggests that the physiological basis of the E dimension lies not only in the ascending reticular activating system, but also in a negative feedback loop consisting of the orbital frontal cortex, the medial septal area, and the hippocampus.

Consistent with this viewpoint, Gray also interprets the N dimension as reflecting differences in

sensitivity to reinforcement conditions. Gray, however, does not in his 1970 statement propose revisions for the physiological mechanisms underlying the N dimension.

This interesting extension of Eysenck's theory proposed by Gray, which Passingham (1970) states is in need of verification, has little direct relevance for predicting habituation outcome as a function of either the E or N dimensions, and therefore will not be treated further in this paper.

It follows from the theoretical considerations offered by Eysenck (1967) that there will be an inverse relationship (negative correlation) between the E variable and habituation measures. It also follows from his theory that the N variable will be found to be relatively unrelated (not significantly correlated) to the habituation measures. This is precisely the argument which is advanced by Eysenck (1967, pp. 167-186) and the experimental findings cited by him at least tentatively support this prediction.

Eysenck's (1967, p. 170) argument that skin conductance and EEG responses are measures of extraversion and not neuroticism is of particular interest to the present study. Although Eysenck (1967, pp. 170-178) cites a number of studies which provide some evidence to support his position, the strongest and most direct evidence comes from the work of Scott and Wilkinson (1962), Savage (1964),

McReynolds, Acker and Brackbill (1966), and Marton and Urban (1966).[8]

This seems rather puzzling in one sense, because one would ordinarily associate higher levels of physiological response with higher levels of anxiety. There are, however, some difficulties with this viewpoint as Eysenck (1967, pp. 167, 229) is quick to point out. Studies which typically manipulate pathological subgroups (e.g., Fox & Lippert, 1963; Hare, 1965; Lader & Wing, 1964), or when subjects are selected on the basis of some anxiety measures (e.g., M. A. S. Taylor, 1953), confound the E and N dimensions.[9]

Eysenck's theory does not rule out a significant E X N interaction affecting differences in physiological response. It, in fact, predicts a curvilinear relationship between some pathological subgroups and physiological (EEG)

---

8 Scott and Wilkinson (1962) reported a significant correlation between E and GSR adaptation. Savage (1964) found that introverts had significantly higher EEG arousal (in the resting state) than extraverts, while no differences were found between the neurotic and stable groups. McReynolds et al. (1966) could find no experimental evidence to support the hypothesis that skin conductance is related to subjective measures of anxiety. Marton and Urban (1966) found significantly longer habituation for introverted, as opposed to extraverted, subjects for both the EEG and GSR indices of habituation.

9 This conclusion follows quite logically if one accepts the assumption that the E and N dimensions are orthogonal (independent) in normal populations of subjects.

response (Eysenck, 1967, p. 66). Eysenck's theory, therefore, predicts that anxiety neurotics (NI) will demonstrate fast EEG response and psychopaths (NE) very slow EEG response.

> Taking these facts in the very broadest fashion, we may perhaps say that they support the generalization that introverted neurotics tend to have fast EEG activity, whereas extraverted neurotics tend to have exceptionally slow EEG activity (pp. 67-68).

Eysenck (1967, pp. 181-182) further suggests that whenever possible, workers would be well advised to examine any interaction effects between the E and N dimensions.

It will now be necessary to review the more recent work which has investigated the effects of the E and N dimensions on habituation outcome.

B. Experimental Evidence Bearing on the Predictive Validity of Eysenck's Theory for Habituation Outcome

Following Eysenck's (1967) most comprehensive and physiologically relevant statement, a number of habituation studies have been reported which were addressed to the E and N dimensions. For the purposes of the review presented in this paper, emphasis will be given to those studies which have investigated the E and N dimensions directly by using either the Eysenck Personality Inventory (Eysenck & Eysenck, 1968) or the Maudsley Personality Inventory (Eysenck, 1962) as defining instruments. These habituation

studies have provided the most direct and critical tests of Eysenck's theory. There are, however, a few habituation studies which have used other personality measures. Some of these studies will also be reviewed inasmuch as they have some relevance, though less direct relevance, for Eysenck's theory. A third group of studies will also be reviewed which have investigated the relationship between the personality dimensions and estimates of spontaneous electrodermal activity (EDA).

Three methodologically similar habituation studies carried out at the University of Ottawa laboratories have manipulated the E dimension while holding the N dimension constant (Bourgeois, 1972; Desjardins, 1973; Stelmack & Mandelzys, 1975). Bourgeois (1972) collected skin resistance (SRR), vasomotor and heart rate (HR) data on high, medium, and low extraverted groups of subjects. He used a "trials-to-criterion"[10] estimate of habituation and found that introverts (LE) required significantly more trials to reach the habituation criterion than extraverts

---

10 The trials-to-criterion measure of habituation was first suggested by Sokolov (1963a, p. 119). When two or three consecutive non-responses are observed, habituation is judged to have taken place. This estimate of habituation is contrasted to trials (TR) or trial blocks (TB) analysis which typically defines habituation as an amplitude change (decrease) across TR or TB. The relative merits of these two different measures of habituation will be discussed more critically in the final section of this chapter.

(HE). In a similar study, Desjardins (1973) used meaningful word stimuli and collected SRR and HR data on high, medium, and low extraverted subjects. A trials-to-criterion estimate of habituation also demonstrated that the introverted (LE) subjects took significantly more trials to reach the criterion than the extraverted subjects for the SRR but not the HR data. More recently, Stelmack and Mandelzys (1975) collected pupillary data across three time periods on high, medium, and low extraverted groups, in response to neutral, affective, and taboo words. Their statistical analysis was analogous to a TB analysis across the three time periods (pre-stimulation, stimulation, and post-stimulation). They found that the introverts gave significantly greater pupillary response (i.e., larger pupil size) than the extraverts under all experimental conditions. They interpreted their data to suggest that the introverts (as opposed to the extraverts) demonstrated higher levels of arousal for the entire experiment.

Fried, Friedman and Welch (1967) gave 20 stimulus presentations of four hues (each hue five times) to high and low N groups of subjects (the E dimension was apparently not controlled). They collected "basal" skin conductance measures and the trend analysis indicated that the HN subjects demonstrated significantly less SC (shorter habituation) than the LN subjects.

There have been a number of studies which have manipulated both the E and N dimensions and, in addition to providing data on the main effects of the E and N dimensions, they have provided a test for Eysenck's (1967) interaction hypothesis (Coles, Gale & Kline, 1971; Gale, Coles, Kline & Penfold, 1971; Koriat, Averill & Malmstrom, 1973; Magan & O'Gorman, 1969; Sadler, Mefferd & Houck, 1971). Mangan and O'Gorman (1969) investigated the effects of a 2 X 2 (N X E) manipulation on two separate subsamples of subjects drawn from the same population. They collected GSR data during both experiments in response to different auditory stimuli (Experiment 1, 60 db, 1000 cps, for 3" duration; Experiment 2, 57 db, 380 cps, for 400 msec duration). They used both initial amplitude and trials-to-criterion measures in the statistical analyses. The results of the first experiment indicated that there was a significant N X E interaction for the trials-to-criterion measure, such that neurotic introverts (NI) and stable extraverts (SE) demonstrated shorter habituation than stable introverts (SI). The analysis of the initial amplitude measure in the first experiment indicated that the HN group gave a significantly larger GSR than the LN group. The results of the second experiment indicated a significant main effect for the E factor on the trials-to-criterion measure such that introverts, as opposed to extraverts, took longer to habituate.

Coles et al. (1971) investigated the effects of a E X N (3 X 2) factorial manipulation in response to 20 tone stimuli (1000 hs, 50 db, 5" duration), while collecting SRR data (converted to SC log data). The converted SC data were analyzed using six different measures as follows. (1) amplitude change (TRs); (2) trials-to-criterion; (3) tonic SC; (4) total number of SCRs during stimulation; (5) number of spontaneous SCRs; (6) initial latency. All statistical analyses were either nonsignificant or did not support Eysenck's predictions with the exception of the spontaneous response measure. Introverts were found to give a significantly greater number of spontaneous SCRs as opposed to extraverts.

Sadler et al. (1971) studied the effects of a E X N (2 X 2) manipulation in response to 20 consonant-trigram stimuli. They collected SR data and analyzed five different SR measures as follows: (1) trials-to-criterion; (2) total number of GSRs; (3) number of dishabituations; (4) "basal" resistance (measures taken before and after the habituation series); (5) initial amplitude. All the statistical analyses were nonsignificant with the exception of a significant main effect for the N variable, such that the low N group gave a greater number of GSRs than the high N group, and a significant E X N interaction for the basal measure. The interaction indicated that the NE and SI

groups gave a greater decrease in resistance (i.e., increase in conductance) on the basal measure than the NI and SE groups. These results were interpreted by the authors to suggest that the NE subjects remained more aroused throughout the experiment than the NI subjects (basal measure only).

Gale et al. (1971) investigated the effects of a E X N (3 X 2) manipulation in response to 20 tone stimuli (1000 cps, 65 db, 5 sec duration) on the EEG response. They analyzed basal and response measures of habituation and found no significant differences between the introverts and extraverts on any of the dependent measures. Neither did they find any significant interactions for any of the measures. They did, however, report a significant main effect for the N variable on the basal measure, such that the HN group gave less EEG arousal (i.e., lower beta, higher "alpha abundance" or shorter habituation) than the LN group. They concluded as follows:

> Paradoxically what Eysenck predicts for extraverts as opposed to introverts is what we obtain for high neurotics as opposed to low neurotics, and the null difference predicted for neuroticism holds for extraversion (p. 540).

Gale et al. (1971) also concluded that they could not replicate the earlier findings of other workers, as well as their own previous work (Gale, Coles & Blaydon, 1969) which suggested that extraverts as opposed to introverts gave lower EEG arousal (short habituation). In

addition, they stated that there are serious methodological problems regarding the quantification of EEG habituation measures. They argue that it would be difficult at the present time to make any final conclusions about personality and EEG habituation.

Koriat et al. (1973), in what was essentially a methodological (habituation) study, collected skin resistance (SCR_{Log}) and heart rate data from 68 subjects in response to three classes of stimuli, recorded on three separate but identical laboratory sessions, as follows: (1) 20 tone stimuli; (2) 20 identical accident scenes from an accident film; and (3) the entire accident film. The subjects were divided into high and low E and N groups yielding an E X N X Sessions (2 X 2 X 3) analysis of variance (ANOVA) design. They analyzed separately five different classes of physiological measures as follows: (1) HR base, (2) HR acceleration, (3) HR deceleration, (4) SC base, and (5) SCR. For each of these five classes of variables they used, when appropriate, (a) trials-to-criterion, (b) amplitude change, (c) total number of responses, and (d) initial response scores. In addition to these measures, they used more complex regression scores (a, b, b^1) which were somewhat removed from the raw data. The results of over 80 *F* ratios indicated that only one three-way interaction was significant, which they interpreted as a chance event.

Jackson and Barry (1967) correlated IPAT Anxiety Scale (Cattell & Scheier, 1957) sten scores with a trials-to-criterion estimate of vasomotor habituation. They reported a significant rho correlation of .79 between the two measures, such that the higher the anxiety the longer the habituation. Cattell's anxiety scale correlates quite highly with the N variable and Eysenck (1967, p. 181) suggests that it can be effectively used as a measure of Neuroticism.

Crider and Lunn (1971) correlated Welsh's (1956) A and (-)R scales (anxiety and extraversion, respectively) from the MMPI with a trials-to-criterion measure of skin potential fluctuations. They reported significant inverse correlations of $r = -.48$, $p < .05$, and $r = -.38$, $p < .05$, between the extraversion measure and the two skin potential measures, respectively. The correlations between the anxiety scores and the skin potential measures did not differ significantly from zero.

There have been a number of studies which have investigated the relationship between manifest anxiety (Taylor, 1953) and habituation outcome (e.g., Epstein & Fenz, 1970; Koepke & Pribram, 1967). It was pointed out above that studies which use measures similar to the MAS cannot be unambiguously interpreted because they may confound the E and N dimensions. Those studies will

not add appreciably to the present analysis and, therefore, will not be reviewed here.

A number of studies have also investigated the relationship between the E and N dimensions and estimates of spontaneous electrodermal activity (EDA). The works of Coles et al. (1971) and Crider and Lunn (1971) have already been reviewed above. Eysenck (1967, pp. 174-175) has discussed the earlier work of Lader and Wing (1964) who reported that "dysthymic" (NI) patients versus normals demonstrated significantly higher levels of spontaneous EDA. Eysenck has interpreted their work to suggest that estimates of spontaneous EDA are measures of extraversion and not neuroticism. There is some evidence, then, to indicate that estimates of spontaneous EDA will correlate inversely with the E dimension but will not correlate significantly with the N dimension.

An adequate analysis of the studies reviewed in this section is difficult because of their methodological differences and the many conflicting results. For example, it is highly unlikely that the results of a study which uses a trials-to-criterion estimate of vasomotor habituation can in any meaningful way be compared with the results of a study reporting a trial blocks analysis of SC (amplitude change) data. Nevertheless, when the 11 studies are arranged in tabular form and categorized in terms of the

most important headings, some rather striking conclusions emerge. (See Table 1.)

Entering the table from left to right, the reader can observe a good deal of similarity in columns 2, 3, and 4. The information given in column 5 indicates that 8 out of the 11 studies analyzed data from the electrodermal system in one form or another, while the remaining three studies analysed pupillary, EEG, or vasomotor data. A consideration of the information in column 6 indicates that at least five different physiological measures are commonly utilized to index the habituation process as follows: (1) a trials (or TB) analysis of amplitude change scores, (2) "basal" or tonic measures during the rest period or across trials (mean prestimulus level). The remaining three measures are specifically applied to ED data as follows: (3) trials-to-criterion, (4) total number of responses (across trials, TB), (5) total number of spontaneous responses (vs. stimulus specific GSRs).

The most important information is revealed in the last column headed, "Support for Eysenck's Theory." Putting aside for a moment the studies done at the University of Ottawa, very little additional support for Eysenck's theory is found. The main exceptions to this conclusion are noted when either a trials-to-criterion measure is used as in the Mangan and O'Gorman (1969) and the Crider

Table 1

Studies Investigating the Relationship Between the Extraversion and Neuroticism Dimensions and Habituation Outcome

(1) Investigator(s)	(2) Personality Instrument	(3) Measure(s) Investigated	(4) Statistical Design	(5) Physiological System(s)	(6) Habituation Measure(s)	(7) Support for Eysenck's Theory (yes) (no)
1. Bourgeois (1972)	EPI (A)	E (N controlled)	ANOVA (H,M,L) (60 Ss)	1. "GSR" (SRR) 2. Vasomotor 3. Heart rate	1. Trials-to-crit. 2. Trials-to-crit. 3. Trials-to-crit.	1. Yes 2. Yes 3. Yes
2. Desjardins (1973)	EPI (A)	E (N controlled)	ANOVA (H,M,L) (60 Ss)	1. SRR 2. Heart rate	1. Trials-to-crit. 2. Trials-to-crit.	1. Yes 2. No
3. Stelmack & Mandelzys (1975)	EPI (A)	E (N controlled)	ANOVA (H,M,L) (33 Ss)	1. Pupillary	1. Trial blocks (amplitude change scores)	1. Yes
4. Fried, Friedman & Welch (1967)	EPI (B)	N (E controlled)	Trend analysis (H, L) (20 Ss)	1. SCR	1. Trials (change score)	1. No (HN group gave longer habituation than LN group)
5. Mangan & O'Gorman (1969) 1. EPI (B) 2. EPI (B)	1. E X N 2. E X N	1. ANOVA (2X2) (20 Ss) 2. ANOVA (2X2) (24 Ss)	1. "GSR" 2. "GSR"	1A. Trials-to-crit. 1B. Initial amplitude 2A. Trials-to-crit.	1A. No (NI habituated faster than SI) 1B. No (HN gave smaller GSR than LN) 2A. Yes (LE required sig. more trials to habituate than HE)	

Table 1 (Cont'd.)

(1) Investigator(s)	(2) Personality Instrument	(3) Measure(s) Investigated	(4) Statistical Design	(5) Physiological System(s)	(6) Habituation Measure(s)	(7) Support for Eysenck's Theory (yes) (no)
6. Coles, Gale & Kline (1971)	EPI (A)	E X N	ANOVA (3X2X20) (60 Ss) (also correlation analyses)	1. SRR→SCR_{Log}	1A. Trials (amplitude change)	1A. No
					1B. Initial latency	1B. No
					1C. Trials-to-crit.	1C. No (HN required more trials than LN)
					1D. Total No. of SCRs	1D. No (HN gave more than LN)
					1E. Spontaneous rs (total number)	1E. Yes (LE gave more than HE)
					1F. Tonic (prestimulus)	1F. No
7. Sadler, Mefferd & Houck (1971)	EPI (?)	E X N	ANOVA (2X2) (38 Ss)	1. SRR	1A. Initial amplitude	1A. No
					1B. Trials-to-crit.	1B. No
					1C. Total No. "GSR"	1C. No (LN gave more than HN)
					1D. "Basal"	1D. No (NI gave more resistance, faster habituation than NF)
					1E. Trials (amplitude change)	1E. No
8. Gale, Coles, Kline & Penfold (1971)	EPI (B)	E X N	ANOVA (3X2) (60 Ss)	1. EEG	1A. Basal (trials) (tonic)	1A. No (HN gave sig. shorter EEG habituation)
					1B. Phasic (amplitude change)	1B. No

Table 1 (Cont'd.)

(1) Investigator(s)	(2) Personality Instrument	(3) Measure(s) Investigated	(4) Statistical Design	(5) Physiological System(s)	(6) Habituation Measure(s)	(7) Support for Eysenck's Theory (yes) (no)
9. Koriat, Averill & Malmstrom (1973)	EPI	E X N	ANOVA (2X2X3) (sessions) (56 Ss)	1. $SRR \rightarrow SCR_{Log}$ 2. Heart rate	1A. SC Base (tonic) 1B. SCR (phasic) 2A. HR (base) 2B. HR (acceleration) 2C. HR (deceleration)	1A. No 1B. No 2A. No 2B. No 2C. No
10. Jackson & Barry (1967)	IPAT (Cattell & Scheier, (1957)	Anxiety (E uncontrolled)	Correlational (46 Ss)	1. Vasomotor	1. Trials-to-crit.	1. No (HN gave longer habituation than LN) (rho = .79 between A and habituation)
11. Crider & Lunn (1971)	MMPI	Welsh's (1956) A (Anxiety) -R (Extraversion)	Correlational (22 Ss)	1. Skin potential response	1A. Trials-to-crit. 1B. Spontaneous fluctuations	1A. Yes (E and Trials-to-crit. r = -.48) 1B. Yes (E and spontaneous fluctuation, r = -.32)

and Lunn (1971) studies, or when a measure of spontaneous activity is used as in the Coles et al. (1971) and Crider and Lunn (1971) studies. The same general conclusion is supported even if the University of Ottawa studies are re-introduced into the analysis.[11]

Could it be that those habituation measures which index the total number of responses defined in terms of a specific criterion (measures 3, 4, and 5 above) are in fact indexing a different but related phenomenon? A resounding "yes" to this question would help make some sense out of the conflicting results reviewed above as far as predictions based on Eysenck's theory are concerned. This question will be treated in considerable detail in the final section of this chapter.

In spite of these qualifications, the overall results of the studies by Mangan and O'Gorman (1969), Coles et al. (1971), Sadler et al. (1971), Gale et al. (1971), and Koriat et al. (1973) provide considerable difficulty for Eysenck's theory, particularly concerning the E dimension which cannot be rationalized solely on the basis of dependent variable unreliability. More specifically, one

---

11 The one exception to this conclusion is the Stelmack and Mandelzys (1975) study. This study, strictly speaking, is not a habituation study because sufficient time was not given between stimulus presentations to allow the pupillary responses to return to prestimulus (tonic) level (Stelmack & Mandelzys, 1975, p. 537).

would clearly expect tonic SC and tonic EEG estimates of habituation to reliably differentiate introverted and extraverted groups of subjects.

The relationship between the N variable and habituation is also problematic for Eysenck's theory. There seem to be equally as many studies supporting the position that HN groups give longer habituation (Coles et al., 1971; Jackson & Barry, 1967), or LN groups give longer habituation (Fried et al., 1967; Gale et al., 1971; Sadler et al., 1971), as there are studies supporting Eysenck's prediction of a null difference between HN and LN groups (Crider & Lunn, 1971; Koriat et al., 1973). Clearly no conclusion is possible at this time with regards to the relationship between the N variable and habituation.

Finally, not one of the studies reviewed above report an E X N interaction supporting Eysenck's hypothesis that NI subjects will give very long, and NE subjects very short, habituation. The two studies reporting a significant E X N interaction found that NI subjects habituated faster than SI subjects (Magan & O'Gorman, 1969), and NI subjects habituated faster than NE subjects (Sadler et al., 1971).

The writer concludes that the studies reviewed above have provided only limited support for Eysenck's theory with respect to habituation. Furthermore, the most important studies have provided negative or conflicting

results. It would be a mistake at the present time to offer any final conclusions about the predictive validity of Eysenck's theory for habituation outcome. More experimental work is needed which will critically deal with the complex methodological issues involved. The hypotheses and predictions relevant to the present study can now be stated.

Hypothesis 4. Individual differences in habituation may be inversely related to individual differences on the extraversion personality dimension.

Prediction 4A (Eysenck's Theory). There will be a significant inverse (negative) correlation between the E variable and the dependent (physiological) measures indexing habituation.

Hypothesis 5. Individual differences in habituation may not be related to individual differences on the neuroticism personality dimension.

Prediction 5A (Eysenck's Theory). There will be no significant correlation between the N variable and the dependent measures indexing habituation.

The next section of this chapter will introduce the most important problematic methodological issues intrinsic to habituation studies.

4. Methodological Problems in Habituation Experiments

What physiological modalities should be monitored during a habituation experiment? Should the experimenter collect electrodermal, heart rate, vasomotor, pupillary, electromyograph, or EEG data? How should the experimenter quantify his physiological data? Should he analyze phasic

or tonic measures collapsed across trials or trial blocks, or should he use a single score estimate of habituation? What is the meaning of the so-called "Law of Initial Values" (LIV)? Does the LIV concept confuse a number of related issues? Does the LIV affect all physiological modalities in a similar manner? What can or should the experimenter do about a significant regression of phasic response on tonic (prestimulus) level? What statistical model can be used to analyze the physiological variables? Most of the studies reviewed in this paper used a (univariate) repeated measures ANOVA. What are the assumptions required for such a statistic? Is there a more appropriate statistical model that can be used to analyze repeated measures data? How reliable or stable are the various habituation measures? What is considered an acceptable or optimum reliability coefficient for the habituation measures? What is the construct validity (intercorrelations) of the habituation measures? What is the construct validity of the various habituation measures between modalities and within the same physiological modality?

The problems identified by these questions plague all psychophysiological research. A simple, satisfactory answer cannot be given to any one of these questions because there is much controversy, and most represent continuing issues in psychophysiological research. They are

both theoretical and methodological problems as Koriat et al. (1973), O'Gorman (1974), and Averill (1974) have made quite clear.

No worker can ignore the existence of these issues, because either implicitly or explicitly he will be required to make decisions about many, if not all, of them. Clearly, this paper is not the place to attempt an extensive analysis of all these problems. In the final section of this chapter the experimenter will present the rationale for the selection of the dependent variables to be used in the present experiment. Some of the issues will only be introduced in this chapter to be treated more extensively in the appropriate sections of Chapter II.

Skin conductance measures will be the dependent variables of choice in the present experiment for a number of reasons. Most of the habituation studies reviewed in all the sections above used "GSR" data in one form or another. For the purposes of a comparison with previous studies, then, electrodermal measures are the dependent variables of choice. In addition, Eysenck has made the specific prediction that SC variables are measures of extraversion and not neuroticism. There is, however, a more important reason for the selection of "GSR" measures. The specific physiological response pattern identifying a stimulus evoked response (OR) which reliably habituates

has not been fully demonstrated for most of the other components.

The response pattern identifying reliable vasomotor habituation has remained consistently problematic, as Ginsberg and Furdey (1974) have recently pointed out. A similar conclusion has been reached for the EEG component by Tizard (1966), McDonald, Johnson and Hord (1964), and Gale et al. (1971). Gale and his coworkers question whether EEG habituation in the Sokolovian (1963a) sense can be demonstrated at all. The Russian worker Shaknovich (1958) has suggested that the pupillary dilatory response to stimuli presented at other than the visual modality will habituate across trials. However, he has presented no data to support this claim. Libby, Lacey and Lacey (1973, pp. 279, 287) reported a significant decrease in pupillary diameter as their experiment progressed. However, little interest in the habituation literature has been given to pupillary phenomena. The writer can only conclude that the reliability of pupillary habituation has not been demonstrated. A similar disinterest in EMG habituation can also be observed. The cardiac orienting response represents the only apparent exception to this general conclusion, largely because of the efforts of Graham (1973) and her associates.

Sokolov's (1960, p. 235; 1963, p. 547) statements about the heart rate orienting response were ambiguous

but suggested the presence of a cardiac acceleratory response. While, on the other hand, the work of Graham and Clifton (1966), Raskin, Kotses and Bever (1969), Smith and Strawbridge (1969), Hatton, Berg and Graham (1970), Hare, Wood, Britain and Frazelle (1971), and Graham, Berg, Berg, Jackson, Hatton and Kantowitz (1970) suggests that the reliable cardiac response to mild or moderate intensity stimuli is deceleration (OR) and the response to high intensity stimuli is acceleration (DR). Nevertheless, the often reported presence of a multiphasic cardiac response to repeated stimulation remains rather problematic as Jackson (1974) has most recently and clearly stated. Furthermore, it is interesting to note that in her work she also collected skin conductance data which were used partly to assist the interpretation of the HR habituation data.

> Perhaps the most complicated and theoretically difficult results in the present experiments are those concerning response to novel test stimuli presented after habituation. The HR results appear particularly complex and probably reflect such factors as competition between OR and DR, and floor effects due to "below zero" habituation as well as the degree of habituation which occurred. On the other hand, the SCR results do provide some relatively clear information concerning the effects of stimulus intensity on hypothetical central processes assumed to mediate test response (Jackson, 1974, p. 657).

In contrast to the physiological modalities previously discussed, the "GSR" is described by Lykken and

Venables (1971) as the most popular and robust of all psychophysiological variables. The specific response pattern indicating the presence of a change in "arousal" or "activation" has been well demonstrated (Edelberg, 1972, p. 404). Finally, it has been conclusively demonstrated on the basis of many studies that a number of "GSR" variables reliably habituate to repeated stimulation.

The writer is not arguing that the other modalities are unworthy of further study or attention, but only that electrodermal habituation measures have been demonstrated to be the most reliable (and valid) thus far. The fact that the vast majority of habituation studies have used GSR measures supports this conclusion. It is also important to study habituation in the other response modalities, but the most important studies routinely collect GSR data also.

In the present study, the experimenter made the decision to record only skin conductance data with the intention of carrying out a fairly extensive analysis. The reasons for choosing the direct measurement of skin conductance over resistance, the techniques used to quantify the SC variables, a more critical discussion of the LIV concept, and the most appropriate statistical models to analyze these variables will all be treated in the appropriate sections of Chapter II. In the remaining paragraphs of this section of the chapter the writer will deal with the

nagging problems of the reliability and construct validity of habituation measures.

The reliability of the various physiological measures is a complex and continuing problem in all psychophysiological research. Within the context of the habituation literature, workers have most often been concerned with test-retest or between sessions reliability (intersession stability). The same subjects are typically run through a standard habituation experiment on more than one occasion, and reliability estimates are calculated for the habituation measures between the sessions. For example, 15 presentations of the same tone stimulus are given, while physiological measures are recorded, and at some regular (or irregular) future time interval an identical experiment is repeated one or more times.

The work of Koriat et al. (1973) was discussed in the section immediately above in terms of its non-support for Eysenck's theory, and it was pointed out that this was essentially a methodological study. They concluded on the basis of a thorough analysis of many habituation measures that none of the measures demonstrated acceptable intersession reliability (three separate sessions).

The between sessions reliability coefficients reported by Koriat et al. (1973, p. 98) were all "disappointingly low." They were able to demonstrate moderate

test-retest reliability coefficients (r) (intersession) only for the HR (.37 to .54, $p < .05$) and SC (.45 to .52, $p < .01$) base level measures. However, none of the habituation measures showed acceptable reliability and many of the coefficients reported were not significantly different from zero.

O'Gorman (1974), commenting on the negative findings of Koriat et al. (1973), objected to their general conclusions and argued that the unreliability of some habituation measures may not be as serious as Koriat et al. suggested. O'Gorman cited the findings of five studies which have reported intersession stability coefficients of .75 (Rachman, 1960), .68 (Bernstein, 1967), .70 (Crider & Lunn, 1971), .68 (O'Gorman, 1971), and .63 (Bull & Gale, 1973) for various measures.[12] O'Gorman concluded that these reliability coefficients reported for various measures of electrodermal habituation are quite adequate, although workers would be well advised not to uncritically assume the reliability of habituation measures.

---

12 Rachman (1960) used a "rank-difference correlation" but did not report the significance level. All the other studies (including that of Koriat et al. [1973]) either reported clearly that they used a Pearson coefficient or implied that they used a Pearson coefficient. The coefficients reported immediately above between .63 and .75 are all significant at least beyond the .05 level.

One of the reasons for the discrepancy between the findings of Koriat et al. and the other studies may reside in the fact that Koriat et al. used complex regression scores (a, b, b^1) which they themselves stated are quite far removed from the raw data, while the other studies used the simpler measures. Nevertheless, inadequate reliability coefficients ($\underline{r}$ = .42, .33, .19) were also reported by Koriat et al., and an acceptable reliability coefficient ($\underline{r}$ = .70) was reported by Crider and Lunn (1971) for a similar trials-to-criterion measure of electrodermal habituation. Koriat et al. suggest that their lower coefficients may be due to the fact that Crider and Lunn used a more intense stimulus and a more sensitive measure.

The present writer adopts the position that the reliability of habituation measures cannot be assumed and that additional experimental findings are needed. However, what represents an acceptable or even optimum stability coefficient for various habituation measures must be decided in terms of the habituation phenomenon itself. This writer will argue that moderately high (average) correlations of about $\underline{r}$ = .75 are optimum within the context of habituation studies. The writer will further argue that this general conclusion holds both for the intersession and intrasession estimates of reliability. Some distinctions will have to be made depending upon

whether the data are quantified across trials (or TBs), or whether one of the single score estimates of habituation (e.g., trials-to-criterion) are used. A hypothetical example of what typically happens to the physiological measures during the habituation process will serve to clarify these points.

Habituation was defined on the first page of this paper as decreased physiological response to repeated stimulation. If, for example, 60 subjects were given 15 presentations of a 50 db tone stimulus at one-minute intervals, while phasic skin conductance responses were recorded continuously, one would expect approximate (mean) SC changes (in micromhos) as follows: 3.0, 2.8, 2.5, 2.0, 1.5, 1.0, 0.5, 0.0, 0.5, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0. If correlation coefficients ($\underline{r}$) were calculated only between adjacent trials (1 with 2, 2 with 3, 3 with 4, etc.), then one would predict moderate correlations for the beginning trials and moderate to high correlations for the later trials. That is, if habituation was reliably occurring across trials (or trial blocks), one would expect the average intrasession (between adjacent trials) correlations to be moderately high ($\underline{r}$ = .75, approx.). Secondly, the lowest correlations would be expected for those trials where the greatest decrease (change) in physiological response had occurred (the beginning trials),

and the highest correlations for those trials where the least decrease in response had occurred (the later trials). Clearly, then, very high average between trials correlations (above .90) would be suspect and would indicate that either habituation was retarded, as in the case of a very "arousing" stimulus (e.g., electric shock), or that few phasic responses had occurred, as in the case of a very "non-arousing" stimulus. Both classes of stimuli are typically not used in habituation studies, and even if they were, the average intrasession reliability coefficient would simply have to be interpreted in terms of the stimulus type employed.

If the hypothetical experiment described above were repeated with the same subjects 14 more times at one-month intervals, then a similar mean intersessions habituation curve could be plotted, and similar test-retest stability coefficients could be calculated. The difference here is that now the other habituation measures (e.g., trials-to-criterion measures) could be included in the analysis. The reason why a similar reliability analysis can be made for the between sessions experiments is because the subjects are not only habituating to the tone stimuli but to all the experimental conditions. Thus it is highly probable that the mean habituation scores for the fifteenth experimental session would be considerably lower than the same

measures taken at the occasion of the first experiment. There would, of course, be differences in the kind of intersession habituation curves obtained for the various habituation measures. For example, tonic as opposed to phasic measures would probably demonstrate a less dramatic (steep) habituation curve.

The habituation phenomenon, then, indicates that test-retest reliability coefficients are appropriately calculated only for adjacent trials, or adjacent sessions. In addition, when between sessions reliability estimates are calculated it is most appropriate to correlate the measures from trial 1 in experiment 1 with the measures from trial 1 in experiment 2. If, for example, a stability coefficient was calculated between trial 1 (x) and trial 9 (y) in the hypothetical experiment described above, one would expect a much lower coefficient, simply as a statistical artifact of the (change) habituation process. A worker can, of course, correlate any two series of measures, but the interpretation of the resulting coefficient must be made (and justified) on logical grounds as a function of the phenomenon under investigation and not solely on the basis of statistical convention. These distinctions are of critical importance when interpreting reliability estimates calculated on habituation measures.

It is not always possible to obtain intersession stability coefficients in many habituation studies simply because the subjects are often only available for one experimental session. However, all habituation experiments will allow for the computation of intrasession (between trials or TBs) reliability estimates, and more reliability data are needed. In the present experiments, intrasession reliability coefficients will be reported for adjacent trial blocks. The construct validity (intercorrelations) of the various habituation measures is an even more complex and difficult theoretical problem, as O'Gorman (1974) and Averill (1974) have most recently emphasized.

When dealing with habituation phenomena, intermodal must be distinguished from intramodal construct validity. The problems of the between modalities relationships for the various habituation measures was discussed in some detail above and will not be treated more extensively here. The inescapable conclusion implied above indicated that the relationships between the various components indexing habituation are not clear. A great deal more experimental and theoretical work needs to be done. The writer, then, will restrict this discussion to the interrelationships between various electrodermal estimates of habituation (intramodal construct validity).

Averill (1974), in his reply to O'Gorman's (1974) statement that Koriat et al. (1973) may have exaggerated the habituation reliability problem, commented on the four studies cited by O'Gorman and very strongly questioned the validity of the trials-to-criterion measure.

> Each of these studies used a trials-to-criterion (no response) index of habituation. But in what sense is this a measure of habituation? From Table 3 of the Koriat et al. article it can be seen that trials-to-criterion is significantly correlated with estimates of initial level (the a score) and also with the "absolute rate of habituation" (the b^1 score). The latter, in turn, is practically redundant with mean reactivity. On the other hand, trials-to-criterion is not correlated with the "simple rate of habituation" (the b score). It is, thus, not clear which aspect of habituation the trials-to-criterion index is measuring, and to what extent it is confounded by other (potentially irrelevant?) factors such as general reactivity. (Crider and Lunn found the trials-to-criterion score to be highly correlated, $\underline{r} = .75$, with the rate of spontaneous fluctuations; they further argued that both of these measures represent a more general trait of electrodermal liability.) The situation is made even more complex by the fact that the trials-to-criterion index is not applicable to many variables, such as heart rate, thus making cross-modality comparisons difficult. In short, although the four studies cited by O'Gorman provide grounds for optimism, they also illustrate one of the major conceptual and methodological issues raised by Koriat et al., which is, namely, that all measures of habituation are not alike (pp. 203-204).

Coles et al. (1971) and Bull and Gale (1973) have also reported significant and moderately high intercorrelations between the single score estimates of habituation (trials-to-criterion, number of spontaneous responses) and total number of response measures. Their findings, then,

support Averill's conclusion that all the single score measures, in contrast to the multiscore measures (trials or TBs), may be indexing the common phenomenon of "electrodermal responsiveness."

Furthermore, habituation, as defined in the paper, implies that there will be a composite difference in physiological response as a function of the joint effects of successive trials or trial blocks. These measures, when plotted and analyzed in terms of their composite effects for several trial blocks, will adequately describe the habituation process in response to any independent variable manipulation. It follows, then, that any of the single score estimates of habituation cannot adequately describe or reflect the habituation process, and important information is lost.

All of these considerations suggest that the single score estimates of habituation, including the trials-to-criterion measure, are not correctly interpreted as measures of habituation. Both the experimental findings reviewed and a thorough understanding of the habituation phenomenon itself suggest that the trials-to-criterion measure is more validly interpreted as a general index of electrodermal reactivity.

In the present experiments, a number of skin conductance measures will be analyzed for the composite effects of several trial blocks. In addition, estimates of spontaneous

skin conductance response will also be correlated with the other dependent variables as well as the E and N scores. This will be done, firstly to test the major predictions of importance to the present study, and secondly to replicate and/or extend some of the findings that were discussed above. A formal definition of all the dependent measures to be used in the present experiments will be given in Chapter II.

A summary and statement of the null hypotheses and related predictions can now be given.

5. Summary and Statement of the Null Hypotheses

Physiological response habituation can be defined in its simplest terms as a decreased response to repeated stimulation. Although a number of theoretical constructs have been advanced to explain the habituation phenomenon, Sokolov's theory is easily the most parsimoniously stated, and directly suggests a number of testable hypotheses and inferences. It is little wonder, then, that his theory has generated a great deal of interest in the published literature over the past decade.

Sokolov's theory for habituation of the orienting reaction is predicated upon the hypothetical assumption that the amplitude and duration of a stimulus evoked physiological response is proportional to the degree of mismatch between the evoking stimulus and a neuronal imprint

of the stimulus recorded in the nervous system. It follows that once the orienting stimulus has been identified (mismatch ceases) the physiological responses will extinguish (habituate). It also follows that any perceptible change in the habituated stimulus will cause the OR to return (dishabituate).

In a major restatement of his theory, Sokolov has defined the orienting reaction as a system of cognitive hypotheses (questions) about the meaning of the stimulus. The duration of habituation was hypothesized to be a function of the degree of mismatch between the meaning of the stimulus operating and the meaning of the stimulus recorded (the neuronal model) in the nervous system. The general hypothesis to be investigated in the present study is that the duration of habituation may be related to the meaning (meaningfulness) of the orienting stimulus.

An extensive review of three classes of habituation experiments (the stimulus change, the stimulus significance, and the information theory studies) provided very little support for the matching hypothesis. The overwhelming experimental evidence suggested that habituation outcome could not be reliably predicted on the basis of the matching assumption alone. It was pointed out that Sokolov's theory is addressed essentially to the structural makeup or the uncertainty of the orienting stimulus and fails to consider

other aspects of the orienting stimulus. It was concluded that habituation may not necessarily be a function of the differences between stimuli (mismatch), but rather a function of the arousal value or energy properties of the stimulus. The possible importance of cognitive, affective, or motivational variables was emphasized in this regard.

It was also argued that Sokolov's theory fails to consider individual differences in the subject's physiological responsiveness to any stimulus (subject variables). Overall, it was concluded that Sokolov's theory has neglected to consider at least two major classes of psychological variables which may differentially affect habituation outcome.

It was further argued that habituation predictions about meaningful stimuli (high and low) based on the matching hypothesis would be contrary to those predictions following from the arousal hypothesis. Thus the matching assumption would predict significantly more habituation in response to a high meaningful stimulus, while the arousal assumption would predict significantly less habituation to the same high meaningful stimulus. These considerations allowed the writer to formulate alternative contrary predictions about the habituation to high and low meaningful stimuli.

A decision was made to use word stimuli in the present experiments because the psychological literature investigating linguistic meaning was quite extensive and

a number of reliable operational indices were available. Although some of the most important earlier work was reviewed, the analysis of linguistic meaning recently proposed by Pavio was emphasized.

It was concluded that denotative and connotative linguistic meaning can be theoretically distinguished and operationally indexed. Denotative linguistic meaning can be operationally defined by imagery (I) and verbal associative (m) measures. Connotative linguistic meaning can be operationally defined by the semantic differential (evaluative) scales. An analysis similar to the imagery construct was offered for the linguistic attribute word concreteness, and it was concluded that habituation predictions based on the concreteness variable would be similar to those based on the denotative measure. Word concreteness can be operationally defined by using a measure which indexes its directness to sensory reference (A-C).

The theoretical analysis of linguistic meaning offered by Pavio (implicit-arousal response hypothesis) was quite similar to the theoretical analysis advanced previously by the writer for the habituation phenomenon (general-arousal response hypothesis). It only remained, then, for the general hypothesis and alternative predictions to be restated in terms of the specific kinds of linguistic meaning. It was hypothesized that individual

differences in habituation to word stimuli may be related to individual differences in the denotative meaning, the connotative meaning, and the concreteness of the word stimuli.

Eysenck's theoretical work represents a major systematic attempt to relate habituation outcome to individual differences in subject variables. Eysenck and Gray have proposed that the Russian personality dimension "strength of nervous system" is quite similar to the extraversion personality dimension, since both postulate a hypothetical excitation-inhibition balance to explain personality differences. The introvert similar to the "weak" nervous system individual will demonstrate relatively long habituation, and the extravert similar to the "strong" nervous system individual will demonstrate relatively short habituation.

Eysenck has postulated the existence of two functionally independent cortical-subcortical loops to explain the psychological differences as well as the independence of the E and N personality dimensions. A cortico-reticular loop identical to that proposed by Sokolov to explain the habituation phenomenon is postulated to be the physiological substrata for the E dimension. A cortico-hypothalamic system is hypothesized to be the physiological basis for the N dimension. Thus the differential psychological effects attributed to the E and N dimensions are

hypothetically related to differential thresholds in the ascending reticular activating system (and possibly also the orbital frontal cortex), and the hypothalamus, respectively.

Eysenck's theory, then, would predict an inverse correlation between the E variable and habituation measures, and no relationship (correlation) between the N variable and habituation measures. Eysenck also predicts a possible E X N interaction such that the neurotic introvert will demonstrate very long, and the neurotic extravert very short habituation.

A critical review of the many studies testing these predictions provided only limited support for Eysenck's theory. The overall experimental findings addressed to the E dimension in particular were found to be problematic or non-supportive of his theory. The writer concluded that, because of the complex physiological measurement problems involved, additional and more critical experimental work is required.

In the final section of the chapter the most important and often controversial methodological issues relevant to habituation experiments were introduced and discussed. It was concluded that a trial blocks analysis of various skin conductance habituation measures would be the dependent variables of choice for the present experiments. The

problem of the construct validity of some electrodermal habituation measures was introduced and it was concluded that the single score habituation estimates cannot adequately describe the habituation process. Finally, it was concluded that, within the context of the habituation process, moderately high reliability estimates (coefficients) are optimum.

The hypotheses and related predictions advanced previously can now be stated in the null form.

Null Hypotheses

1. There is no difference between high and low denotative linguistic meaningful stimuli in the (various) skin conductance habituation measures.

2. There is no difference between high and low connotative linguistic meaningful stimuli in the (various) skin conductance habituation measures.

3. There is no difference between high and low concrete linguistic stimuli in the (various) skin conductance habituation measures.

4. There is no inverse correlation between the extraversion personality variable and skin conductance habituation measures.

5. There is no correlation between the neuroticism personality variable and skin conductance habituation measures.

Predictions

1A. (Mismatch Hypothesis)
There will be significantly more skin conductance habituation in response to a high denotative linguistic meaningful stimulus and significantly less habituation in response to a low denotative linguistic meaningful stimulus.

1B. (Arousal Hypothesis)
There will be significantly less skin conductance habituation in response to a high denotative linguistic meaningful stimulus and significantly more habituation in response to a low denotative linguistic meaningful stimulus.

2A. (Mismatch Hypothesis)
There will be significantly more skin conductance habituation in response to a high connotative linguistic meaningful stimulus and significantly less habituation in response to a low connotative linguistic meaningful stimulus.

2B. (Arousal Hypothesis)
There will be significantly less skin conductance habituation in response to a high connotative linguistic meaningful stimulus and significantly more habituation in response to a low connotative linguistic meaningful stimulus.

3A. (Mismatch Hypothesis)
There will be significantly more skin conductance habituation in response to a high concrete word stimulus and significantly less habituation in response to a low concrete word stimulus.

3B. (Arousal Hypothesis)
There will be significantly less skin conductance habituation in response to a high concrete word stimulus and significantly more habituation in response to a low concrete word stimulus.

4. (Eysenck's Hypothesis)
There will be a significant inverse correlation between the extraversion personality variable and skin conductance habituation measures.

5. (Eysenck's Hypothesis)
There will be no correlation between the neuroticism personality variable and skin conductance habituation measures.

The experimental procedures employed to test these hypotheses are described in the following chapter.

CHAPTER II

EXPERIMENTAL METHODOLOGY

This chapter is divided into three sections. Sections 1 and 2 describe the psychological and psychophysiological (habituation) experiments. In section 3 the null hypotheses stated in Chapter I are restated in statistical and operational terms.

1. The Psychological Experiment

The first section of Chapter II describes the subjects, instruments, list of words, data collection procedures, and the statistical analyses used to search out and define the independent measures of the study.

A. The Two Subsamples of Subjects

The sample for the psychological part of the study consisted of 104 female student nurses who were enrolled in the registered nurses program at the Ottawa Civic Hospital School of Nursing.[1] These subjects were selected from an original sample of over 200 student nurse-volunteers on the basis of their availability to participate in the first

---

1 This is a two-year diploma program which qualifies the graduates to write the registration examination administered by the Province of Ontario.

part of the study. The remaining volunteers who, because of their schedules at the nursing school, would not become available until later, were asked to participate in the second part of the study. The sample of 104 subjects was divided into two subgroups of 52 subjects each (using an odd-even criterion) after the psychological tests had been administered and just prior to the statistical analyses.

The means and standard deviations for the subjects' age for subsample I (n=52) were 19.67 and .97, respectively, and for subsample II (n=52) were 19.52 and .73, respectively. The mean and standard deviation for the subjects' age for the total sample (N=104) were 19.60 and .85, respectively.

The subjects participating in the psychological part of the study came for one experimental session of approximately three hours duration. They were paid for their services.

B. The Psychological Instruments

The review of the linguistic meaning literature presented in Chapter I indicated that it would be necessary to obtain five different measures on the same linguistic stimuli. The writer pointed out that, although a good deal of work had been done previously, it was not possible to find a list of words which simultaneously provided scores for all the relevant variables on the same list of

words. In the present study, then, the measures obtained on the selected list of words were Pavio's rated imagery (I), Nobel's production method for word associations (m), the semantic differential rating scales (SD, evaluative factor only), rated concreteness (A-C), and an index of word familiarity (f).

The imagery ratings were obtained using the modified scale constructed by Pavio, Yuille and Madigan (1968). The modified scale which uses a 7-point low imagery-high imagery scale replaced the earlier (Pavio, 1963) 5-point very difficult image-very easy image scale. Pavio et al. (1968) found that the modified scale increased the variability of the I scores and they argued that the later version constitutes a genuine improvement over the earlier scale.

The instructions were the same as those used in the Pavio et al. (1968) study with the exception of a few minor changes which were necessary in order to adapt the instrument to the specific needs of the present study as follows: (1) All italicized words were underlined. (2) The word "experiment" appearing in the third sentence of the first paragraph was changed to the word "test." (3) The word "examples" appearing in the first sentence of the third paragraph was changed to the words "sample items." (4) The last two sentences in the final paragraph of the instructions were deleted as irrelevant and replaced with the

standard sentence, "DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL." A copy of the test booklet which was presented to the subjects is given in Appendix 1.

Nobel's (1952) production method of continuous written associations was used to define the "m" values of the words. The instructions, data collection procedures, and the scoring of the responses were identical to those used by Nobel with the exception of two minor changes as follows: (1) The italicized words in the instructions were underlined. (2) The sample item "Korea" was deleted and only the sample item "Ham" was used. A copy of the test booklet which was presented to the subjects is given in Appendix 2.

The semantic differential rating scales (evaluative factor) were used to define the connotative or affective meaning of the words. Ten bipolar adjective rating scales were selected on the basis of their high factor loadings in the original factor analyses (Osgood & Suci, 1955), and on the basis of their face validity. The following 10 bipolar adjectives were selected which gave a mean factor loading of .83 and a factor loading range from .76 to .88: good-bad, clean-dirty, beautiful-ugly, sweet-sour, nice-awful, happy-sad, pleasant-unpleasant, kind-cruel, valuable-worthless, fair-unfair.

The instructions and the data collection procedures were the same as those used by Osgood, Suci and Tannenbaum (1957) except for the following changes which were necessary primarily because only the evaluative scales were being used: (1) The word "study" which appeared in the first sentence of the instructions was changed to "test." (2) The bipolar adjectives "fair-unfair," "strong-weak," and "active-passive" which were used in the examples in the instructions were all changed to the bipolar adjective "good-bad." In a similar manner the bipolar adjective "safe-dangerous" was changed to "clean-dirty." (3) All italicized words were underlined. A copy of the test booklet that was presented to the subjects is given in Appendix 3.

The word concreteness ratings were obtained by using the general instructions of Spreen and Schultz (1966), and the modifications proposed by Pavio et al. (1968). The ends of the scale which were originally defined by Spreen and Schultz to read "low concreteness-high concreteness" were changed to read "highly abstract-highly concrete." The second paragraph of the instructions was adapted directly from the imagery instructions of Pavio et al. A copy of the test booklet which was presented to the subjects is given in Appendix 4.

An index of word familiarity was obtained using the rating scale constructed by Nobel (1953). The test

booklet format and the instructions were similar to those used by Nobel with the following changes: (1) In paragraph 2 of the instructions the number "56" was deleted and the phrase, "by simply placing a check mark (✓)," was changed to read, "by simply placing an (X)." (2) All italicized words were underlined. (3) In paragraph 6 the words "FLIGHT CHIEF," used in the example were changed to the word "SUPERVISOR." (4) After the example given in the instructions, the sentence, "Please turn to the sample items," was inserted. (5) In paragraph 7, the sentence which read, "This is not a speed test, for each man will be given plenty of time to finish," was changed to read, "This is not a speed test and you will be given adequate time to finish." (6) The first phrase in sentence 2 of paragraph 8, which read "Many of the words in this test are very rare," was changed to read, "A number of words in this test are rare." (7) The final paragraph of the instructions was judged to be irrelevant. It was deleted and replaced with the sentence, "DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL." A copy of the test booklet which was presented to the subjects is given in Appendix 5.

The writer concludes that the relatively minor changes made in the instructions of the five instruments were absolutely necessary in order to make the tests

intelligible to the (female) subjects. In all cases the rating scales or test format (Nobel's m) were identical to those of Pavio et al. (1968), Nobel (1952, 1953), and Osgood et al. (1957), and the results of the present experiments should be directly comparable to their earlier findings.

The procedures for the printing, arranging, and assembling of the test booklets were generally the same as those used by the above authors. The word association test and the semantic differential scales were printed with one item per page. The imagery concreteness and familiarity rating scales were printed with four items per page. The four items for each page, which formed a set, were selected from the pool of word stimuli on a random basis. Once the set of four words and the order was determined, the same set of four words in the predetermined order appeared together on all three tests. The order of the pages in the test booklets was shuffled at the time that the booklets were assembled for all five tests.

The arrangement of the bipolar adjectives for the SD scales was determined on a random basis with the positive adjective always appearing on the left side and the negative adjective on the right side. The 10 bipolar adjectives were printed on 10 small cards which were placed in a box, shaken, and drawn out, one at a time. Once the

serial order was determined it remained the same for all the words.

Some workers (e.g., Jenkins, Russell & Suci, 1958) have systematically counterbalanced the left and right ends of the scales with the intention of preventing the subjects from rating a particular concept according to a predetermined set. For example, if the first set of adjectives reads good-bad, the second set would read dirty-clean, and so on, alternating every second pair. Guilford (1954), however, has provided a very thorough discussion of the many difficulties encountered when a series of bipolar adjectives are used to rate a concept. He argued that it is better to keep all the positive adjectives on one side and all the negative adjectives on the other side because this will substantially reduce the rating errors on the part of the subject and the scoring errors on the part of the experimenter.

The quantification of the data from the five instruments was,generally speaking, straightforward and objective. On the imagery and concreteness scales a value of 1 was assigned to the low (left) and 7 to the high (right) ends of the scale, with the between ratings receiving the values of 2, 3, 4, 5, and 6, respectively. On the familiarity scale the "never" rating was assigned a value of 1, and "very often" a value of 5, with "rarely," "sometimes," and "often" receiving values of 2, 3, and 4, respectively.

The procedure used to score the responses on the word association test was identical to that proposed by Nobel (1952). In order to be scored as an acceptable association, the response had to be (1) legible, (2) not perseverated, and (3) of the same set. Finally, the "rule of thumb" proposed by Nobel was used which indicated that if there was any doubt that one of the three criteria had been violated, the subject was given the benefit of the doubt.[2] The "m" value for each word (for each subject) was defined as the total number of acceptable associations given for the 60-second period.

DiVesta (1966) has pointed out that the semantic differential scales generate a great deal of data which may be analyzed in a number of different ways. In the original work which led to the development of the SD scales (Osgood & Suci, 1955; Osgood et al., 1957), the seven scale positions were either arbitrarily assigned a number from 1 to 7 (from left to right), or the middle position was assigned a zero value with the three positions to the left and right receiving values of (plus or minus) 1, 2, 3 (+3, +2, +1, 0, -1, -2, -3). Osgood and his coworkers

---

2 Nobel (1952), Rocklyn, Hessert and Braun (1957), and Nobel and Parker (1960 have reported very high inter-group reliability estimates of .97 and above for the m scale scores. Similar reliability coefficients will be calculated and reported in the present study.

suggest that either choice is acceptable although, for heuristic reasons, they favored the latter notation.

A number of workers have also analyzed SD data using a polarity or intensity measure (Frincke, 1968; Jenkins & Russell, 1956; Pavio, 1968; Staats & Staats, 1959). This measure is defined as the mean (or the sum) of the absolute deviations from the midpoint on each scale. It is the same as the latter of the two notations above with the exception that the plus or minus sign differences are ignored.

The polarity measure is particularly appropriate for the present experiments because the experimenter is interested primarily in the quantitative and not the qualitative differences in the affective meaning of the words. That is, positive (good) and negative (bad) affective meaning will not be distinguished in the present habituation experiments.

The semantic differential data in the present study were quantified by assigning a zero value to the middle position and the values of 1, 2, and 3 to the remaining positions, left and right of the center (3, 2, 1, 0, 1, 2, 3). The scores were summed over the 10 bipolar scales for each word yielding a single score with a potential range of values from 0 to 30 for each word.

C. The Linguistic Stimuli

No source could be found in the published literature which simultaneously gave normative data on all five word attributes for the same list of words. It would not be possible without these data to systematically manipulate (in the same experiments) the independent variables of interest to the present study. There are, however, a number of sources available which provide normative data on some of these linguistic measures as follows: imagery, concreteness, and meaningfulness (m)--Pavio (1968); meaningfulness (m)--Nobel (1952, 1960); the semantic differential scales--Heise (1965), Gerow and Pollio (1965), Jenkins, Russell and Suci (1958), DiVesta and Walls (1970).

Pavio's (1968) dictionary provided the major source of word stimuli to be used in the present study, firstly because it gave values for three of the five linguistic measures, and secondly because his list was extensive (N=925). Heise's (1965) dictionary was the second source to be used in the present study because his list contained SD factor scores (evaluative, potency, and activity) for the 1000 most frequently used English words. Finally, a few words were taken from Nobel's (1960) list.

A successive series of steps were required in order to select the final sample of words which were to be used

in the present experiments. Pavio's list of 925 nouns was scanned to select those dissyllable words which gave a range of values from high to low for denotative linguistic meaning. Denotative linguistic meaning was operationally defined by combining (adding) the I and m scores reported by Pavio.[3] For this purpose only, those words were selected which had similar values for both measures. For example, if a word had a high imagery score, it also had to have a high m score in order to be selected. A number of low m words were added from Nobel's list to ensure a low denotative extreme on the scale. There are 18 artificial (very low m) words on Nobel's list, but for the purposes of the present study, only real (dictionary-listed) words were selected.

The resulting pool of words was then rank ordered as a function of the predicted connotative linguistic meaning for each word. This was accomplished with the assistance of Heise's dictionary or, if the word was not on his list, the writer estimated the word's position on the connotative scale. Following this procedure, a few

---

3 The theoretical rationale for this was developed in Chapter I. The statistical justification for employing this procedure with the scores obtained on the words used in the present experiments will be treated in the appropriate sections of Chapters III and IV.

dissyllable words were added directly from Heise's list in order to increase the number of high and middle values on the connotative scale.

The next step was to rank order the pool of words as a function of their concreteness values. This was a fairly simple task because the concreteness scores for most of the words were available from Pavio's dictionary. If the word was not listed in Pavio's dictionary, the writer estimated its position on the concreteness scale.

Finally, by comparing the hypothesized rank order scales for all three word attributes (denotative and connotative linguistic meaning and word concreteness) the final number of two-syllable nouns was reduced to 60. It had been decided on an a priori basis that 60 words would be the maximum number that could be reasonably processed in the present study. This decision was based on the limited availability of the subjects, as well as on the limited resources available to the experimenter. Lastly, it was concluded that because the experimenter had drawn very heavily on the normative data provided by the previous workers, the resulting scale values would quite probably vary systematically for all the word attributes.

The final list of two-syllable nouns which made up the word sample that was used in the first part of this study is presented in Table 2. Notations are given to

Table 2

List of Two-Syllable Word (Noun) Stimuli Selected from the Dictionaries of Pavio (1968), Heise (1965), and Nobel (1960) (N=60)

Word Number	Word	Pavio	Heise	Nobel
1	ADAGE	x		
2	AMOUR	x		
3	ANGER	x		
4	ARRAY	x		
5	ATTAR			x
6	BABY	x	x	
7	BLISTER	x		
8	BODICE			x
9	BOSOM	x		
10	CAROM			x
11	CONCEPT	x		
12	COTTON	x		
13	CRADLE	x		
14	DANGER		x	
15	DAVIT			x
16	DECEIT	x		
17	DEVIL	x		
18	DIVORCE			
19	DUMMY	x		
20	ESSENCE	x		
21	EVENT	x	x	
22	FABRIC	x		
23	FOIBLE	x		
24	FOLLY	x		
25	GADFLY	x		
26	GAMIN			x
27	GARRET	x		
28	IRON	x	x	
29	MAELSTROM			x
30	MALICE	x		

Table 2 (Cont'd.)

Word Number	Word	Pavio	Heise	Nobel
31	MARKET	x	x	
32	MATRIX			x
33	MATTER		x	
34	MERCY	x		
35	METAL	x	x	
36	NONSENSE			
37	NUMBER		x	
38	OBJECT		x	
39	OFFICE		x	
40	OUTCOME	x		
41	PANIC	x		
42	PAPER	x	x	
43	PASSION	x		
44	PENCIL	x		
45	PERCEPT			x
46	PERSON	x	x	
47	PRISON	x		
48	QUOTA			x
49	RIVER	x	x	
50	SALOON	x		
51	SAVANT	x		
52	SEQUENCE			x
53	SUNBURN	x		
54	SURFACE		x	
55	SURTAX	x		
56	TABLE	x		
57	TEMPER			
58	TROUBLE	x	x	
59	VIRTUE	x		
60	WATER	x	x	

indicate the sources from which the words were selected. It can be seen that some words were listed in more than one source. The word TEMPER did not appear specifically on any of the three lists. It was added by the author to increase the number of abstract/affective words.

D. The Psychological Experiment

The subjects were solicited by requesting permission from the Director of the Nursing School to enter the classrooms and ask for volunteers. The teachers at the school arranged to have the writer meet with the students in two large groups. The first group was made up of approximately 140 students, and the second group was made up of approximately 130 students. At the appointed time, the experimenter entered the classroom and, after being introduced by the teacher, read the following prepared statement:

> Female-unilingual-English-speaking subjects are needed for a psychophysiological study. The experimental work will be done at the Faculty of Psychology laboratories at the University of Ottawa. You will be asked to come for one, and only one, of two sessions which will take place approximately three months apart. At the occasion of the first experimental session a number of psychological tests will be given. During the second session some physiological measures will be recorded in response to some stimulus slides projected onto a screen. Concerning the first session, no IQ, personality, or other diagnostic tests will be given. During the second or physiological part of the study, no painful or harmful stimuli will be administered. You will all be paid for your services.

After reading the prepared statement, the experimenter asked if there were any questions. In response to the appropriate questions the experimenter explained that those students volunteering for the first part of the study would receive $10.00 each (for three hours time), and those in the second part of the study would receive $5.00 (for 1.5 hours time). The experimenter further explained that he would need about 200 subjects for the two parts of the study, and he hoped that most of the students would volunteer to participate.

Following these additional explanations, 3 X 5 inch cards were distributed to those who wished to volunteer. They were asked to write appropriate identifying data (name, address, age) and particularly telephone numbers where they could be reached, as well as which of the two sessions they wished to attend.

At the time of the initial contact with the perspective subjects, 240 subjects filled out cards. This indicated that the majority (approximately 88%) of the students at the school volunteered. However, from the time of the initial contact to the time that the experimenter actually phoned to invite the subjects to come for one of the sessions, an attrition rate of approximately 10% was effected. This was due to a number of factors: (1) Some subjects had changed their minds (no more than

10 subjects). (2) Some subjects had left the school (no more than 5 subjects). (3) The remaining subjects could not be contacted.

The final number of subjects who actually participated in the study was 200. This is approximately 77% of the total number of students who were enrolled in the nursing school at the time of the study.

Those subjects volunteering to participate in the first part of the study were invited to come to one of the classrooms for the psychological testing. The testing was done by the writer in five groups of 22, 18, 23, 17, and 24 subjects. The five psychological tests were administered in a counterbalanced order. The order in which the tests were administered and the number of subjects in each group is reported in Appendix 6.

The testing took place between 8:45 a.m. and 12.15 p.m. in a large classroom where the subjects were required to leave two empty seats between each other. The administration procedures were similar for all five tests. The test booklets and pens were distributed and the subjects were asked to fill out the identifying data on the front page. Each subject was then given a code number and asked to write that number in the upper right hand corner of every page in the test booklets (the same number for all five tests). The instructions were read aloud by the experimenter, while the subjects followed along, and the

sample items were completed whenever appropriate. Any additional questions were dealt with by the experimenter, and the tests were administered.

During the word association test the subjects were required to work for exactly 60 seconds on each word. This was accomplished by the experimenter with the assistance of a stopwatch. On the other tests, the subjects were allowed to work at their own speed, although they were asked to remain in their seats until all the subjects in the group had completed each test.

A number of short rest periods were programmed into the test administration procedure in order to counteract and reduce the effects of fatigue.[3] After every 15 items on the word association test, the subjects were given a 4-minute break. For this purpose they were asked to put their pens down and were allowed to stand, stretch, and move about in place. After completing the word association test, the subjects were given a 15-minute break, during which time they were allowed to leave the room. When the word association test was in the last order position (see Appendix 6), the subjects were given a 15-minute break after the SD test, and the break between every 15

---

3 The experimenter was well aware that the subjects would be accomplishing a full morning's work.

items on the word association test was extended to five minutes. A 10-minute break was given after the SD test and a 5-minute break after the other three tests. Once again, the subjects were allowed to leave the room if they wished, but were asked to stay close by.

The time required for the entire testing procedure was as follows: (1) testing time (approximately) m = 60', SD = 25', I, f, A-C = 15'; (2) break time (approximately) m = 30', SD = 10', I, f, A-C = 5'. The total testing time, then, was approximately 135' and the total break time was approximately 55'. This resulted in an overall procedure time of slightly more than three hours (190').

After completion of the last test the subjects were paid by cheque and thanked for their services.

After all the linguistic data had been collected, the pages of the test booklets were separated according to the subjects' code numbers and systematically arranged so that the tests could be scored and made ready for analysis. The scoring of the word association tests, and the calculation of the SD scores were done by two assistants contracted and trained by the experimenter for these tasks. The scores were then transcribed onto IBM coding sheets in such a way that all variables could be identified. This was checked and double-checked by the laboratory assistants. The data were then keypunched onto IBM cards. The preliminary

statistical analyses revealed a number of additional (mechanical) errors. An "Exec Print" of the data matrix allowed the experimenter to very quickly locate any remaining errors, which were corrected prior to the final series of analyses.

The raw data for the linguistic variables of the study are presented in Appendix 7. The raw data were photocopied directly from the corrected "Exec Print" and are presented with the necessary identification code.

E. Statistical Procedures for the Linguistic Measures

The usual descriptive statistics were first calculated for the six linguistic measures, for the 60 words taken together, and subsamples I and II combined. Specifically, three measures of central tendency (mean, mode, and median), two measures of variability (standard deviation and range), and estimates of the relative skewness and kurtoses of the resulting data distributions were obtained.

In order to investigate the relationships between the various linguistic measures, the Pearson (r) coefficient of correlation was employed. The correlational analysis was done after an examination of the distribution characteristics for each measure indicated that the normality assumption was reasonably well approximated.

Finally, the means and standard deviations for each of the 60 words, for all six linguistic measures,

were calculated (subsamples I and II combined). These values were required so that the words could be rank ordered for each measure. This enabled the experimenter to carry out a four-way split for each measure, and further allowed for the selection of the words, either high or low on the linguistic measures, as required for the experimental manipulation of the linguistic measures for the habituation experiments.

All statistical analyses were carried out with standard SPSS subprograms.[4] The significance level of the kurtosis and skewness values was estimated employing the critical ratio tests of significance for kurtosis (CR_{ku}) and skewness (CR_{sk}) suggested by Dayhaw (1966, pp. 335-336).

2. The Habituation Experiments

The second section of Chapter II describes the subjects, the construction of the linguistic-stimuli slides, the physiological instrumentation, the physiological data collection procedures, the quantification of the physiological (dependent) measures, and the statistical models used to analyze the dependent measures and test the hypotheses advanced in Chapter I.

---

4 Norman H. Nie, C. H. Hull, Jean G. Jenkins, Karen Steinbrenner, and Dale H. Bent, Statistical package for the social sciences (2nd ed.). New York: McGraw-Hill, 1975, xxiv-675 p.

A. The Subjects in Habituation Experiments I and II

The subjects for the two habituation experiments consisted of 96 female student nurses, who were drawn from the same population as described above. The first 48 subjects who arrived to participate in the physiological part of the study were assigned randomly to one of the four conditions in experiment I, and the second 48 subjects were assigned randomly to one of the four conditions in experiment II.

The means and standard deviations for the subjects' age for experiment I were 20.58 and 1.32, respectively, and for experiment II were 20.13 and 1.36, respectively. The mean and standard deviation for the subjects' age for the two experiments (N=96) were 20.34 and 1.34, respectively.

The subjects who participated in the physiological part of the study came for one laboratory session of approximately 1.5 hours duration. They were paid for their services.

B. The Construction of the Linguistic (Visual) Stimuli

It was decided on the basis of earlier work done by the writer (1973) that the word stimuli could be effectively presented visually to the subjects during the habituation trials using a double-slide projector technique. The

words were typed in capital letters, using an IBM Model 82 electric typewriter and a high quality IBM film ribbon (Black No. 1136466) onto prestige bond ("Brite White") $8\frac{1}{2}$" X 11" paper.[5]

The personnel at the Graphic Arts Department of the University of Ottawa processed (photographed) the sheets of paper with the typed words and produced standard 2" X 2" plastic 35 mm projector slides with one word on each slide. A number of blank slides were also produced by photographing sheets of the same quality white paper. Duplicate copies of all slides were made so that backup materials would be available once the data collection had begun. All slides were carefully checked by the experimenter prior to the data collection in order to ensure that the slides were impeccably clear and did not contain any artifacts which might detract the subjects during the habituation trials (e.g., dust, finger marks, etc.).

C. The Physiological Instrumentation and Apparatus

In order to record the physiological responses to the word stimuli, an automated system was constructed by the technical staff at the Faculty of Psychology laboratories.

---

5 Domtar Fine Papers Ltd., Ottawa, Ontario, Canada.

The system was made up of (1) the sensing, amplifying and recording instruments, (2) the equipment and procedure used to project the word stimuli onto the projection screen, and (3) a specially constructed experimental chamber where the subjects sat during the habituation trials.

The silver-silver chloride electrode is clearly the electrode of choice for electrodermal measures, primarily because of its properties of stability and durability (Edelberg, 1964; Johnson & Lubin, 1966; Lykken & Venables, 1971; Venables & Sayer, 1963). In the present experiments the skin conductance response was detected using a recently developed silver-silver chloride pellet carefully compounded to hold offset voltage and polarization low. The recessed pellet which is contained in a hard plastic casing is also designed to keep source impedence and noise low.[6]

The electrodes were applied to the skin using the standard two-sided adhesive collars (Beckman Instruments Inc.). These collars are the same shape and size as the electrodes and have a hole in the center which allows for the precise control of the effective electrode-skin area.

---

6 Beckman Electronics Instruments Division, Inc., 3900 River Road, Schiller Park, Illinois. Bulletin No. 5047 suggests that the offset voltage is less than 250 microvolts after presoaking in saline. The polarization voltage is as low as 5 microvolts per 24 hours with the electrodes placed face-to-face in saline at constant temperature. Finally, the bulletin indicates that the source impedence is maintained as low as 100 ohms.

The size of the electrode itself is unimportant (within reasonable limits) and the skin conductance level will vary linearly with the area of skin surface that makes contact with the electrode paste (Lykken, 1970).

The question of the proper electrode paste, however, is quite another matter. It is well known that the type of electrode paste can have a marked effect on the electrodermal activity (Edelberg, 1972). For example, standard EEG or EKG pastes are made up of strongly hypertonic solutions and are, therefore, inappropriate for electrodermal measures. The problem has not apparently been studied systematically. For the purposes of the present experiments the formula recommended by Lykken and Venables (1971, p. 665) was used.[7]

The electrodes were connected to a skin conductance signal conditioner which was constructed with a standard plug-in chassis (Lykken & Venables, 1971, p. 663). This is a constant voltage system and allows for the direct measurement of skin conductance. It was designed so that with the proper amplification and calibration, it would read or record directly in micromhos. An input conductance box with five "dummy subjects" of 1, 2, 5, 10, and 20 micromhos

---

7 One pound of unibase (Parke-Davis) plus 1/2 part by volume physiological saline. Beat until creamy.

was also connected to the system for calibration purposes. The system was designed so that when the "dummy subject" was switched in, the real subject was automatically switched out and vice versa.

The skin conductance signal conditioner was connected to a Watanabe Multirecorder, Model Mc611.[8] This polygraph amplifying and recording system is designed to be used for research which requires the recording of multiple input variables. It is a 6-channel servo-type potentiometric recorder, constructed so that both the servo mechanism and the amplifiers for each channel can be removed or added depending upon the number of variables the experimenter chooses to monitor and record. The manual (No. 1700) states that the fully solid-state amplifier chasses possess a very high degree of sensitivity and reliability.

The recording system is serviced by separate ink pens for each channel. In the present experiments standard Watanabe recording paper (Chart No. SP-216A) was used. This paper is lined both horizontally and vertically. The horizontal divisions mark off units of 1.0 cm, and the vertical divisions mark off units of 0.1, 0.5, and 1.0 inches.

Three channels were used in the present research. Channel I (blue ink) and channel II (red ink) were used to

---

8 Watanabe Instruments Corp., 3-19-6 Nishishnagawa Shinagawa -Ku, Tokyo, Japan.

record skin conductance activity. Channel III (green ink) was used as a stimulus event marker. Channels I and II were calibrated and adjusted for the range setting during the pilot work, and once the settings were determined, they remained unchanged until the end of the experiment. This was done in order to facilitate the between-subject comparisons of skin conductance activity.

Channel I was calibrated so that 0.5 inches of pen deflection (the middle-sized vertical unit) represented exactly 1.0 micromhos. The smallest unit of SCR that could be detected on channel I was (1.0 ÷ 5) 0.2 micromhos. Since the vertical dimensions of the paper were ruled to 10 inches, the overall range of skin conductance response that could be recorded on channel I was from 0.2 to 20 micromhos. Lykken and Venables (1971) suggest that in electrodermal research, when using a constant voltage system and two small finger electrodes, the range of skin conductance is likely to be below 10 micromhos. (Actually, in the present experiments, the mean tonic level (SCL) was 12.93, and the mean phasic response (SCR) was 0.86 micromhos, respectively). This indicates that the detectable range of skin conductance activity from 0.2 to 20 micromhos was quite adequate for the present research.

Channel II was added to provide a backup source of data and to increase the sensitivity of the present system.

Channel II was calibrated to have 10 times the sensitivity and 1/10 the range of channel I. That is, five inches of pen deflection represented a SCR of exactly 1.0 micromhos. The range of SCRs that could be detected on channel II was from .02 to 2.0 micromhos. Employing both channels I and II, then, gave an overall range of SCRs from .02 to 20 micromhos for the system.

Channel III was used to record the onset and offset of the stimulus. The input for channel III came from a Lafayette VIII Bank Timer[9] (Model 5431A) set at recycle. The VIII bank timer was connected to a Lafayette predetermined countdown timer (Model 5812), and to the stimulus source.

The VIII bank timer was used to present to the subjects a stimulus of 2 sec duration, followed by seven different interstimulus intervals of 49, 34, 46, 40, 33, 43, and 37 sec. The predetermined countdown timer allowed the sequence to continue until a total of 30 stimulus presentations were given to the subject.

The duration and order for the interstimulus intervals were determined as follows: Pilot work indicated that the optimum time between stimulus presentation was between 30 and 50 sec. A list of random numbers was consulted

---

9 Lafayette Instrument Co., Lafayette, Indiana.

and the first seven numbers found between 30 and 50 were selected. Each number was written on a small square of paper and placed in a box. After the box was shaken for some time, the papers were drawn out and the resulting order was used to program the VIII bank timer. That is, number 49 was drawn first, 34 second, and so on, to number 37 in the last position. Once the sequence was started, the cycle repeated until 30 stimuli had been given (4 and 2/7 times), at which time the sequence automatically terminated.

The stimuli were presented to the subject visually by two Argus, Model 505, slide projectors. The projectors were modified so that the lamps could be turned on and off by the external timer, while the fans operated continuously. This provided a constant background noise. No sound could be detected when the lamps were turned on and off by the automatic timer. Both projectors were fitted with new Sylvania CWD projector lamps of 300 watts and 120V, which were guaranteed to burn for 25 hours. The lamps were replaced with new ones after every 12 hours of use, until all the testing was completed.

The projectors were mounted behind the subject's chair in a superimposed position. They were adjusted and checked before each testing session to ensure that the two images projected onto the screen coincided. This allowed

for a constant background illumination (the interstimulus interval), followed by the stimulus on for two seconds and then a return to the background conditions, with no perceptible change in illumination.

The subject sat in a specially constructed, sound attenuated chamber for the habituation trials. The 6' wide, by 7' long, by 7' high chamber was sound insulated, and fitted with double doors and no windows. The room attenuated sound up to 65 db.

It was important that the experimental chamber be temperature controlled because the physiological data collection took place during the summer months (May, June, and July), and secondly because the chamber tended to heat up while the slide projectors were operating. Both the amplitude (Maulsby & Edelberg, 1960; Venables, 1955) and latency (Gildemeister & Ellinghaus, 1923) of the electrodermal response can be significantly affected by peripheral temperature changes. In general, both the amplitude and latency of the response are increased as the temperature decreases, although there can be considerable individual variation. Apparently, palmar skin conductance, among the other commonly measured electrodermal phenomena, is least affected by changes in temperature (Wenger & Cullen, 1962).

The effect that changes in relative humidity may exert on electrodermal phenomena is not clear. Edelberg

(1972, p. 375), commenting on the unexpected negative correlation between relative humidity and skin conductance, and the nonsignificant correlation between temperature and palmar conductance reported by Wenger and Cullen (1962), suggests that this may mean that palmar skin conductance may not be controlled by thermoregulatory mechanisms.

There is, at any rate, some evidence to suggest that changes in both the temperature and relative humidity may introduce a source of error variance in some electrodermal measures if not controlled. In addition, the experimenter wanted the subjects to be relatively comfortable during the habituation trials.

The experimental chamber was temperature controlled by a Comfort-Air air conditioner (Model WG-111).[10] The thermostatic control was set to maintain the average room temperature at approximately 72°F as follows. Pilot work indicated that the temperature in the experimental chamber rose about 4° during the 40 minutes that the subject was in the chamber. While the subject was seated in the chamber with the doors closed and the slide projectors turned on, the temperature would rise about 4° during the first 10 minutes. Thereafter, the temperature would remain

---

10 Heat Controller Inc., Jackson, Michigan. Model WG-111 presumably removes 11,000 BTU of heat from the air every hour.

essentially unchanged for the remainder of the session. This indicated that the thermostate on the air conditioner had to be adjusted so that the chamber and the outside room temperature was maintained at 68°F, before the subject entered and both doors were closed.

The cool air from the air conditioner was channeled directly into the experimental chamber through a specially constructed duct and an intake fan. The warmer air was removed by an exhaust fan and duct which were installed in the upper opposite corner of the room.

The operation of the air conditioner maintained the relative humidity in the experimental chamber at approximately 40% (±3%).

The arms on the padded chair were modified and extended so that the subject's arm would remain in a stationary but comfortable position. When seated, the subject's head was approximately 45 inches directly across from the 22 X 28 inch projector screen which was attached to the wall of the chamber.

The projectors were mounted in a superimposed position approximately 20 inches behind and 25 inches to the right side of the subject. The stimulus words when projected onto the screen were 1 inch in height and between 3.8 and 7.5 inches in length, depending upon which word was projected. The pilot work suggested that this provided

optimum size and distance specifications, enabling the subjects to view the linguistic stimuli with clarity and comfort. The subjects were allowed to wear glasses during the habituation trials if required.

The light intensity and background illumination in the chamber were measured with a light level meter,[11] which gave the following results. When the photocell was placed in the approximate position of the subject's head and facing the projector screen, the light meter registered 4 foot candles of light intensity both for the background and word stimulus slide conditions. When the slide changed automatically from the stimulus-on to the stimulus-off condition and vice versa, the light intensity in the room was reduced by 0.3 foot candles for a fraction of a second. This was caused by the simultaneous heating up of the tungsten element in one bulb and the cooling off of the element in the other bulb.

Because there were no windows in the room, a Mini Scan, Model 5050, closed circuit TV, with a two-way intercom and buzzer, was mounted in one of the upper corners of the chamber. This allowed the experimenter to monitor the subjects at all times, while attending to the polygraph and other equipment in the room.

---

11 Basic Sciences Industries.

The system described above allowed the experimenter to process each subject during the habituation trials in a fully automated manner. Once the electrodes had been properly placed on the subject's palmar skin surface, the polygraph equipment calibrated, the pens centered, and satisfactory resting SCL recordings were achieved, the experimenter pressed the red initiate button on the timer, and 30 stimulus trials were presented to the subject while her skin conductance activity was recorded.

D. The Habituation Experiments I and II

The subjects for the physiological part of the study were scheduled for either a morning (a.m.) or afternoon (p.m.) session. The morning session was defined as being between 9:00 a.m. and 1:00 p.m., and the afternoon session as being between 2:00 and 6:00 p.m.

When the subjects were contacted to be given an appointment, each was asked to refrain from taking all medication, including alcohol, for a minimum cf 48 hours prior to the experimental session. Each subject was also asked to be sure to have her usual night's rest and to take either her usual breakfast or lunch prior to the session.

The experimental procedure was the same for both experiments. The only differences were in the words which were selected for the four conditions in each experiment.

The statistical analyses of the linguistic measures (reported in Chapter III) indicated that two experiments would be required to test the hypotheses of interest to the present study. In the first experiment, high and low denotative and high and low connotative linguistic meaning would be systematically manipulated. In the second experiment, high and low word concreteness and high and low connotative linguistic meaning would be manipulated. This generated four conditions in each of the two experiments. Two words were selected, on statistical grounds, for each of the four conditions for the two experiments. The procedures used to select the words for each of the conditions are described in Chapter III.

The subjects in experiment I were assigned to one of the four conditions, to one of the two words in each condition, and to either an a.m. or p.m. session, as follows. The experimenter had decided on an a priori basis that 12 subjects per cell would be the minimum number required. The subjects were numbered 1 through 48, based on their order of appearance at the laboratory. The four experimental conditions were systematically numbered 1 through 4. A random list of numbers was consulted (Fisher & Yates, 1963), and the first 48 numbers between 1 and 4 inclusive were selected and assigned to the 48 subject numbers. This indicated the cell or condition to which the subject was

assigned. The eight words (4 cells X 2 words) were previously numbered 1 through 8 in a systematic fashion (Chapter III). That is, the two words in cell one were numbered 1, 2, the two words in cell two, 3, 4 and so on. The subjects were then assigned alternatively to one of the two words and one of the two time conditions in each cell.

A similar procedure was followed for experiment II with the exception that the subjects were numbered 49 through 96 inclusive, and the eight words were numbered 9 through 16 inclusive.

In summary, this indicates that in both experiments the subjects were randomly assigned to one of the four conditions, and that counterbalancing procedures were used to minimize any effects due to either idiosyncratic responses to a specific word, or differences in the subject's tonic skin conductance (arousal level) as a function of the time of day.

When the subject arrived at the laboratory, she was asked to remove any rings or watches. She was then taken into a nearby room and instructed to wash her hands with soap and water, to rinse thoroughly, and to dry her hands with the towels provided for this purpose. The subject returned to the laboratory proper and was seated on a stool. The experimenter then examined the palmar skin

surface on the distal phalanx of the first and third fingers with a lens, for abrasions, lacerations or scar tissue. Both the SCL and the SCR are linearly related to the density of active sweat glands in the chosen skin area (Lykken & Venables, 1971, pp. 664-665). The two fingertips were then cleansed with 70% methyl alcohol and dried thoroughly with sterile cotton. A standard adhesive electrode collar was then placed over the central portion of the cleansed skin surface so that the opening in the collar would provide a precise control of the effective skin area. A second collar was attached to the proper surface of the silver-silver chloride electrode.

The cavity of the recessed electrode was filled with electrode paste and adjusted with a small cotton Q tip. The electrode with the adhesive collar attached was then centered and gently pressed against the collar that had been previously applied to the subject's finger, producing a secure attachment of the electrode to the finger. The attached electrode was then further secured by gently wrapping a small strip of adhesive tape around the finger and the electrode. The lead coming from the electrode was then fed up the ventral surface of the subject's forearm and secured with adhesive tape just below the wrist and elbow. This was a precaution to help prevent detachment of the electrode in the event that the subject unwittingly moved her arm.

After both electrodes were attached, the subject was invited into the experimental chamber and seated in the chair. The electrode leads were then plugged into the leads which were permanently connected to the skin conductance signal conditioner. The stimulus word and background slides were placed in the projectors and checked out while the subject was previously washing her hands. The experimenter then turned on both projectors which showed only the background slide condition at this point in the experiment. (The stimulus word was automatically turned on and off by the automatic timer after the initiate button was triggered.) The subject was then read the following instructions:

> In a moment I will leave this room closing both unlocked doors behind me. About 15 minutes will be required to calibrate the instruments and arrive at satisfactory baseline levels. Then a series of slides will be projected onto the screen. You are asked to sit up in an attentive position, to remain quiet as possible and to look at the screen at all times. The entire procedure will take about 40 minutes. You will be monitored by this closed circuit TV. A two-way intercom is operating should you need to talk to me. However, as a general rule you are asked not to talk at all. Remember now, sit up, remain quiet but attentive, and look at the screen at all times.

The polygraph equipment was calibrated using the "dummy" conductances; the pens were centered, and 15 minutes of resting prestimulation SCL was recorded. The 30 habituation trials were then administered. After the thirtieth stimulus presentation, the experimenter waited one minute and then pressed the intercom buzzer. Immediately after

the buzzer was sounded, the experimenter recited the following words to the subject who was still in the chamber:

> You're all finished now! However, I want you to remain quiet for three more minutes, after which time I will come in and get you.

Pilot work indicated that the combination of the buzzer, followed by the experimenter's voice, invariably produced a startle response and a large skin conductance response. This was used for the range correction procedures which are described in the next section of this chapter.

After the three-minute period, the polygraph equipment was switched to the "hold" position, and the subject was removed from the chamber. The electrodes were taken off and the residual paste was removed with alcohol and cotton. The subject was then invited to sit at a small desk in the laboratory proper and was administered both forms A and B of the Eysenck Personality Inventory [(EPI), (Appendix 21)]. The two forms were administered to the subjects in a counterbalanced order. When these were completed the subject was thanked for her services and paid by cheque.

The procedure took approximately 1.5 hours for each subject. There were no equipment failures and no spoiled data.

E. The Quantification of the Electrodermal Measures

Edelberg (1967), in what Lykken and Venables (1971) refer to as "his thorough and remarkably impartial review" (p. 660), discussed many of the problematic methodological and interpretive aspects of electrodermal activity. In a more recent paper, Edelberg (1972) argued that it would probably be more precise to label EDA "neurodermal activity," because what is actually being monitored and measured is the result of preceding neurophysiological events.

It appears that there may be more than one relatively independent control area that exerts influence on EDA as follows: (1) the autonomic nervous system, sympathetic division (Richter, 1930; Wang & Lu, 1930), and possibly the parasympathetic division (Darrow, 1937); (2) the hypothalamus (Langworthy & Richter, 1930; Wang & Richter, 1928); (3) the anterior limbic cortex (Isamat, 1961), and possibly other parts of the limbic system (Lang, Tuovinen & Valleala, 1964; MacLean, 1955; Papez, 1937; Wang, 1964); (4) the premotor cortex (Wilcott, 1969); and (5) the reticular formation (Bloch & Bonvallet, 1961; Shimamura & Fujimori, 1961).

Although there is now excellent physiological evidence (as above) to indicate that the various electrodermal phenomena are to some degree under central cortical

control, the experimenter needs also to clearly recognize that when one monitors the electrical activity of the skin (in response to some stimulus treatment), one can only make inferences about cortical (and subcortical) events. It follows, then, that in some experiments alternative interpretations of electrodermal data may be possible and legitimate.

On the physiological side of the argument, an electrodermal response may well indicate the presence of cortical activity. However, it may also indicate (1) changes in the thermoregulatory mechanism, (2) changes in the surface properties of the skin for manipulative contact, or even (3) the secretion of odoriferous substances to allow tracking.

An excellent overview of the psychological correlates of EDA has been given by Edelberg (1972, pp. 404-409). He points out that changes in the electrodermal indicators have been associated with: (1) the general level of activation or arousal; (2) emotional "arousal"; (3) personality traits and psychiatric categories; (4) stimulus specific responses; (5) conditioned learning; (6) the various stages of sleep, and so on.

This paper is not the appropriate place to offer a comprehensive review of the electrodermal literature. This has been done extensively by other, more able, workers

(Edelberg, 1967, 1970, 1972; Lykken, 1968; Lykken & Venables, 1971; Martin & Venables, 1966; Venables & Martin, 1967). What is important for the present research is that the most advanced electrodermal technology presently available be considered by the experimenter.

Lykken and Venables (1971) have fairly recently suggested that even if there is still some uncertainty about the mechanism and interpretation of the "GSR," nevertheless it is possible and advisable to standardize the measurement procedures. They have, therefore, offered suggestions for the provisional standardization of the direct measurement of skin conductance, and have argued somewhat convincingly that "this method represents the current state of the art" (p. 656). They make recommendations for changes in terminology and argue specifically that the direct measurement of conductance, using a constant voltage method, is a preferred measure over resistance. Finally, they have offered a penetrating and incisive analysis of the continuing and difficult issues with regard to the units of measurement and their statistical treatment.

The recommended changes in terminology are designed to give more precision to the relevant concepts and greater specificity to the techniques employed. The average prestimulus level was previously referred to as "base" level (conductance or resistance), and the transient, wave-like

changes were referred to as "GSR." The term basal, which was taken over from metabolic physiology, is particularly inappropriate because it implies the presence of a "standard, reproducible reference level obtained in a stress-free, resting situation" (Lykken & Venables, 1971, p. 657). They recommended that the term tonic level replace the "basal" terminology because it suggests the presence of slow, long-term, or "tide-like" changes in the electrical activity of the skin. The abbreviations suggested for tonic levels of conductance or resistance were SCL and SRL, respectively. It was also suggested that the short-term or "phasic" changes, previously called "GSR," be referred to as skin conductance response, and skin resistance response, abbreviated as SCR and SRR, respectively.

Lykken and Venables (1971, pp. 660-661) argued that because of the electrophysical properties of the skin, as well as the physical and mathematical properties of conductors and resistors, the direct measurement of skin conductance offers clear-cut advantages over resistance measurement for most experiments. In this regard they decidedly disagree with Edelberg's (1967, pp. 26-27) contention that there are a number of advantages to each system. They concluded that the advantages Edelberg lists for resistance (i.e., greater amplifier sensitivity and the minimization of the polarization effect) are only apparent and easily out-voted by the many advantages of measuring skin conductance directly.

The advantages that Lykken and Venables list for the direct measurement of skin conductance may be summarized as follows. (1) Skin conductance is the simplest and most meaningful unit for psychophysiological studies because it is linearly related to the rate of sweat secretion (Darrow, 1934, 1964).[12] (2) It is easier and more accurate to measure skin conductance directly than to measure SR and convert to conductance mathematically. (3) Employing the constant voltage method, both the voltages and current density can be kept low, very probably avoiding the region of nonlinearity. (That is, in the constant current method, as the measuring current increases the voltage current curves become nonlinear.) (4) High and possibly dangerous voltage levels are avoided in the direct measurement of skin conductance.

After the tonic measures and phasic change scores have been obtained, and prior to the statistical analysis, it is important to consider three problem issues: (1) statistical assumptions, (2) individual differences in

---

12 Implied here is the fact that an arousing stimulus produces an increase in sudomotor activity (sweat), thereby increasing the skin's function as a conductor. Furthermore, the conductance of a parallel circuit is a simple sum of the conductances in parallel (i.e., the sweat glands) and a change in one produces a corresponding change in the total, independent of the values of the others. This is not true for the resistance of a parallel circuit.

range of response, and (3) the dependency (correlation) of phasic response on tonic level.[13]

The "normality assumption" is required for many of the commonly used statistics. Often data transformations are performed with the intention of reducing the pathology in the variable distributions (skewness or kurtosis). The inference is then made explicit or implicit that the transformed variable (i.e., the new variable) will now be a simple linear function of the underlying variable of interest. This doctrine is often unreasonable and workers should resist attaching any magical significance to ad hoc transformed data. Furthermore, it could be argued that the systematic selection of a data transformation procedure (e.g., Kirk, 1968, pp. 66-67) is particularly inappropriate when one is dealing with repeated measures data. There are other assumptions to be considered when analyzing repeated measures data, but these will be treated in the next section of this chapter.

It is now well established that individual differences in range of response can be observed across subjects, which most often have little to do with the psychological variables being studied (Lykken, Miller & Strahan, 1968). It follows, then, that a significant proportion of the

---

13 A systematic treatment of these problems has been generally ignored in the habituation studies reported in the professional journal literature.

variance in the ED scores is related to physiological differences which may have little relevance to the psychological variables of interest.[14]

> That is, both the maximum and minimum SCL of which a given S is capable must be determined by structural, physiological and biochemical factors which themselves differ widely from one individual to another; it is the variation within these limits which is normally of psychological interest (Lykken & Venables, 1971, p. 666).

Range correction procedures can be applied, if one can obtain reasonable estimates of each subject's maximum and minimum limits. Lykken and Venables (1971, pp. 667-668) suggest that both the tonic and phasic skin conductance be range corrected separately. The formula suggested by Lykken, Rose, Luther and Maley (1966) is used to correct tonic level.

$$\text{SCL-RAN} = \frac{SCL_{ix} - SCL_{min}}{SCL_{max} - SCL_{min}}$$

where: SCL_{ix} is the SCL for each specific trial.

A formula similar to that developed for the Paintal index (Paintal, 1951) is used to correct individual differences in range of phasic response.

---

14 This statement will need to be qualified in a later chapter. From the theoretical analysis advanced in Chapter I, it follows that the obvious exception to this general proposition occurs when one is interested in studying individual differences in subjects' responsiveness, regardless of the stimulus treatment (or resting condition).

$$\text{SCR-RAN} = \frac{SCR_{ix}}{SCR_{max}}$$

where: SCR_{ix} is the SCR for each specific trial.

These procedures, then, will allow the experimenter to express both the subject's tonic level and phasic responses as a proportion of each subject's individual variation (range of response). Both procedures will be used to range correct the skin conductance data in the present experiments.

The problem of the regression of phasic response on tonic prestimulus level has produced a vast literature which is often discussed imprecisely under the heading of the "Law of Initial Value."[15] Ever since Wilder's (1950, 1957, 1962) observations that the size of a response is inversely related to the prestimulus level of the variable under study, there has been almost an obsession to "undo" the LIV. Whether or not such a concept is applicable to electrodermal phenomena

---

15 The writer offers this judgment after reviewing a substantial portion of the LIV literature. There are essentially three positions adopted by those who have studied the problem, as follows: (1) those who hold that some kind of statistical adjustment must be done to the scores if the LIV is operating (e.g., Lacey's [1956] "Regression Approach," or Benjamin's [1963, 1967] analysis of covariance procedure); (2) those who hold that the LIV does not operate for electrodermal measures (Harding, Stevens & Martson, 1973) or the converse of the LIV holds for electrodermal measures (Hord, Johnson, Lubin, 1964); (3) those who hold that analysis of covariance procedures should not be done on a routine basis to "undo" a possible LIV effect (Edelberg, 1972; Lykken & Venables, 1971).

at all is presently a major source of contention (Edelberg, 1972, pp. 398-399). The present analysis will be restricted to electrodermal measures.

Lykken and Venables (1971, pp. 668-671) observe that the covariation between the tonic level and amplitude of phasic response may result from at least four factors, not just the one that is implied in the LIV concept, as follows: (1) the improper choice of basic units; (2) the presence of a common extraneous factor in both the SCL and SCR which is not related to the experiment; (3) the presence of an SCL which is nearing the upper limits; and (4) the different tonic levels represent different states of arousal.

An additional reason for the choice of conductance as a basic unit over resistance is the probability that SCR and SCL may be independent. This follows from the assumption that the amplitude increase in a "GSR" stems from an increase in the number of conductance units (i.e., sweat glands) operating in the skin, and the differential behavior of the conductance versus the resistance of a parallel circuit. While, on the other hand, it is probable that there will be a high correlation between SRL and SRR simply as an arithmatic artifact. The way to avoid this source of tonic phasic dependency is to select conductance as the basic unit of measurement.

Individual differences in the range of response for both SCL and SCR may provide a second source of phasic-tonic correlation. If one assumes that the SCL is a product of the level of central arousal and some measure of end organ activity, and if one uses as a skin conductance measure the difference between the pre- and post-stimulus level, then there will be no correlation between SCL and SCR, provided the range of response is constant across subjects. However, it was pointed out above that wide individual differences in range of response have been observed and this may produce high between subject correlations for raw data. The obvious solution is to use range correction procedures.

A third possible source of a phasic-tonic dependency can be observed when the subject's SCL is very high and approaching its upper limits. This is more closely related to the original idea incorporated in the LIV concept. If, for example, a subject receives a series of very strong stimuli, then the amplitude of SCRs will be expected to decrease as the tonic level rises. The use of analysis of covariance procedures is particularly inappropriate to deal with this problem because the expected covariation will not be linear. Examining the range corrected data will allow one to know when this effect is present even if there is no way to avoid it.

The fourth source of a phasic-tonic correlation is suggested by the experimental evidence which supports the hypothesis that different tonic skin conductance levels represent different levels of arousal between subjects. In this contex one would expect the psychological reactions to any stimulus to be different. It is not always wise to "undo" such a relationship because it is at least probable that a given subject's sensitivity to a stimulus may be stronger or weaker, depending upon the subject's state of arousal.

The writer concludes that the proposals for the tentative standardization of skin conductance measures offered by Lykken and Venables represent one of the most enlightened analyses of these difficult issues yet published. In the present experiments, then, both raw and range corrected data will be analyzed.

In the present study, eight physiological dependent variables were analyzed separately. In addition, two physiological correlates and two psychological correlates were analyzed. The primary dependent measures consisted of two estimates of tonic skin conductance, four estimates of phasic skin conductance, and two estimates of the onset latency of SCR. In addition, two estimates of spontaneous skin conductance activity and the extraversion and neuroticism scores were correlated with the other dependent measures.

Tonic skin conductance (SCL) was defined as the average 4-second prestimulus skin conductance level. This is the procedure recommended by Edelberg (1972, pp. 395-396) and Lykken and Venables (1971) to define SCL. The 4-second mean was used because it represented a convenient horizontal division of the polygraph paper. Two prestimulus measures were taken, one at four seconds and one at two seconds prior to stimulus onset. The final SCL raw score that was used in the analysis was the average of the two above scores.

The reader will observe that the data base upon which the "averaging procedure" for the two SCL measures was performed is not given in the appendix for the raw physiological data (Appendix 10). What appears in Appendix 10 is the final score-mean for the two measures. Pilot work indicated that the "averaging procedure" could more effectively and conveniently be carried out directly on the polygraph paper. The pilot work indicated that in the majority of cases (trials) the tonic prestimulus level was represented on the polygraph paper by a straight line. Therefore, in these cases, the two measures taken at 4- and 2-prestimulus seconds were identical and no calculation was necessary. The averaging procedure was designed more specifically to estimate the tonic level for those trials when "anticipatory SCRs" were given just prior to stimulus onset. In the latter case, the scorer was instructed as follows: (1) Mark the polygraph

paper at 4- and 2-prestimulus seconds; (2) define a point halfway between the two marks which now differ also on the vertical axis; (3) using a ruler, draw in the "new mean tonic level" along the horizontal axis. This "new" mean tonic level was also used as the frame of reference to take the SCR measure. The writer argues that to show the data base upon which the final SCL measures were calculated would be redundant, and only increase the probability of coding and keypunching errors.

The skin conductance level was range corrected using the formula described above. Estimates of the maximum and minimum SCL were obtained by instructing the scorer to scan the entire polygraph record, including the later part of the record where the startle procedure was recorded. The highest mean 4-second SCL and the lowest mean 4-second SCL (defined as above) to appear on the record were defined as the SCL_{max} and SCL_{min}, respectively. The SCL_{max} and SCL_{min} scores for the subjects in experiments I and II are reported in Appendix 8.

The phasic skin conductance response (SCR) was defined as the first SC change, to peak, occurring from the moment of stimulus onset up to and including five post-stimulus seconds. Five seconds is the usual latency period within which a phasic score is allowed (Edelberg, 1972, p. 369). The SCRs were range corrected using the formula

described above for this purpose. An estimate of the maximum SCR was obtained by instructing the scorer to scan the entire record including the later part of the record where the startle procedure was recorded. The SCR_{max}, then, was defined as the largest SCR to occur on the record. The SCR_{max} scores for each subject are also reported in Appendix 8.

In addition to the two phasic measures, SCR and SCR-RAN, the latency criterion was extended to include the total interstimulus interval (TISI) up to six seconds prior to the next stimulus presentation. This was done to correspond to the Latency 2 (LAT_2) score which will be described below. The two dependent variables, SCR-TISI and SCR-TISI-RAN, were defined the same as the two phasic scores above, with the exception that the latency window was extended to include the total interstimulus interval.

The average latency of a first electrodermal response to peak is about 2.0 seconds, with a range of about 0.5-5.0 seconds (Edelberg, 1971, pp. 369-370). For habituation studies, the usual latency period within which an amplitude-change response is scored is about 5.0 seconds following stimulus onset (Eysenck, 1974; Geer, 1969; Ginsberg & Furedy, 1974; O'Gorman, 1970). There are, however, some exceptions to this general trend, e.g., Bernstein (1969), 1-3 seconds;

Hare (1973), Lykken, Macindoe and Tellegen (1972), 1-10 seconds.

The fact that a number of different latency criteria have been reported in the literature suggests that there is no hard and fast rule to apply which will enable an experimenter to distinguish between true or genuine responses and spurious or spontaneous responses. However, even if there were an absolute consensus in the experimental literature, the question of the optimum latency criterion for EDA would still be open to scientific investigation, as Ginsberg and Furedy (1974, p. 37) have recently pointed out.

A consideration of the nonspecific nature of electrodermal activity suggests that there may well be an optimum latency period beyond which stimulus-specific responses are unlikely to occur. Thus a response which occurs two seconds after stimulus onset very probably is a stimulus-specific response, but it less probably may be an artifactual response. While, on the other hand, a response which occurs at 30 poststimulus seconds very probably is a nonspecific response, but it less probably may still be a stimulus-specific response.

When a worker makes a decision about the latency period within which to allow an amplitude change score, he is in fact making a decision about the probability (of occurrence) of a real versus a chance event. Therefore,

the worker who chooses a relatively short latency period (0-5 seconds) implicitly makes the decision to maximize the probability of accepting only true responses, but he also minimizes the probability of accepting all the true responses. (That is, those true responses occurring outside the limited latency period are lost.) On the other hand, the worker who chooses a relatively long latency period (10 seconds or more), implicitly makes the decision to maximize the probability of accepting most or all of the true responses, but he also minimizes the probability of accepting only true responses. (That is, those spurious responses occurring within the extended latency period will be scored as true.)

In the former case the worker likely increases the proportion of true variance in the electrodermal scores, but he also likely loses some (true) data, while in the latter case, the worker likely increases the proportion of error variance in the ED scores, but he also much less likely loses true data.

It is clear, then, that any decision about the latency period within which to allow an electrodermal amplitude-change score has both advantages and disadvantages. Moreover, if this decision is to be made on rational grounds, it needs to be made within the context of the specific experiment. For example, the use of "strong" stimulus

conditions (e.g., electric shock) or some motor task requirement will tend to keep the latency of a response relatively short. The use of "weaker" stimulus conditions, as in a typical habituation experiment, will tend to maintain a relatively longer latency of response.

Sokolov (1963a, p. 118) has argued that the habituation process is not only characterized by a decrease in amplitude of response ("GSR") but also by a shift from a shorter to a longer latency of response. This suggests the presence of a negative correlation between the amplitude and latency of response. In support of this hypothesis, O'Gorman (1971) has reported high inverse correlations (r = -.65, -.73, $p < .01$) between the latency of response (GSR) to the initial stimulus and a trials-to-criterion estimate of habituation. These findings indicate that the usual 5-second latency criterion for the electrodermal response may be too short within the context of the habituation experiment. The latency of the EDR, as a separate dependent variable, has been investigated by a number of other workers.

Wolfensberger and O'Connor (1967) studied the effects of manipulating various stimulus conditions (intensity, duration, and repetition of light flashes) on the latency of the SRR with normal and retarded subjects. They concluded that their latency score was the least sensitive to both the stimulus and subject differences. Surwillo (1967)

studied the latency of the skin potential response in an experiment with two groups of subjects, one which had to discriminate between two tones, and another group which did not have to perform the discrimination task. He reported significantly shorter latencies for the condition where the subjects were required to pay close attention to the stimulus. More recently, Cowles (1973) investigated the latency of the SRR in a reaction time study. He found a significant negative correlation (-.44, $p \leq .01$) between the latency of SRR and a mean conductance change score. He suggested that the latency of the SRR may prove to be a reliable dependent measure, and it deserves further study.

In the studies cited immediately above there are two difficulties which limit the generalization of their findings to habituation studies. In the Wolfensberger and O'Connor and Cowles studies, a limited latency criterion of only five seconds was employed. That is, responses occurring outside the 5-second criterion were not scored. This, then, would only provide a limited test of the latency hypothesis. Secondly, in the Surwillo and Cowles studies, the perceptual task was combined with a motor task requirement (press a button). This would also tend to keep the latency of response short.

The writer concludes that further, more critical, studies are required to test the hypothesis that the onset latency of an electrodermal response may be a reliable physiological measure to index the habituation process.

In the present experiments, two latency measures were analyzed separately. The first latency measure (LAT_1) was defined as the onset latency of the first SCR to occur following stimulus on, up to and including five post-stimulus seconds. The second latency score (LAT_2) was defined as the onset latency of the first SCR to occur following stimulus on, up to and including the total interstimulus interval (TISI).

For the case when no SCR was recorded for either or both of the latency intervals, the maximum latency score for that interval was given. It was assumed, therefore, that a non-response (i.e., no SCR) indicated that the latency period (for that interval) was not sufficient. The closest approximation of the "true" latency score, then, was the maximum allowed for that interval. It was further assumed that the "true" latency of all responses, for all intervals, was some finite number of seconds, and that if the interstimulus intervals had been extended (some finite number of seconds), a SCR would eventually have occurred.

A number of different methods for estimating spontaneous EDA have been reported. Some workers have taken the measures during the resting prestimulation period (O'Gorman, 1972), some during the stimulation period (Fisher & Kotses, 1973), and finally, some during both the resting and stimulation periods (Coles, Gale & Kline, 1971).

Edelberg (1972, p. 395) has suggested that, when using a constant voltage system (direct measurement of skin conductance), a constant criterion can be used to estimate the spontaneous SCR activity. In the present study, a spontaneous SCR was defined as a SCR of at least 0.2 micromhos, corresponding to the smallest vertical division of the polygraph paper. Two separate estimates of spontaneous SC activity were obtained in the present study.

The first measure ($Spont_1$) was defined as the total number of SCRs of at least 0.2 micromhos, recorded during the middle 5-minute period of the resting phase. The second measure ($Spont_2$) was defined as the total number of SCRs of at least 0.2 micromhos, recorded during the 30 interstimulus intervals, starting with the second response to occur during each interstimulus interval. For the purposes of the $Spont_2$ measure, then, the first SCR was assumed to be stimulus specific.

Table 3 gives a summary of the primary dependent measures and their correlates, which were analyzed in experiments I and II.

Before any of the polygraph records were scored, all the records from experiments I and II were numbered 1-48, and 49-96, respectively, in a random order by a member of the technical staff. The (real) subject numbers and the scoring code numbers for experiments I and II are given in Appendix 9.

Table 3

The Skin Conductance (Dependent) Measures and Their Correlates in Habituation Experiments I and II

Dependent Measure	Definition of the Dependent Measure
1. LAT_1	The onset latency of the first SCR following stimulus onset, up to and including five post-stimulus seconds.
2. LAT_2	The onset latency of the first SCR following stimulus onset, up to and including the total interstimulus interval.
3. SCL	The average 4-second prestimulus skin conductance level (tonic SC, the mean of two scores)
4. SCR	The first SCR change to peak occurring from the moment of stimulus onset up to five post-stimulus seconds (phasic SC)
5. SCR-TISI	The first SCR change to peak occurring from the moment of stimulus onset up to and including the total interstimulus interval.
6. SCL-RAN	The SCL range corrected and expressed as a proportion of the subject's tonic range. $\text{SCL-RAN} = \frac{SCL_{ix} - SCL_{min}}{SCL_{max} - SCL_{min}}$
7. SCR-RAN	The SCR range corrected and expressed as proportion of each subject's phasic range. $\text{SCR-RAN} = \frac{SCR_{ix}}{SCR_{max}}$
8. SCR-TISI-RAN	The SCR-TISI range corrected and expressed as a proportion of each subject's phasic range.

Table 3 (Cont'd.)

Dependent Measure	Definition of the Dependent Measure
9. $Spont_1$*	The total number of SCRs, of at least 0.2 micromhos, recorded during the middle 5-minute period of the resting (pre-habituation) phase.
10. $Spont_2$*	The total number of SCRs, of at least 0.2 micromhos, recorded during the 30 inter-stimulus intervals, starting with the second response to occur during each interstimulus interval.
11. E (A+B)*	The Eysenckian personality measure, extraversion forms A and B combined (raw scores).
12. N (A+B)*	The Eysenckian personality measure, neuroticism forms A and B combined (raw scores).

* Correlates of the primary dependent measures.

The polygraph records were scored blindly by a person contracted for this purpose, and the scoring code was never revealed to her.

The scorer was trained by the experimenter to score the polygraph records for all the physiological variables as operationally defined in Table 3. All the phasic and tonic scores were converted to specific skin surface prior to the range correction procedures.[16] Each phasic and tonic measure was then range corrected with the assistance of a Monroe electronic programmable calculator, Model 1785 (The Litton Business Systems Inc., Orange, New Jersey). After these two procedures were completed, all variables were coded on IBM coding sheets and keypunched. Finally, an "Exec Print" was done on the data sets from both experiments, and the variables were checked and double-checked against the coding sheets to eliminate any keypunching errors prior to the statistical analyses. Finally, the preliminary descriptive statistical analysis allowed the experimenter to locate any remaining errors which were corrected prior to the final series of analyses.

---

16 The specific skin conductance (cm^2 of skin surface) is equal to the measured skin conductance divided by 1/2 the area of one electrode (Lykken & Venables, 1971, p. 665). In the present study this is equal to 0.7855 X 1/2 = 0.39275. Thus each score was divided by 0.39275 to give the SC in cm^2 of skin surface.

The raw data for the physiological variables and their correlates in experiments I and II are presented in Appendix 10. The physiological raw data were photocopied directly from the computer printout and are presented with the necessary identification code.

F. Statistical Procedures for the Skin Conductance (Dependent) Measures

The results of the correlational analyses carried out on the linguistic measures indicated that at least two psychophysiological experiments would be required to test the major hypotheses of interest to the present study. The analysis suggested that it would be most appropriate to manipulate denotative and connotative linguistic meaning in one experimental design, and word concreteness and connotative linguistic meaning in a second experiment. The minimum requirements for a factorial analysis of variance design (ANOVA), then, would be to have at least two levels for each factor (high and low) for both experiments. This would result in a 2 X 2 random factorial ANOVA design with two main effects (A, B) and one two-way interaction (A X B).

It was, however, decided in Chapter I that a multiple-measure index of the habituation process would be the preferred method to define habituation in the present experiments. Thus a trial blocks analysis of the various skin conductance

measures was selected. In the present experiments, 30 habituation trials were given to each subject and it was decided that three trial blocks of 10 trials each would be optimum for the present experiments. (The reasons for the choice of three TBs rather than 2, 6, or 5 TBs will be given in a paragraph below.)

The 2 X 2 ANOVA design would then become a 2 X 2 X 3 design with repeated measures on the third factor. The repeated measures factorial design is by far the most common design employed in habituation studies, and one of the most common designs used for all psychophysiological experiments. It is, however, very questionable whether a univariate model is the appropriate statistic to analyze the repeated measures design because a highly restrictive compound symmetry assumption is required. Compound symmetry assumes that the variance-covariance matrices are equal and symmetrical. This is a most improbable assumption, particularly within the context of an habituation study.

Kirk (1968, Chap. 8) provides an extensive discussion of this design which he terms a split-plot factorial, repeated measures design (SPF-p.q.). Following on the earlier work of Box (1953, 1954) and Geisser and Greenhouse (1958), Kirk (1968, p. 262) suggests that when there is reason to question the compound symmetry assumption, an approximate conservative $\underline{F}$ test can be done. The conservative $\underline{F}$ test is

similar to the conventional F test with the exception that reduced degrees of freedom are used. It is also recommended that the conventional F test be done because the conservative test is negatively biased. The problem arises when the conventional F test is significant, and the conservative test is not significant. In this case, a more exact (multivariate) test is required.

Most recently Timm (1975, pp. 237, 453), drawing on the work of Bock (1963), Koch (1969), and Huynh and Feldt (1970), has argued that it is more appropriate to analyze split-plot repeated measures data by multivariate methods, firstly because the analysis is valid whether the compound-symmetry assumption is satisfied or not, and secondly because the multivariate solution provides a more natural and precise definition of the repeated measures problem. Thus the univariate repeated measures problem is redefined as a multivariate problem (with more than one dependent measure), and hence a multivariate solution is required.

The experimental designs utilized in the present habituation studies, therefore, were conceptualized as 2 X 2 multivariate analyses (MANOVA) with three dependent measures, TB_1, TB_2, and TB_3 (p=3).

There are a number of well established test criteria which can be applied to a multivariate analysis, as follows: Wilks' Λ (1932) or maximum likelihood criterion; Roy's θ_s (1957),

or largest root criterion, and the two trace criteria; Lawley (1938)-Hotelling's (1951) $U^{(s)}$ statistic; and Pillai's (1960) $V^{(s)}$ statistic. Timm (1975, pp. 141-149, 372) provides an excellent discussion of the mathematical derivation of these test criteria and points out that all are characteristic functions of the successive roots $(\lambda_1, \lambda_2 \ldots . \lambda_s)$ of the basic determinental equation:

$$\left| Q_h - \lambda Q_e \right| = 0$$

where Q_h and Q_e are independent matrices for the hypothesis and error vector terms, respectively.

Timm (1975, p. 149) also indicates that little is known about the relative or comparative power of the various multivariate criteria, although some important work has been reported, hence the reason for employing more than one criterion to test each multivariate hypothesis.

In order to find the critical values needed to evaluate the significance of the various multivariate test results, it is first necessary to establish the parameters for the multivariate criteria. This is analogous to finding the degrees of freedom in a univariate ANOVA. Timm (1975, pp. 147, 406) gives the formulae required to find the parameters for the four tests which, when applied to the present experiments, are as follows:

Wilks' Λ (p, v_h, v_e) (p=3, DF 1,44)

where: p = number of dependent variables (3)

v_h = DF for hypothesis (1)

v_e = DF for error

= N-k (44)

s, m, n are the parameters needed for Roy's, Lawley-Hotelling's, and Pillai's multivariate tests.

$$s = \text{MIN}\ (v_h,\ p) = \text{MIN}\ (1,3) = 1$$

$$m = \frac{|v_h - p| - 1}{2} = \frac{|1-3|-1}{2} = \frac{|-2|-1}{2} = 1/2 = 0.5$$

$$n = \frac{v_e - p - 1}{2} = \frac{N-k-p-1}{2} = \frac{48-4-3-1}{2} = \frac{40}{2} = 20$$

The parameters for the multivariate criteria for the present habituation experiments, then are Λ(p=3, DF 1,44) and θ_s, $U^{(s)}$, and $V^{(s)}$ are s=1, m=0.5, n=20. The percentage points for the U distribution which is used to evaluate the significance of the Λ criterion is given in Wall's (1968) tables. The critical value for p=3, DF 1,44 from the tables is .840. Thus, if the obtained values are .840 or less, the multivariate hypothesis can be rejected on the basis of the Λ criterion (α=.05 level of confidence).

Heck's (1960) charts which give the upper percentage points for the distribution of the largest root criterion are used to evaluate Roy's test. However, as Timm (1975, p. 168)

indicates, Heck's charts do not exist for s=1. He suggests instead that the tables for the U distribution be used and θ becomes:

$$\theta = 1 - U^{.05} \quad (p=3, \text{ DF } 1,44)$$

$$\theta = 1 - .840$$

$$\theta = .160$$

If the obtained value for θ is .160 or greater, the multivariate hypothesis can be rejected on the basis of the Roy criterion (α=.05 level of confidence).

Pillai (1960) has constructed tables for the upper percentage points for the distribution of the Lawley-Hotelling trace criterion, but Pillai's tables do not exist for s=1. However, because of the relationship between Hotelling's generalized T^2 and the $U^{(s)}$ statistics, ($U^{(s)} = \frac{T^2}{N-1}$), Timm (1975, pp. 168, 372) indicates that the critical value for $U^{(s)}$ (s=1) can be determined by substituting the T^2 value from the tables constructed for the T^2 distribution (Jensen & Howe, 1968) into the equation and solving for $U^{(s)}$ as follows:

$$U^{(s)} = \frac{T^2}{N-1}$$

where T_o^2 (p, N-1) = 8.80 (3,47)

$$U^{(s)} = \frac{8.80}{48-1}$$

$$U^{(s)} = \frac{8.80}{47}$$

$$U^{(s)} = .187.$$

Therefore, the critical value for $U^{(s)}$ in the present experiments is .187 or greater (α=.05).

Finally, Pillai (1960) has also constructed tables which give the upper percentage points for the $V^{(s)}$ statistic. However, once again, his tables do not exist for s=1. When s=1, the values for Pillai's and Roy's criteria are identical (Timm, 1975, pp. 149, 164, 372). Therefore, the critical value for Pillai's trace criterion for the present experiments is $V^{(s)}$ = .160 (>, s=1, α=.05)

A summary of the critical values and the parameters necessary for the four multivariate test criteria (Λ, θ_s, $U^{(s)}$, $V^{(s)}$) for the multivariate hypotheses (H_A, H_B, H_{AB}) are given in Appendix 11. A multivariate hypothesis will be rejected when one or more of the multivariate tests are significant at the α=.05 level of confidence. Before describing the post hoc procedures to be utilized with the multivariate analyses in the present experiments, something needs to be said (briefly) about the assumptions required for the MANOVA statistic.

The multivariate normal distribution (m.n.d.) is the primary assumption necessary for multivariate analyses.[17] Cooley and Lohnes (1971) provide a very brief but adequate

---

17 The assumptions of homogeneity of variance and covariance are also required for the MANOVA model (Van Egeren, 1973).

introduction to multivariate distribution theory. They point out that there are many ways in which the m. n. d. assumption can be violated. However, they have argued that individual researchers need not be too concerned with the m. n. d. assumption, because the multivariate models are interpreted as heuristic rather than inferential. They, therefore, place a great deal of emphasis on the replication of the multivariate experiment.

Timm (1975, pp. 259-260) discusses, in passing, the use of gamma-plotting techniques to investigate the multivariate normality assumption. He does, however, imply that the routine use of gamma-plotting techniques to investigate the m. n. d. assumption is not appropriate at this time. Secondly, as Cooley and Lohnes (1971) point out, the use of plotting techniques and normalizing transformations performed on the marginal distributions does not guarantee a multivariate normal distribution. The reason for this is that the conditional and component distributions may also not be normal, both of which are required derivatives from a parent m. n. d. The problem of the relative robustness and power of the multivariate test criteria, then, becomes most important. Work has only begun in this difficult and complex area.

Olson (1974) has made a recent and very important contribution. Using a "Monte Carlo" experimental strategy

he investigated the effects of violating the multivariate normality and homogeneity of covariance assumptions on the behavior of six multivariate tests (Wilks', Roy's, Lawley-Hotelling's, and the Pillai criteria were included) for the one-way fixed-effects MANOVA model. In his computer-simulated experiments he manipulated 10 factors (number of dependent variable observations (p), number of groups (k), group size (n), concentration of the contamination, degree of contamination, form of the violation, etc.). In general, he found that kurtosis had a much less significant effect on the MANOVA tests than heterogeneity of the covariance matrices. He also found that increasing the number of dependent variables in the design decreased the robustness of the tests. He suggests that the value for p be kept relatively small because this will increase the robustness of the tests, and make interpretation easier. Finally, his results indicate that the Pillai trace criterion (V) is the most robust of the MANOVA tests within the limitations of his study:

> For general protection against departures from normality and from homogeneity of covariance matrices in the fixed-effects model, the V test is recommended as the most robust of the MANOVA tests, with adequate power against a variety of alternatives (p. 907).

In the present habituation experiments, therefore, it was decided to use three TBs rather than five or six in order to increase the robustness of the multivariate tests.

When a multivariate hypothesis of equal treatment effects is rejected for one or more of the multivariate tests, the simultaneous confidence intervals for the analysis of the simple contrasts, and a generalized discriminant function analysis can be employed as post hoc procedures to give the researcher further insight into the relative contribution of the dependent variables to the rejection of the hypothesis. Roy and Bose (1953) have generalized the Scheffé's (1953) method to the multivariate case. Timm (1975, p. 406) gives the formula used to estimate the confidence intervals for the simple contrasts as follows:

> The estimate of the contrast ± (critical constant X the standard error of the contrast)
>
> where the critical constant (c_o) for the Roy procedure is

$$c_o = \left[\left(V_e \quad \frac{\theta}{1-\theta}\right)\right]^{\frac{1}{2}}$$

For the present analyses, the critical constant for the contrasts (Roy's criterion) becomes:

$$c_o = \sqrt{44 \quad \frac{.160}{1-.160}}$$

$$c_o = \sqrt{44 \text{ X } .190}$$

$$c_o = \sqrt{8.38}$$

$$c_o = 2.89$$

When an interval does not contain a zero, it can be concluded that the specific contrast for the dependent variables is significant for that particular treatment effect (i.e., the main effects or interaction in a two-way layout). However, as Timm (1975, p. 373) indicates, the Roy criterion is extremely conservative for the analysis of simple contrasts when the researcher is primarily concerned with the comparisons within the dependent measures, between the treatment groups. Furthermore, it is possible to have all the multivariate criteria significant for a particular MANOVA hypothesis and to find none of the simple contrasts singificant. For the purposes of the present MANOVA analyses, it was decided that if a confidence interval for the simple contrasts crossed over the zero for up to .04, it would be rounded off to 0.00, and therefore be interpreted as significant for that particular contrast. In spite of this minor "extension" of the confidence bounds, the very high degree of conservatism attributed to the simple contrasts for Roy's criterion remains.

Porebski (1966) and Bargmann (1970) have suggested an examination of the correlations between the discriminant function and each dependent measure in order to determine the relative contribution of each variable to the rejection of the multivariate hypothesis. Timm (1975, p. 374) suggests that the discriminant function analysis can be used in

conjunction with the Roy-Bose procedure to determine the linear combination of variables most sensitive to deviations from the multivariate hypothesis. First, the generalized discriminant function analysis (GDFA) is done, employing Bartlett's (1951) test to assess the significance of the discriminant functions. Then, the variance-covariance matrix is transformed to a correlation matrix, yielding the correlations between the discriminant functions and each dependent measure (Timm, 1975, p. 415).

The multivariate analyses were carried out employing the FRMLM (Full Rank Multivariate Linear Model) computer program (Carlson & Timm, 1974). This program yields the values for the four multivariate tests (Λ, θ_s, $U^{(s)}$, $V^{(s)}$, and the necessary supporting statistics to obtain the confidence intervals for the simple contrasts (estimate of the contrasts, and the standard errors of contrasts) for each hypothesis specified. It also gives the results of a generalized discriminant function analysis and the correlations between the discriminant function and each dependent measure, for each multivariate hypothesis.

The descriptive statistics for the dependent measures for each of the three trial blocks separately were obtained (experiments I and II combined). The mean, mode, median, standard deviation, range, and estimates of kurtosis and skewness were obtained for the physiological measures and

their correlates. The significance level of the kurtosis and skewness values was estimated employing the critical ratio tests of significance for kurtosis (CR_{ku}) and skewness (CR_{sk}) suggested by Dayhaw (1966, pp. 335-336).

The relationships between the various dependent measures and, in particular, the relationships between the extraversion and neuroticism variables and the physiological measures were investigated by a series of correlational analyses. Separate intercorrelation matrices (12 X 12) were obtained for the dependent measures for each of the three trial blocks (experiments I and II combined, $\underline{N}$=96). Both the Pearson $\underline{r}$ and the Kendall tau coefficients were obtained for each of the three trial blocks.

The reason for reporting both the $\underline{r}$ and tau coefficients is that, particularly for the later trial blocks (TB_2, TB_3), the distributions of some of the physiological measures departed from normality. This, of course, is quite predictable, especially for the phasic-change scores in an habituation study. The writer adopts the position that the Pearson $\underline{r}$ is always the preferred coefficient because it is the coefficient most often reported in the literature. Thus, if a researcher wishes to compare his results with the results of other workers, the $\underline{r}$ coefficient is preferred.

Furthermore, as Snedecor and Cochran (1971, p. 193) point out for the case of the bivariate correlation (x, y),

if one of the variables is distributed normally the r coefficient can still be used. Guilford (1965) takes the argument further and suggests that even if an examination of the scattergram indicates a minor deviation from linearity, one may still assume an approximation of linearity. Guilford concludes on the subject:

> There is nothing in what has been said to demand that the Pearson r be computed only with normal distributions. The forms of distributions may vary, so long as they are fairly symmetrical and unimodal; even rectangular ones will do (p. 108).

At any rate, for the purposes of the present correlational analysis, whenever the linearity assumption is seriously in question, the results of both correlation analyses (r, tau) can be compared. The reader will observe in Chapters III and IV that in the vast majority of cases, the interpretations and conclusions inferred from the correlations will be the same for both coefficients.

Finally, in order to further investigate the relationships between the E and N variables (as a set) and selected sets of physiological variables, two canonical correlation analyses were carried out and reported. Canonical correlation analysis can be used to test the degree of independence (or association) between two sets of variables (Timm, 1975, p. 348). In the first canonical correlation analysis, the E and N variables make up the first set, and the three variables, $SCL\text{-}TB_1$, $SCL\text{-}TB_2$, $SCL\text{-}TB_3$, make up the

second set. In the second canonical analysis, the E and N variables make up the first set and the $Spont_1$ and $Spont_2$ measures make up the second set. The reasons for the selection of these sets of variables for the canonical correlational analysis are given in Chapter IV, after the univariate correlations are (reported and examined) discussed.

The descriptive statistics, the r and tau correlation coefficients, and the canonical correlation analyses were carried out employing standard SPSS computer subprograms.

3. The Statistical Null Hypotheses.

The five null hypotheses advanced in Chapter I will now be restated in statistical and operational terms. That is, the hypotheses brought forth in Chapter I will be conceptualized either in terms of a multivariate or univariate statistical model, and stated in terms of the eight dependent measures, or their correlates (LAT_1, LAT_2, SCL, SCR, SCR-TISI, SCL-RAN, SCR-RAN, SCR-TISI-RAN, $Spont_1$, $Spont_2$, E, and N) as operationally defined in Table 2 above.

A. The Multivariate (MANOVA) Null Hypotheses

1.1 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_1), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.2 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_2), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.3 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance level (SCL), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.4 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response (SCR), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.5 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval (SCR-TISI), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.6 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance level-range corrected (SCL-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.7 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-range corrected (SCR-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

1.8 There is no difference between high and low denotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval-range corrected (SCR-TISI-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.1 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_1), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.2 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_2), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.3 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance level (SCL), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.4 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response (SCR), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.5 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval (SCR-TISI), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.6 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance level-range corrected (SCL-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.7 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-range corrected (SCR-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

2.8 There is no difference between high and low connotative linguistic meaningful stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval-range corrected (SCR-TISI-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.1 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_1), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.2 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, latency of SCR (LAT_2), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.3 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance level (SCL), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.4 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance response (SCR), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.5 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval (SCR-TISI), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.6 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance level-range corrected (SCL-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.7 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance response-range corrected (SCR-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

3.8 There is no difference between high and low concrete linguistic stimuli in the mean skin conductance habituation measures, skin conductance response-total interstimulus interval-range corrected (SCR-TISI-RAN), for a composite of three trial blocks (TB_1, TB_2, TB_3).

B. The Correlational (Univariate) Hypotheses

4.1 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, latency of SCR (LAT_1).

4.2 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, latency of SCR (LAT_2).

4.3 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance level (SCL).

4.4 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance response (SCR).

4.5 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance response-total interstimulus interval (SCR-TISI).

4.6 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance level-range corrected (SCL-RAN).

4.7 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance response-range corrected (SCR-RAN).

4.8 There is no inverse (negative) correlation between the extraversion personality variable and the skin conductance habituation measure, skin conductance response-total interstimulus interval-range corrected (SCR-TISI-RAN).

4.9 There is no inverse (negative) correlation between the extraversion personality variable and an estimate of spontaneous skin conductance activity ($Spont_1$).

4.10 There is no inverse (negative) correlation between the extraversion personality variable and an estimate of spontaneous skin conductance activity ($Spont_2$).

5.1 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, latency of SCR (LAT_1).

5.2 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, latency of SCR (LAT_2).

5.3 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance level (SCL).

5.4 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance response (SCR).

5.5 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance response-total interstimulus interval (SCR-TISI).

5.6 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance level-range corrected (SCL-RAN).

5.7 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance response-range corrected (SCR-RAN).

5.8 There is no correlation between the neuroticism personality variable and the skin conductance habituation measure, skin conductance response-total interstimulus interval-range corrected (SCR-TISI-RAN).

5.9 There is no correlation between the neuroticism personality variable and an estimate of spontaneous skin conductance activity ($Spont_1$).

5.10 There is no correlation between the neuroticism personality variable and an estimate of spontaneous skin conductance activity ($Spont_2$).

The results of the statistical analyses carried out on the independent and dependent measures of the study are reported in Chapter III.

CHAPTER III

REPORT OF RESULTS

This chapter is divided into three sections. Section 1 gives the results of the statistical analyses obtained on the linguistic measures, and the procedures used to select the independent measures (word stimuli) of the study. Section 2 reports the results of the statistical analyses obtained for the skin conductance measures in habituation experiments I and II. In section 3 the statistical null hypotheses stated in the final section of Chapter II are evaluated.

1. The Selection of the Independent Measures of the Study

This section of Chapter III presents the results of the statistical analyses carried out on the linguistic measures. It reports the descriptive statistics for the linguistic measures obtained on the word stimuli, the intercorrelations between the linguistic measures, and estimates of the between groups reliability for the measures. Finally, the procedures used to select the word stimuli for the two habituation experiments are described.

A. The Linguistic Measures of the Study

The overall descriptive statistics for the six linguistic measures, m, I, Den (Denotative linguistic meaning, m+I scores), Conn (connotative linguistic meaning, SD scores), f, and A-C, for the word stimuli are given in Table 4. Three measures of central tendency (mean, mode, median), two measures of dispersion (standard deviation and range), as well as estimates of kurtosis and skewness are reported.

B. The Intercorrelations Between the Linguistic Measures

The intercorrelation matrices for the six linguistic measures (overall for the 60 words) for subsamples I and II, and subsamples I and II combined are presented in Table 5.

A consideration of the correlations in Table 5 indicates a low but significant correlation between indices of denotative and connotative linguistic meaning ($r = .30$, $p < .01$). This suggests that it would be possible to systematically manipulate levels of denotative and connotative meaning in the same experiment. Denotative meaning correlates highly and significantly with both familiarity ($r = .68$, $p < .001$), and word concreteness ($r = .60$, $p < .001$). These correlations argue against the systematic manipulation of either familiarity or word concreteness with denotative meaning in the same experiment.

Table 4

The Descriptive Statistics for the Six Linguistic Measures in Subsamples I and II Combined (N=104)

Linguistic Measures	Mean	Mode	Median	SD	Range	Kurtosis[a]	Skewness[b]
m	6.49	5.0	6.17	4.02	0-24	-0.56	0.33
I	4.81	7.0	5.67	2.34	1-7	-1.31**	-0.54
Den	11.30	14.0	11.59	5.74	1-31	-0.87	-0.04
Conn	12.30	0.0	11.46	7.75	0-30	-0.66	0.38
f	3.61	5.0	3.86	1.30	1-5	-0.57	-0.69**
A-C	4.37	7.0	4.58	2.41	1-7	-1.58**	-0.20

[a]Kurtosis values significant at the .01 level of confidence (**), if >1.3, N=104.

[b]Skewness values significant at the .01 level of confidence (**), if >.61, N=104.

Table 5

Intercorrelation Matrices for the Six Linguistic Measures in Subsamples I (n=52) and II (n=52) and Subsamples I and II Combined (N=104)

		Variables[a]					
		1	2	3	4	5	6
Subsamples I and II	1	1.00					
	2	.60*	1.00				
	3	.95*	.83*	1.00			
	4	.29*	.23*	.30*	1.00		
	5	.63*	.59*	.68*	.28*	1.00	
	6	.51*	.59*	.60*	.06	.42*	1.00
Subsample II	1	1.00					
	2	.60*	1.00				
	3	.94*	.83*	1.00			
	4	.28*	.21*	.28*	1.00		
	5	.63*	.59*	.68*	.28*	1.00	
	6	.53*	.61*	.62*	.04	.42*	1.00
Subsample I	1	1.00					
	2	.61*	1.00				
	3	.95*	.83*	1.00			
	4	.29*	.25*	.31*	1.00		
	5	.64*	.59*	.69*	.29*	1.00	
	6	.50*	.58*	.58*	.08	.42*	1.00

[a]Variables:
1 = m
2 = I
3 = Den
4 = Conn
5 = f
6 = A-C

*r = .19, p <.05, N=100

While, on the other hand, the nonsignificant correlation between word concreteness and connotative meaning (r = .06) and the significant and moderate correlation between word concreteness and familiarity (r = .42, p <.001) suggests that it would be possible to systematically manipulate levels of word concreteness and connotative linguistic meaning in the same experiment.

An examination of the intercorrelations between the linguistic measures, then, indicated that a minimum of two habituation experiments would be necessary in order to provide an empirical test of the hypotheses generated in Chapter I. In the first experiment two levels of denotative and connotative linguistic meaning will be systematically manipulated. A second experiment will manipulate two levels of word concreteness and connotative linguistic meaning. A further discussion of the linguistic measures and their interrelationships will be provided in the appropriate section of Chapter IV.

C. The Reliability of the Linguistic Measures

A comparison of the overall means and standard deviations for the six linguistic measures between subsamples I and II are presented in Table 6. A comparison of the means and standard deviations for the list of 60 two-syllable words for the six linguistic measures

Table 6

A Comparison of the Means ($\bar{X}_1$, $\bar{X}_2$) and Standard Deviations (SD_1, SD_2) for the Six Linguistic Measures in Subsample I and Subsample II (N=3120)

Linguistic Measure	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
m	6.66	6.31	4.11	3.91
I	4.97	4.67	2.33	2.34
Den	11.62	10.97	5.82	5.64
Conn	12.49	12.10	7.85	7.65
f	3.68	3.54	1.29	1.31
A-C	4.41	4.32	2.43	2.38

m, I, Den, Conn, f, and A-C, are presented in Appendices 12, 13, 14, 15, 16, and 17, respectively.

The between group reliability coefficients for the mean values, for subsamples I(x) and II(y) for the six linguistic measures are as follows: (1) m, r = .995; (2) I, r = .985; (3) Den, r = .997; (4) Conn, r = .971; (5) f, r = .992; (6) A-C, r = .992. (N = 60, all significant at the p <.001 level of confidence.)

D. The Selection of the Word Stimuli for Habituation Experiments I and II

The 60 word stimuli were arranged in rank order of decreasing mean scores for denotative linguistic meaning, connotative linguistic meaning, and word concreteness (subsamples I and II combined). A four-way split of the distributions of scores for the three linguistic measures was then carried out, yielding 15 words per fourth (25%) or 30 words per half (50%). The words in the upper half were designated "high" and the words in the lower half were designated "low" for the three linguistic measures and are reported in Tables 7, 8, and 9, respectively.

The 2 X 2 factorial manipulation for experiment I gave the following four cells for high and low denotative, and high and low connotative linguistic meaning: high denotative-high connotative (HDen HConn), low denotative-

high connotative (LDen HConn), high denotative-low connotative (HDen LConn), and low denotative-low connotative (LDen LConn). In a similar manner, the 2 X 2 factorial manipulation for experiment II gave the following four cells for high and low word concreteness, and high and low connotative linguistic meaning: high concreteness-high connotative (HA-C HConn), low concreteness-high connotative (LA-C HConn), high concreteness-low connotative (HA-C LConn), and low concreteness-low connotative (LA-C LConn).

It was decided that wherever possible the words for each cell would be selected from the upper and lower fourths (25%) for the two measures in each experiment. For the cases where this was not possible, the words were selected from the upper and lower halves (50%) for the two measures in each experiment. Thus, in order to maximize the possibility of finding differences, which is the raison d'être for the extreme groups design (Myers, 1966), the words were systematically selected as high or low as possible for the two measures in each experiment.

Secondly, in order to minimize the possibility of experimenter bias in the selection of the final two words for each cell, it was decided that a partial randomization procedure would also be employed. The systematic selection of the words (high or low) for the two measures in each experiment indicated that eight words could be readily

selected, on statistical grounds, for each cell. When this had been accomplished, the eight words for each cell were written on small squares of paper and placed in a box which was vigorously shaken. The first two words drawn out were the final two words selected for each cell. This procedure was carried out separately for the words in each cell for the two experiments.

Tables 7 and 8 were used to select the words for experiment I, and Tables 9 and 8 were used to select the words for experiment II. The final eight words were selected first for experiment I (2 words X 4 cells), and then eliminated from the word list, so that the same words would not also be selected for experiment II.

The 32 words (8 words X 4 cells) selected for experiments I and II, along with the appropriate cell identifications are presented in Tables 10 and 11, respectively. A summary of the experimental designs and the final two words selected for each of the four cells in habituation experiments I and II is given in Table 12.

Finally, the 60-word stimuli arranged in rank order of decreasing mean scores for the m, I, and f measures are given in Appendices 18, 19, and 20, respectively.

Table 7

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Denotative Linguistic Meaning (Mean) Scores (m+I scores) for Subsamples I and II Combined (N=104)

Word Number	Rank	Word	$\bar{X}$	SD
60	60	WATER	19.82	2.78
6	59	BABY	18.88	2.92
49	58	RIVER	18.63	2.89
42	57	PAPER	18.14	2.83
47	56	PRISON	17.80	2.90
56	55	TABLE	17.38	2.96
44	54	PENCIL	17.22	3.23
53	53	SUNBURN	17.14	2.64
39	52	OFFICE	16.91	2.67
12	51	COTTON	16.90	2.82
50	50	SALOON	16.73	3.04
31	49	MARKET	16.46	2.87
7	48	BLISTER	16.24	2.29
22	47	FABRIC	16.21	2.54
28	46	IRON	16.20	3.09
35	45	METAL	15.73	3.28
17	44	DEVIL	15.43	2.71
13	43	CRADLE	15.37	2.69
18	42	DIVORCE	14.55	3.16
37	41	NUMBER	14.38	3.23
46	40	PERSON	14.36	3.10
14	39	DANGER	13.53	3.43
41	38	PANIC	13.46	3.21
9	37	BOSOM	13.32	3.44
43	36	PASSION	12.92	3.47
3	35	ANGER	12.90	3.29
8	34	BODICE	12.71	3.91
54	33	SURFACE	12.69	2.54
57	32	TEMPER	12.63	2.89
38	31	OBJECT	12.38	3.24

Table 7 (Cont'd.)

Word Number	Rank	Word	$\bar{X}$	SD
19	30	DUMMY	11.93	2.58
2	29	AMOUR	11.35	4.58
34	28	MERCY	10.47	3.48
58	27	TROUBLE	10.43	3.01
33	26	MATTER	10.00	3.52
52	25	SEQUENCE	9.51	2.46
21	24	EVENT	9.37	2.53
48	23	QUOTA	8.61	2.81
40	22	OUTCOME	8.56	3.20
4	21	ARRAY	8.38	3.17
32	20	MATRIX	8.17	2.86
16	19	DECEIT	7.98	2.90
36	18	NONSENSE	7.49	3.08
59	17	VIRTUE	7.26	2.45
55	16	SURTAX	7.25	2.88
27	15	GARRET	7.22	4.54
30	14	MALICE	6.99	2.86
45	13	PERCEPT	6.97	3.26
11	12	CONCEPT	6.59	2.37
20	11	ESSENCE	6.58	2.61
24	10	FOLLY	6.38	2.83
25	9	GADFLY	5.74	3.67
51	8	SAVANT	4.71	3.32
29	7	MAELSTROM	3.97	3.54
1	6	ADAGE	3.75	3.25
26	5	GAMIN	3.48	3.02
23	4	FOIBLE	3.45	1.98
15	3	DAVIT	2.75	2.13
5	2	ATTAR	2.70	1.79
10	1	CAROM	2.66	2.29

Table 8

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Connotative Linguistic Meaning (Mean) Scores (SD Scores) for Subsamples I and II Combined (N=104)

Word Number	Rank	Word	$\bar{X}$	SD
2	60	AMOUR	22.65	6.66
16	59	DECEIT	22.13	6.41
6	58	BABY	21.99	5.62
17	57	DEVIL	21.38	6.03
30	56	MALICE	19.85	6.82
59	55	VIRTUE	19.43	7.55
43	54	PASSION	18.44	7.76
47	53	PRISON	18.41	6.15
34	52	MERCY	18.27	7.30
13	51	CRADLE	18.03	6.33
60	50	WATER	17.20	6.32
49	49	RIVER	16.85	5.79
46	48	PERSON	16.53	9.93
58	47	TROUBLE	16.50	6.09
7	46	BLISTER	15.95	5.99
18	45	DIVORCE	15.38	6.43
14	44	DANGER	15.02	5.98
3	43	ANGER	14.83	6.03
31	42	MARKET	14.53	6.22
12	41	COTTON	14.46	4.95
57	40	TEMPER	14.44	6.66
41	39	PANIC	13.90	5.49
9	38	BOSOM	13.69	7.10
22	37	FABRIC	13.41	5.80
53	36	SUNBURN	13.04	6.11
39	35	OFFICE	12.18	5.89
20	34	ESSENCE	12.08	7.53
21	33	EVENT	12.05	8.02
11	32	CONCEPT	11.33	7.56
4	31	ARRAY	11.20	7.41

Table 8 (Cont'd.)

Word Number	Rank	Word	$\bar{X}$	SD
24	30	FOLLY	10.99	6.08
56	29	TABLE	10.60	5.31
40	28	OUTCOME	10.37	7.73
35	27	METAL	10.25	4.66
42	26	PAPER	10.13	4.44
50	25	SALOON	9.81	4.91
8	24	BODICE	9.59	6.22
28	23	IRON	9.54	4.40
45	22	PERCEPT	9.38	6.26
37	21	NUMBER	9.29	5.91
19	20	DUMMY	9.18	4.98
55	19	SURTAX	9.10	5.31
36	18	NONSENSE	8.64	5.15
51	17	SAVANT	8.59	6.52
44	16	PENCIL	8.57	4.07
52	15	SEQUENCE	8.52	5.12
54	14	SURFACE	8.46	6.01
25	13	GADFLY	8.43	6.39
29	12	MAELSTROM	8.10	7.09
32	11	MATRIX	8.00	5.99
33	10	MATTER	7.80	6.76
48	9	QUOTA	7.75	4.36
27	8	GARRET	7.71	5.53
38	7	OBJECT	6.94	6.97
5	6	ATTAR	6.66	6.85
1	5	ADAGE	6.63	6.09
23	4	FOIBLE	6.54	4.77
26	3	GAMIN	6.18	5.98
15	2	DAVIT	6.09	5.70
10	1	CAROM	4.96	5.88

Table 9

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing (Mean) Concreteness Scores (A-C) for Subsamples I and II Combined (N=104)

Word Number	Rank	Word	$\bar{X}$	SD
60	60	WATER	6.93	.32
44	59	PENCIL	6.92	.60
42	58	PAPER	6.91	.61
56	57	TABLE	6.87	.84
6	56	BABY	6.81	.75
12	55	COTTON	6.80	.54
7	54	BLISTER	6.79	.76
49	53	RIVER	6.78	.78
22	52	FABRIC	6.76	.73
13	51	CRADLE	6.72	.88
53	50	SUNBURN	6.68	.74
28	49	IRON	6.62	1.07
35	48	METAL	6.61	1.01
46	47	PERSON	6.43	1.33
47	46	PRISON	6.41	1.27
39	45	OFFICE	6.39	1.22
50	44	SALOON	6.24	1.30
31	43	MARKET	6.21	1.22
9	42	BOSOM	6.13	1.39
8	41	BODICE	6.07	1.42
54	40	SURFACE	6.05	.14
38	39	OBJECT	5.92	1.70
37	38	NUMBER	4.90	2.25
33	37	MATTER	4.45	2.18
32	36	MATRIX	4.34	2.06
19	35	DUMMY	4.19	.74
25	34	GADFLY	3.85	2.42
27	33	GARRET	3.79	2.26
18	32	DIVORCE	3.72	2.03
4	31	ARRAY	3.64	1.89

Table 9 (Cont'd.)

Word Number	Rank	Word	$\bar{X}$	SD
55	30	SURTAX	3.63	2.08
48	29	QUOTA	3.60	2.01
21	28	EVENT	3.56	1.86
52	27	SEQUENCE	3.49	2.08
41	26	PANIC	3.44	2.02
14	25	DANGER	3.38	2.00
3	24	ANGER	3.34	2.05
17	23	DEVIL	3.33	2.28
43	22	PASSION	3.21	2.02
2	21	AMOUR	3.19	2.03
20	20	ESSENCE	3.18	2.22
58	19	TROUBLE	3.08	1.67
57	18	TEMPER	3.01	1.84
26	17	GAMIN	2.96	1.93
29	16	MAELSTROM	2.89	2.00
40	15	OUTCOME	2.64	1.72
24	14	FOLLY	2.62	1.52
15	13	DAVIT	2.60	1.78
5	12	ATTAR	2.59	1.75
10	11	CAROM	2.55	1.69
51	10	SAVANT	2.45	1.58
30	9	MALICE	2.43	1.63
16	8	DECEIT	2.41	1.50
23	7	FOIBLE	2.40	1.51
36	6	NONSENSE	2.38	1.61
1	5	ADAGE	2.33	1.63
34	4	MERCY	2.15	1.39
45	3	PERCEPT	2.00	1.32
59	2	VIRTUE	1.88	1.40
11	1	CONCEPT	1.61	1.15

Table 10

The Linguistic Stimuli for the Four Cells in Habituation Experiment I (High and Low Denotative, and High and Low Connotative Linguistic Meaning)

High Denotative-High Connotative	Low Denotative-High Connotative
water	concept
[a]prison	malice
river	[a]virtue
[a]baby	amour
devil	mercy
blister	[a]deceit
fabric	event
cradle	trouble
High Denotative-Low Connotative	**Low Denotative-Low Connotative**
paper	attar
table	[a]carom
[a]pencil	gamin
saloon	foible
[a]iron	[a]davit
number	adage
metal	gadfly
bodice	maelstrom

[a]Final words selected for the habituation experiment.

Table 11

The Linguistic Stimuli for the Four Cells in Habituation Experiment II (High and Low Word Concreteness, and High and Low Connotative Linguistic Meaning)

High Concreteness-High Connotative	Low Concreteness-High Connotative
[a]water	malice
cotton	[a]mercy
blister	amour
fabric	passion
river	[a]trouble
[a]cradle	temper
sunburn	devil
person	essence
High Concreteness-Low Connotative	**Low Concreteness Low Connotative**
object	percept
surface	[a]adage
number	nonsense
[a]paper	savant
[a]metal	[a]foible
table	attar
bodice	outcome
saloon	folly

[a]Final words selected for the habituation experiment.

Table 12

Summary of the Experimental Designs Indicating the Final Words Selected for Habituation Experiments I (Denotative and Connotative Linguistic Meaning), and II (Word Concreteness and Connotative Linguistic Meaning)

EXPERIMENT I

	A_1	A_2
B_1	baby (1)[a] prison (2)	deceit (3) virtue (4)
B_2	pencil (5) iron (6)	carom (7) davit (8)

A = Denotative linguistic meaning
B = Connotative linguistic meaning
(1 = high, 2 = low)

EXPERIMENT II

	A_1	A_2
B_1	cradle (9) water (10)	mercy (11) trouble (12)
B_2	paper (13) metal (14)	adage (15) foible (16)

A = Word concreteness
B = Connotative linguistic meaning
(1 = high, 2 = low)

[a]Identification numbers for the words.

2. The Skin Conductance Habituation Measures

This section of Chapter III presents the results of the statistical analyses carried out on the skin conductance measures. It gives the results of the multivariate analyses obtained on the skin conductance measures in habituation experiments I and II, the descriptive statistics for the dependent measures, and the intercorrelations between the dependent measures. Finally, some reliability estimates for the skin conductance measures are reported.

A. The Effects of Denotative and Connotative Linguistic Meaning on SC Habituation: Experiment I

A similar procedure will be used to report the results of the habituation outcome data for both experiments. The first table (in each series) will report the cell means for each dependent measure across the three trial blocks. This will be followed by a figure which will provide a graphic representation of the cell means for each TB. Then the results of the multivariate analysis of variance for each dependent measure, for the three trial blocks, will be reported. Finally, when one or more of the three hypotheses (H_A, H_B, H_{AB}) are rejected at the $\alpha=.05$ level of significance for one or more of the multivariate criteria (for each dependent measure), both the analysis

of simple contrasts (Roy's criterion) and a generalized discriminant function analysis will be reported as post hoc procedures.

At the conclusion of each series of analyses for the eight dependent measures in each experiment, three summary tables will be presented as follows: (1) summary of the multivariate analyses, (2) summary of the analysis of simple contrasts, and (3) summary of the generalized disciminant function analyses. These summary tables will facilitate the simultaneous comparison of the effects of the independent measures on the eight dependent variables. Secondly, the summary tables will allow the results of the two experiments to be conveniently compared.

The mean scores for the dependent measures, LAT_1, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli, are presented in Table 13, and the graphic representation of the cell means is given in Figure 2. The MANOVA results for the LAT_1 measure are given in Table 14. The analysis of simple contrasts and the GDFA for the main effect, connotative linguistic meaning, are reported in Tables 15 and 16, respectively.

Table 13

Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_1)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
LAT_1-TB_1	2.93	3.13
LAT_1-TB_2	3.48	3.93
LAT_1-TB_3	3.83	4.03
Average	3.41	3.70
	HDen LConn	LDen LConn
LAT_1-TB_1	3.25	4.09
LAT_1-TB_2	3.44	4.46
LAT_1-TB_3	3.62	4.38
Average	3.47	4.31

[a]LAT_1 is the onset latency of the first SCR following stimulus onset, up to and including five poststimulus seconds.

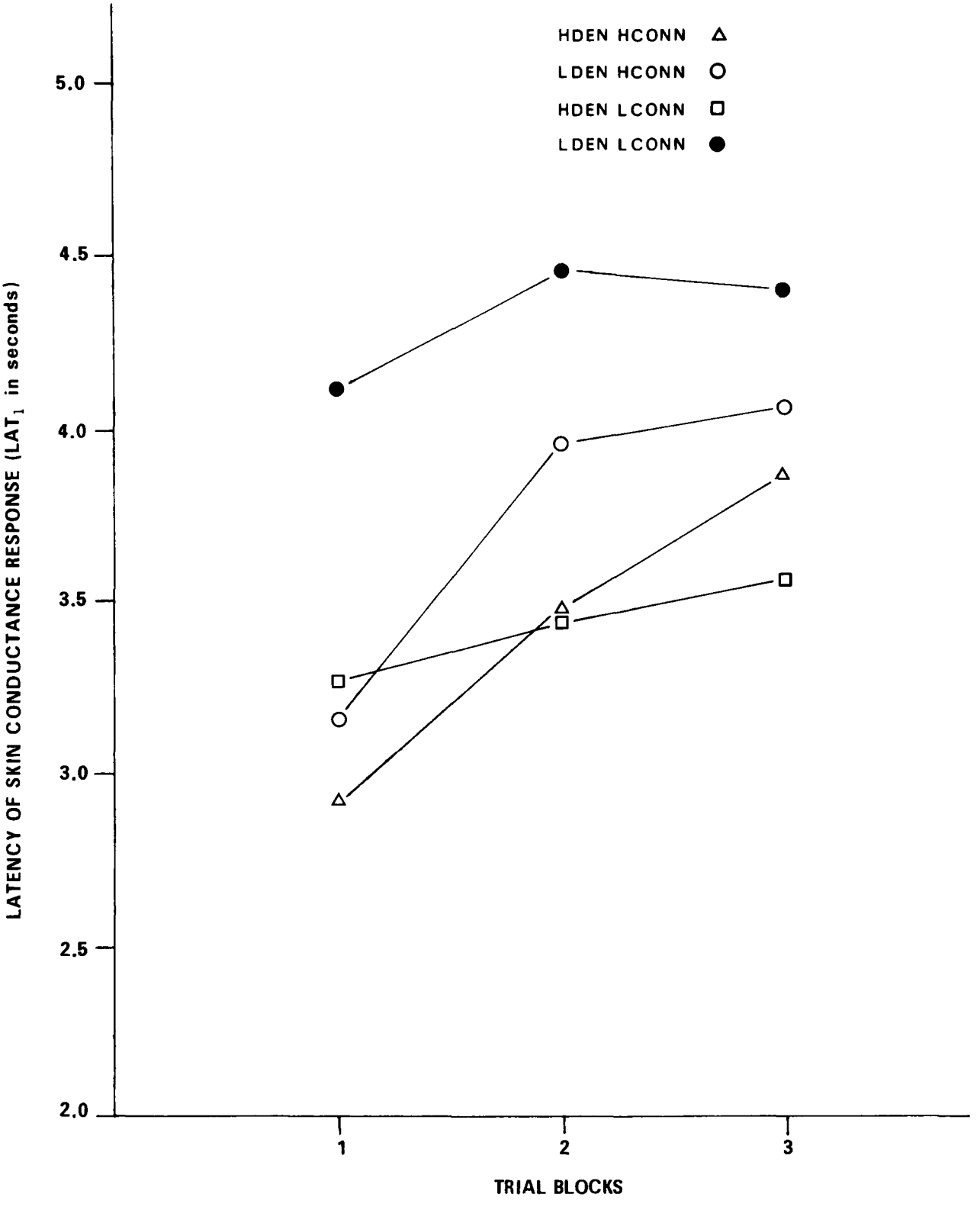


Fig. 2 – Mean latency of skin conductance response (LAT_1) to high and low denotative (HDEN,LDEN) and high and low connotative (HCONN,LCONN) linguistic meaningful stimuli.

Table 14

Multivariate Analysis of Variance for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.843	.809*	.957
Roy	.157	.191*	.043
Lawley-Hotelling	.186	.236*	.045
Pillai	.157	.196*	.043

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05, if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 15

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, LAT_1, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
B at TB_1	-0.66	0.24	.02 to -1.32	sig.
B at TB_2	-0.25	0.26	.49 to -.98	n.s.
B at TB_3	-0.07	0.26	.69 to -.83	n.s.

[a]Critical constant=2.89

Table 16

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
LAT_1-TB_1	-0.76	0.84	-0.96
LAT_1-TB_2	-0.99	0.30	-0.79
LAT_1-TB_3	-0.63	0.08	-0.76
Bartlett's Test Sig. df (χ^2)	7.25	8.99*	1.87

*$p<.05$, df 3.0

The mean scores for the dependent measures, LAT_2, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli, are presented in Table 17, and the graphic representation of the cell means is given in Figure 3. The MANOVA results for the LAT_2 measure are given in Table 18. The analysis of simple contrasts and the GDFA for the main effects, denotative and connotative linguistic meaning, are reported in Tables 19 and 20, respectively.

Table 17

Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_2)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
LAT_2-TB_1	9.48	12.53
LAT_2-TB_2	13.93	19.87
LAT_2-TB_3	18.19	18.60
Average	13.87	17.00
	HDen LConn	LDen LConn
LAT_2-TB_1	13.05	22.78
LAT_2-TB_2	12.68	25.76
LAT_2-TB_3	15.64	24.05
Average	13.78	24.20

[a]LAT_2 is the onset latency of the first SCR following stimulus onset, up to and including the total inter-stimulus interval.

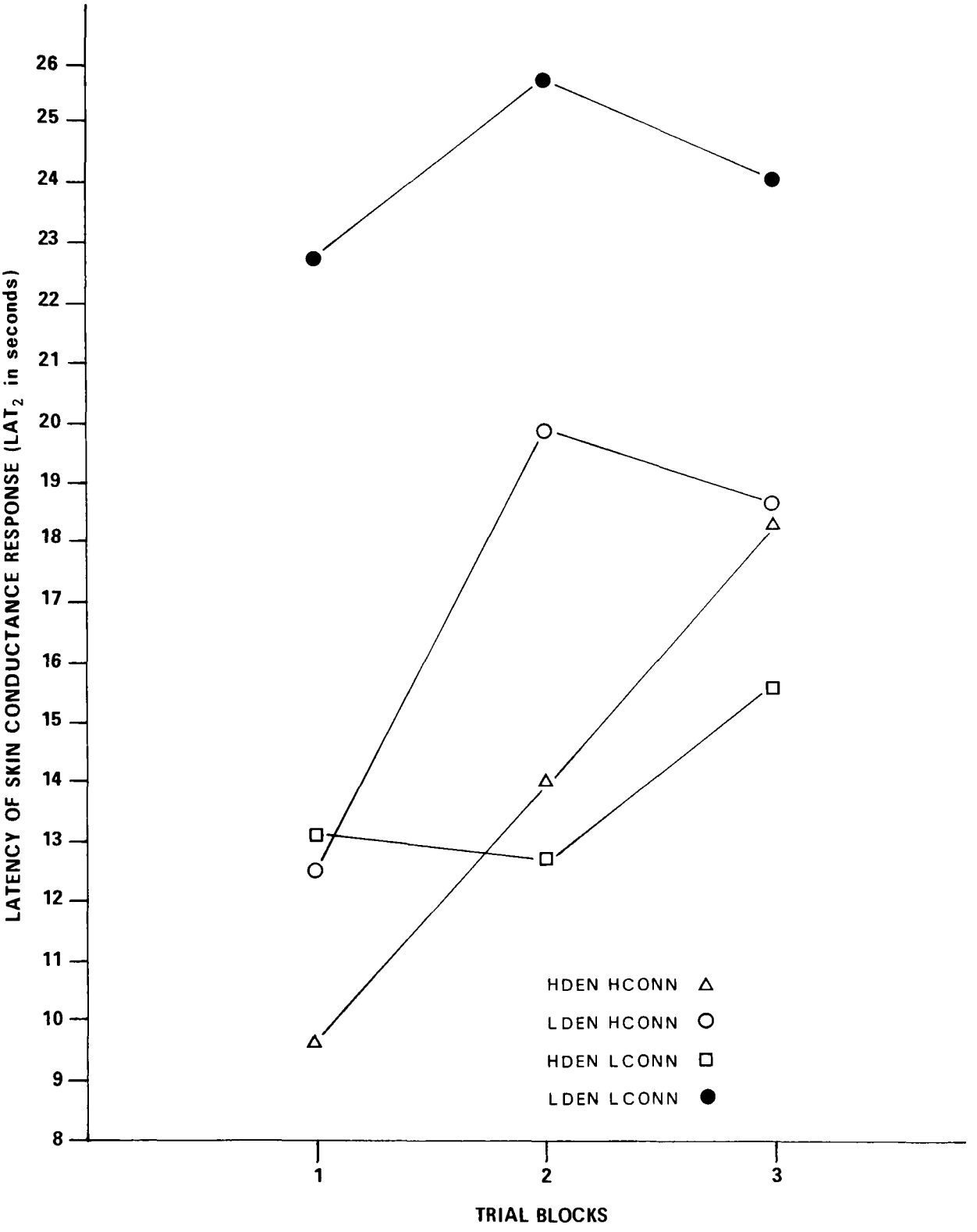


Fig. 3 — Mean latency of skin conductance response (LAT_2) to high and low denotative (HDEN,LDEN) and high and low connotative (HCONN,LCONN) linguistic meaningful stimuli.

Table 18

Multivariate Analysis of Variance for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.759*	.755*	.943
Roy	.241*	.245*	.057
Lawley-Hotelling	.318*	.324*	.061
Pillai	.241*	.245*	.057

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 19

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, LAT_2, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative (B) Linguistic Meaning

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	-6.40	2.28	.20 to -13.00	n.s.
A at TB_2	-9.51	2.85	-1.27 to -17.75	sig.
A at TB_3	-4.41	2.76	3.57 to -12.39	n.s.
B at TB_1	-6.91	2.28	-.31 to -13.51	sig.
B at TB_2	-2.32	2.85	5.92 to -10.56	n.s.
B at TB_3	-1.45	2.76	6.53 to -9.43	n.s.

[a]Critical constant=2.89

Table 20

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
LAT_2-TB_1	-0.75	0.80	-0.90
LAT_2-TB_2	-0.89	0.22	-0.77
LAT_2-TB_3	-0.43	0.14	-0.86
Bartlett's Test Sig. df (χ^2)	11.75**	11.93**	2.51

**p<.01, df 3.0

The mean scores for the dependent measures, SCL, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 21, and the graphic representation of the cell means is given in Figure 4. The MANOVA results for the SCL measure are given in Table 22. The analysis of simple contrasts, and the GDFA for the main effect, denotative linguistic meaning, are reported in Tables 23 and 24, respectively.

Table 21

Mean Scores for the Dependent Measures, Skin Conductance Level (SCL)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
$SCL\text{-}TB_1$	16.20	15.45
$SCL\text{-}TB_2$	15.94	14.82
$SCL\text{-}TB_3$	14.56	14.86
Average	15.57	15.04
	HDen LConn	LDen LConn
$SCL\text{-}TB_1$	13.84	10.10
$SCL\text{-}TB_2$	14.79	9.31
$SCL\text{-}TB_3$	14.63	9.38
Average	14.42	9.60

[a]SCL is the average four-second prestimulus skin conductance level (tonic SC).

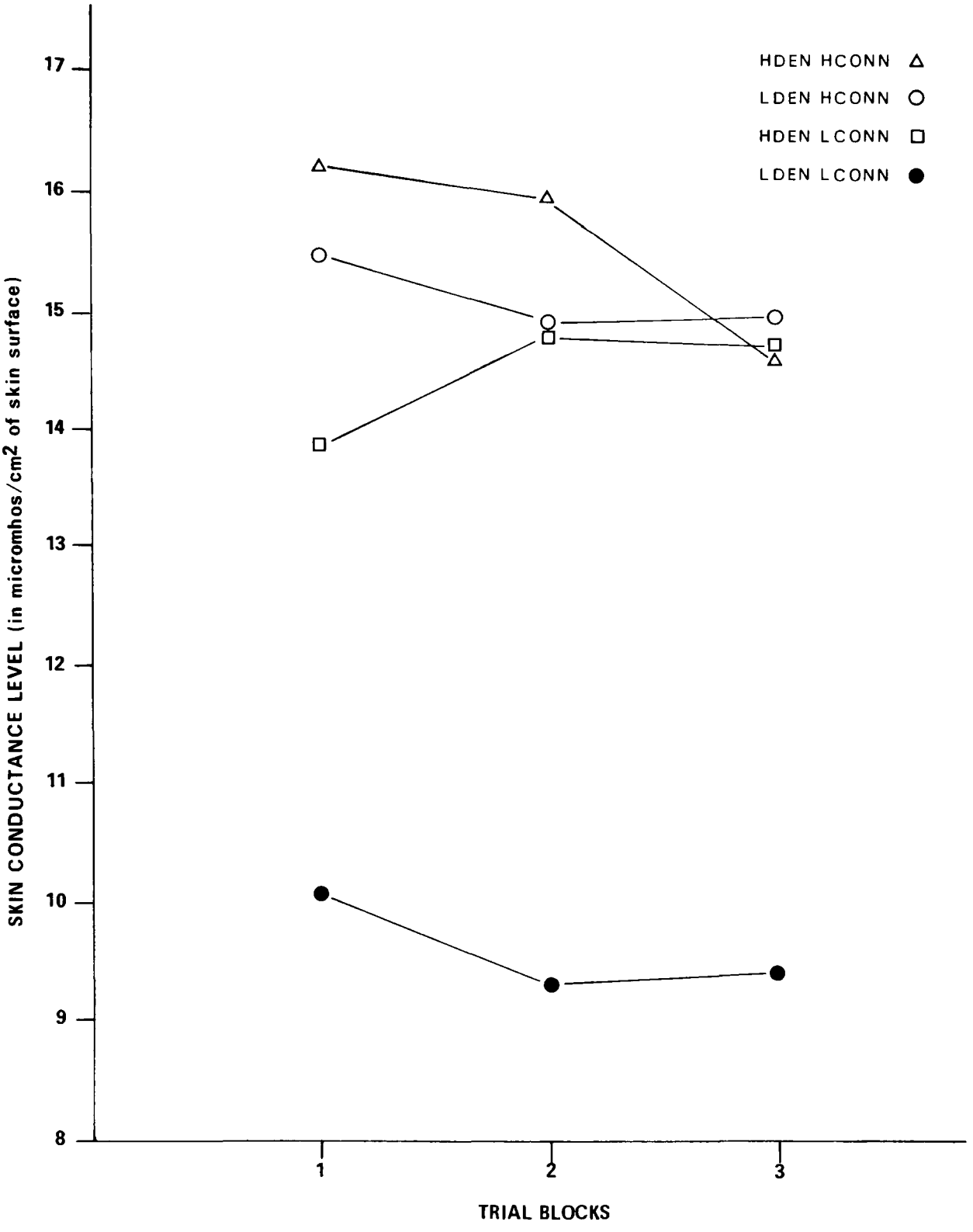


Fig. 4 — Mean skin conductance level to high and low denotative (HDEN,LDEN) and high and low connotative (HCONN,LCONN) linguistic meaningful stimuli.

Table 22

Multivariate Analysis of Variance for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.729*	.848	.915
Roy	.271*	.152	.085
Lawley-Hotelling	.373*	.179	.093
Pillai	.271*	.152	.085

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 23

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCL, for Three Trial Blocks for the Main Effect, Denotative Linguistic Meaning (A)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	2.24	1.59	7.04 to -2.36	n.s.
A at TB_2	3.30	1.71	8.24 to -1.64	n.s.
A at TB_3	2.48	1.75	7.54 to -2.58	n.s.

[a]Critical constant 2.89

Table 24

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
$SCL\text{-}TB_1$	-0.35	0.87	-0.47
$SCL\text{-}TB_2$	-0.48	0.69	-0.63
$SCL\text{-}TB_3$	-0.35	0.55	-0.78
Bartlett's Test Sig. df (χ^2)	13.46**	6.99	3.79

**$p<.01$, df 3.0

The mean scores for the dependent measures, SCR, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 25, and the graphic representation of the cell means is given in Figure 5. The MANOVA results for the SCR measure are given in Table 26. The analysis of simple contrasts, and the GDFA for the main effect, connotative linguistic meaning, are reported in Tables 27 and 28, respectively.

Table 25

Mean Scores for the Dependent Measures, Skin Conductance Response (SCR)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
$SCR\text{-}TB_1$	2.03	1.72
$SCR\text{-}TB_2$	0.90	0.85
$SCR\text{-}TB_3$	1.08	0.73
Average	1.34	1.10
	HDen LConn	LDen LConn
$SCR\text{-}TB_1$	1.63	0.56
$SCR\text{-}TB_2$	1.30	0.35
$SCR\text{-}TB_3$	1.13	0.42
Average	1.35	0.44

[a]SCR is the first SCR change to peak, occurring from the moment of stimulus onset up to five poststimulus seconds.

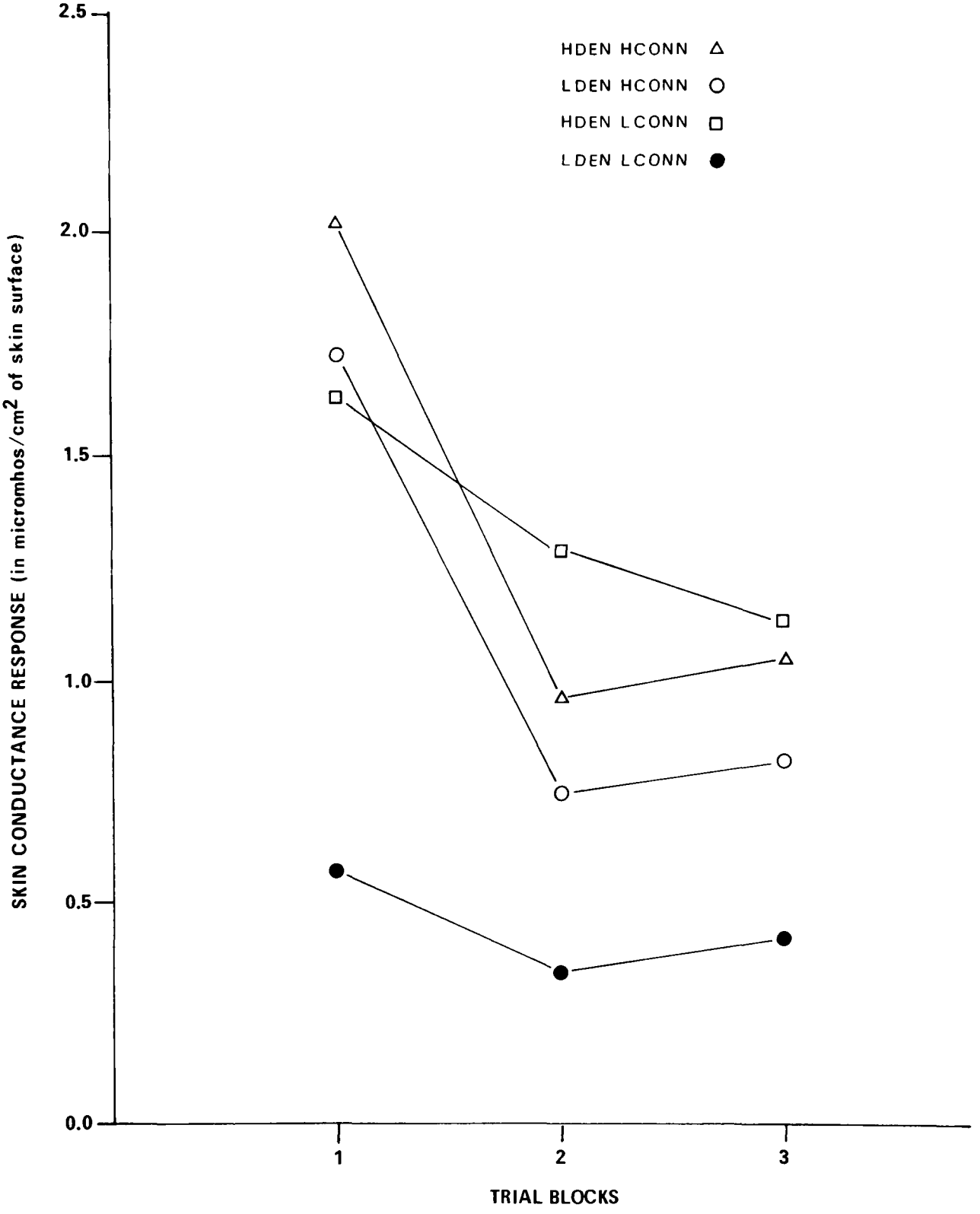


Fig. 5 — Mean skin conductance response to high and low denotative (HDEN, LDEN) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 26

Multivariate Analysis of Variance for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.885	.780*	.929
Roy	.115	.220*	.071
Lawley-Hotelling	.130	.282*	.076
Pillai	.115	.220*	.071

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 27

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
B at TB_1	.78	.30	1.65 to -.09	n.s.
B at TB_2	.06	.30	.93 to -.81	n.s.
B at TB_3	.13	.33	1.08 to -.82	n.s.

[a]Critical constant=2.89

Table 28

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
$SCR\text{-}TB_1$	-0.93	0.71	-0.67
$SCR\text{-}TB_2$	-0.70	0.05	-0.83
$SCR\text{-}TB_3$	-0.68	0.11	-0.30
Bartlett's Test Sig. df (χ^2)	5.20	10.55**	3.13

**$p<.01$, df 3.0

The mean scores for the dependent measures, SCR-TISI, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 29, and the graphic representation of the cell means is given in Figure 6. The MANOVA results for the SCR-TISI measure are given in Table 30. The analysis of simple contrasts, and the GDFA for the main effect, connotative linguistic meaning, are given in Tables 31 and 32, respectively.

Table 29

Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval (SCR-TISI)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure	HDen HConn	LDen HConn
$SCR\text{-}TISI\text{-}TB_1$	2.18	1.90
$SCR\text{-}TISI\text{-}TB_2$	1.37	1.22
$SCR\text{-}TISI\text{-}TB_3$	1.46	1.26
Average	1.67	1.46
	HDen LConn	LDen LConn
$SCR\text{-}TISI\text{-}TB_1$	1.79	0.60
$SCR\text{-}TISI\text{-}TB_2$	1.65	0.45
$SCR\text{-}TISI\text{-}TB_3$	1.42	0.53
Average	1.62	0.53

[a]SCR-TISI is the first SC change to peak, occurring from the moment of stimulus onset up to and including the total interstimulus interval.

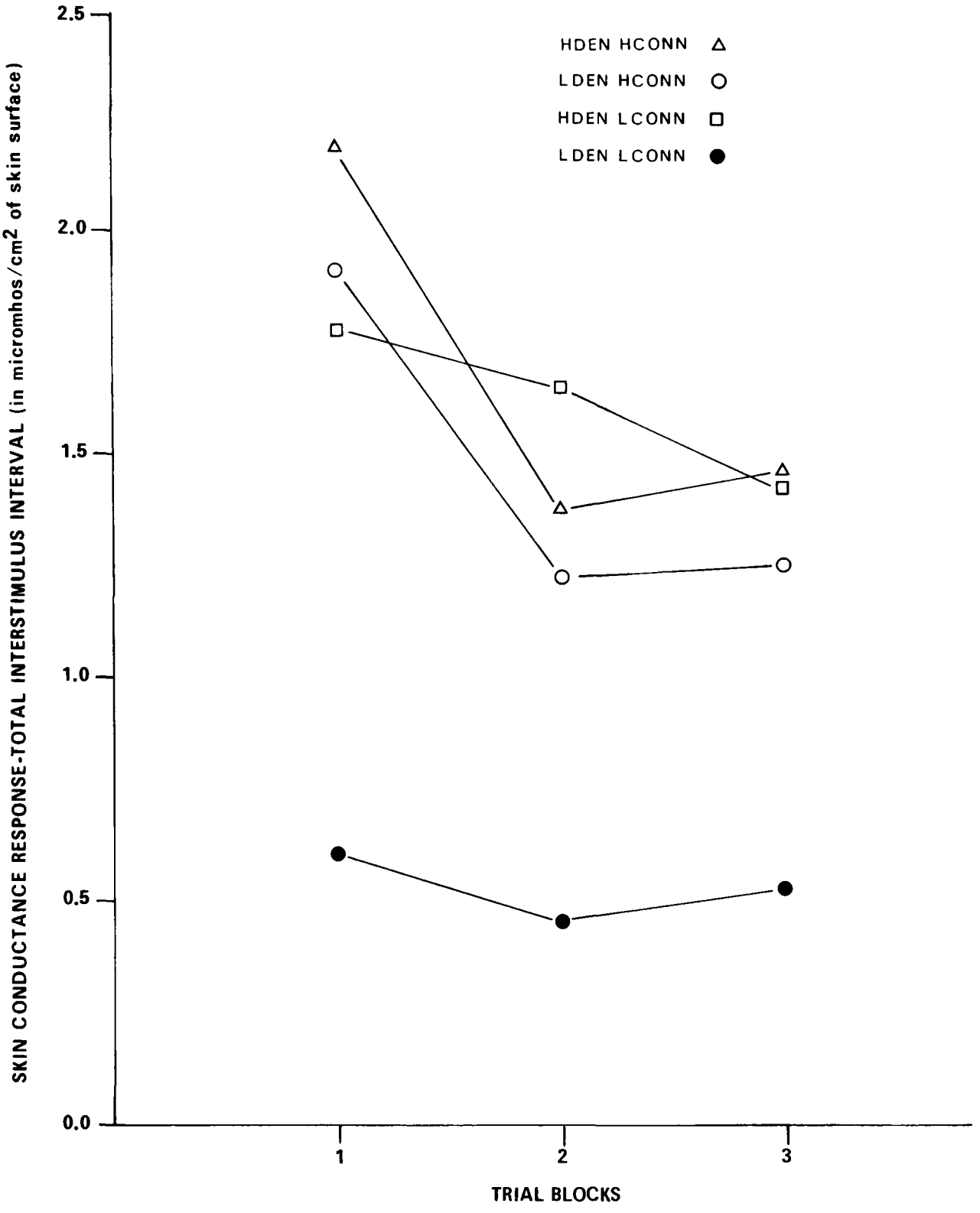


Fig. 6— Mean skin conductance response-total interstimulus interval to high and low denotative (HDEN, LDEN) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 30

Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Criteria \ Hypotheses	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.877	.804*	.930
Roy	.123	.196*	.070
Lawley-Hotelling	.141	.245*	.076
Pillai	.123	.196*	.070

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 31

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR-TISI, for Three Trial Blocks for the Main Effect, Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
B at TB_1	.84	.30	.03 to -1.71	sig.
B at TB_2	.24	.32	1.17 to - .69	n.s.
B at TB_3	.39	.33	1.34 to - .56	n.s.

[a]Critical constant=2.89

Table 32

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI,for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
SCR-TISI-TB_1	-0.94	0.81	-0.79
SCR-TISI-TB_2	-0.85	0.23	-0.90
SCR-TISI-TB_3	-0.66	0.36	-0.57
Bartlett's Test Sig. df (χ^2)	5.59	9.30*	3.10

*$p<.05$, df 3.0

The mean scores for the dependent measures, SCL-RAN, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 33, and the graphic representation of the cell means is given in Figure 7. The MANOVA results for the SCL-RAN measure are given in Table 34. The analysis of simple contrasts and the GDFA for the main effect, denotative linguistic meaning, are given in Tables 35 and 36, respectively.

Table 33

Mean Scores for the Dependent Measures, Skin Conductance Level-Range Corrected (SCL-RAN)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
$SCL\text{-}RAN\text{-}TB_1$	0.52	0.43
$SCL\text{-}RAN\text{-}TB_2$	0.47	0.34
$SCL\text{-}RAN\text{-}TB_3$	0.27	0.33
Average	0.42	0.37
	HDen LConn	LDen LConn
$SCL\text{-}RAN\text{-}TB_1$	0.34	0.50
$SCL\text{-}RAN\text{-}TB_2$	0.44	0.32
$SCL\text{-}RAN\text{-}TB_3$	0.41	0.28
Average	0.40	0.37

[a]SCL-RAN is the SCL range corrected and expressed as a proportion of the subject's tonic range.

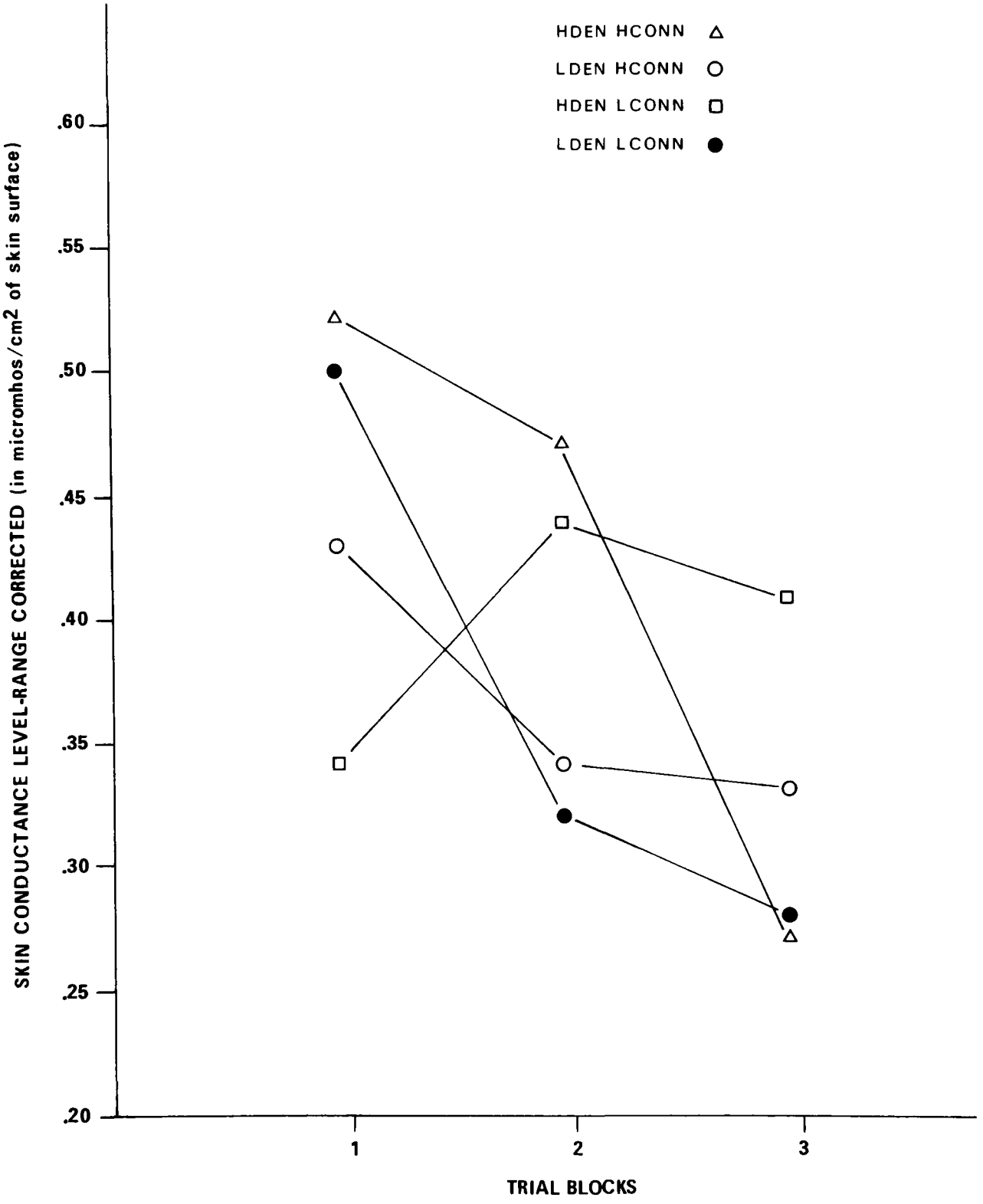


Fig. 7 — Mean skin conductance level-range corrected to high and low denotative (HDEN, LDEN) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 34

Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Criteria \ Hypotheses	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.744*	.965	.892
Roy	.256*	.035	.108
Lawley-Hotelling	.343*	.036	.121
Pillai	.256*	.035	.108

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 35

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCL-RAN, for Three Trial Blocks for the Main Effect, Denotative Linguistic Meaning (A)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	-.04	.07	.16 to -.24	n.s.
A at TB_2	.13	.05	.27 to 0.00	sig.
A at TB_3	.03	.05	.12 to -.18	n.s.

[a]Critical constant=2.89

Table 36

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
SCL-RAN-TB_1	0.14	-0.60	0.78
SCL-RAN-TB_2	-0.71	-0.41	0.07
SCL-RAN-TB_3	-0.16	0.64	-0.85
Bartlett's Test Sig. df (χ^2)	12.55**	1.52	4.85

**$p<.01$, df 3.0

The mean scores for the dependent measures, SCR-RAN, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 37, and the graphic representation of the cell means is given in Figure 8. The MANOVA results for the SCR-RAN measure are given in Table 38. The analysis of simple contrasts and the GDFA for the main effects, denotative and connotative linguistic meaning, are given in Tables 39 and 40, respectively.

Table 37

Mean Scores for the Dependent Measures, Skin Conductance Response-Range Corrected (SCR-RAN)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
$SCR\text{-}RAN\text{-}TB_1$	0.31	0.19
$SCR\text{-}RAN\text{-}TB_2$	0.15	0.08
$SCR\text{-}RAN\text{-}TB_3$	0.15	0.06
Average	0.20	0.11
	HDen LConn	LDen LConn
$SCR\text{-}RAN\text{-}TB_1$	0.23	0.08
$SCR\text{-}RAN\text{-}TB_2$	0.18	0.04
$SCR\text{-}RAN\text{-}TB_3$	0.16	0.05
Average	0.19	0.06

[a]SCR-RAN is the SCR range corrected and expressed as a proportion of the subject's phasic range.

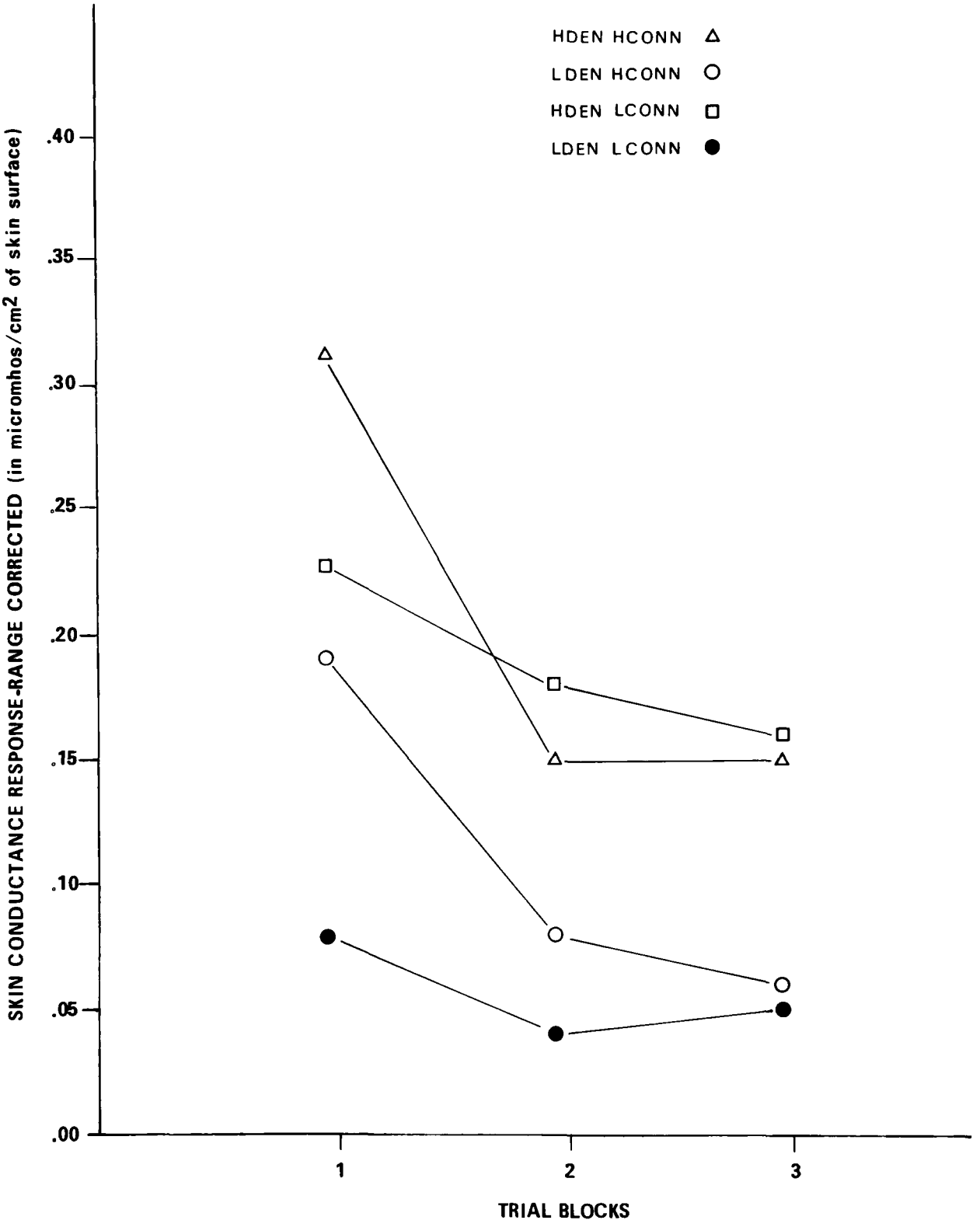


Fig. 8 — Mean skin conductance response-range corrected to high and low denotative (HDEN,LDEN) and high and low connotative (HCONN,LCONN) linguistic meaningful stimuli.

Table 38

Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Criteria \ Hypotheses	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.737*	.803*	.954
Roy	.263*	.197*	.046
Lawley-Hotelling	.356*	.245*	.048
Pillai	.263*	.197*	.046

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 39

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR-RAN, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative Linguistic Meaning (B)

Contrast Source	Estimate of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	.14	.04	.25 to .03	sig.
A at TB_2	.10	.04	.21 to -.02	sig.
A at TB_3	.10	.04	.21 to -.02	sig.
B at TB_1	.09	.04	.20 to -.03	sig.
B at TB_2	.01	.04	.11 to -.09	n.s.
B at TB_3	-.01	.04	.10 to -.12	n.s.

[a]Critical constant=2.89

Table 40

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
SCR-RAN-TB_1	-0.90	0.74	-0.26
SCR-RAN-TB_2	-0.71	0.05	-0.68
SCR-RAN-TB_3	-0.67	-0.03	-0.19
Bartlett's Test Sig. df (χ^2)	12.959**	9.303*	2.01

*$p<.05$, df 3.0
**$p<.01$, df 3.0

The mean scores for the dependent measures, SCR-TISI-RAN, for three trial blocks, to high and low denotative and high and low connotative linguistic meaningful stimuli are presented in Table 41, and the graphic representation of the cell means is given in Figure 9. The MANOVA results for the SCR-TISI-RAN measures are given in Table 42. The analysis of simple contrasts and the GDFA for the main effects, denotative and connotative linguistic meaning, are given in Tables 43 and 44, respectively.

Table 41

Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval-Range Corrected (SCR-TISI-RAN)[a], for Three Trial Blocks, to High and Low Denotative (HDen, LDen) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HDen HConn	LDen HConn
SCR-TISI-RAN-TB_1	0.33	0.21
SCR-TISI-RAN-TB_2	0.21	0.13
SCR-TISI-RAN-TB_3	0.22	0.12
Average	0.25	0.15
	HDen LConn	LDen LConn
SCR-TISI-RAN-TB_1	0.26	0.09
SCR-TISI-RAN-TB_2	0.23	0.06
SCR-TISI-RAN-TB_3	0.21	0.08
Average	0.23	0.08

[a]SCR-TISI-RAN is the SCR-TISI range corrected and expressed as a proportion of the subject's phasic range.

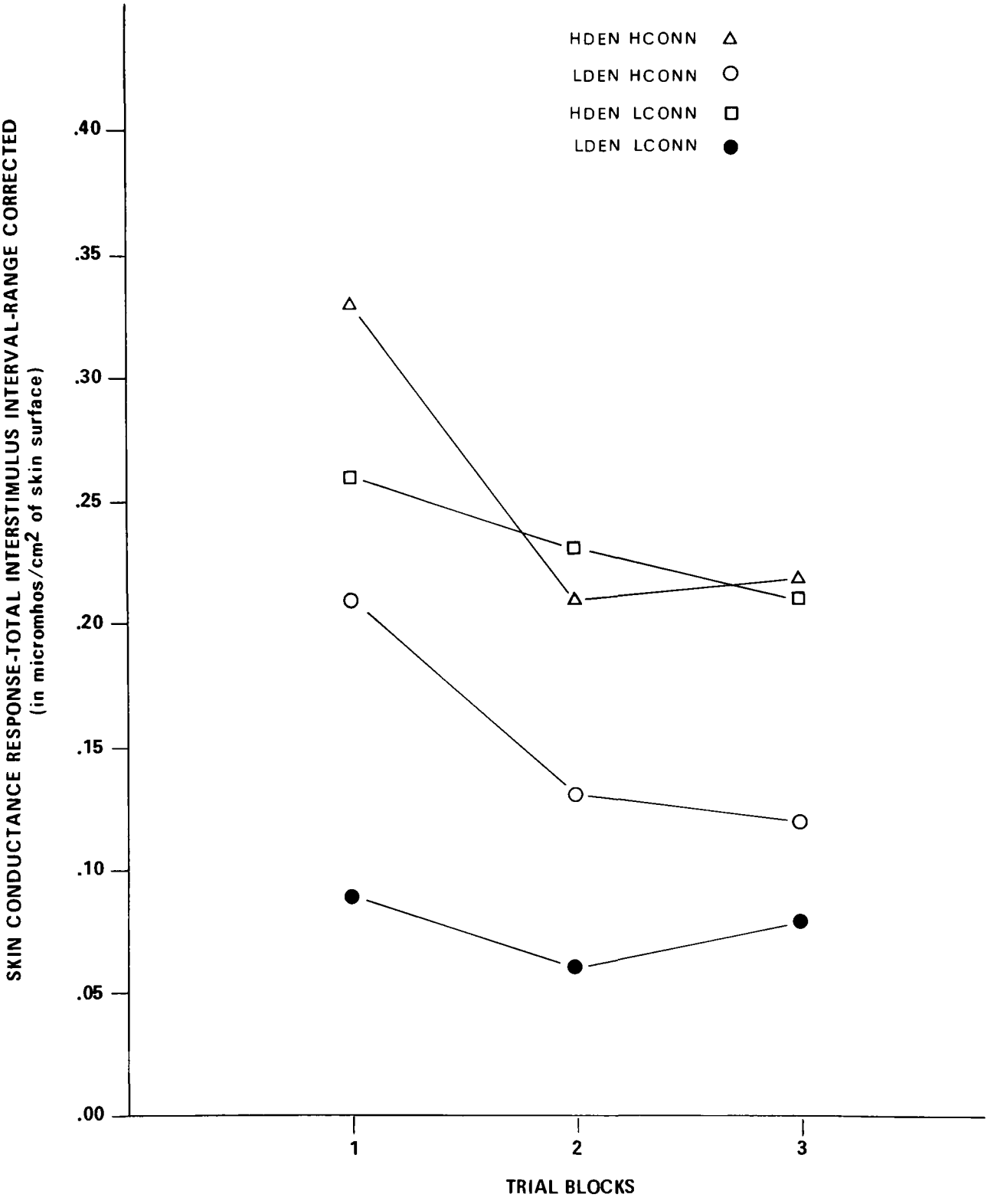


Fig. 9 — Mean skin conductance response-total interstimulus interval-range corrected to high and low denotative (HDEN, LDEN) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 42

Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
Wilks	.735*	.835*	.933
Roy	.265*	.165*	.067
Lawley-Hotelling	.360*	.198*	.072
Pillai	.265*	.165*	.067

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05, if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 43

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks for the Main Effects, Denotative (A) and Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	.14	.04	.25 to .03	sig.
A at TB_2	.13	.04	.24 to .02	sig.
A at TB_3	.11	.04	.22 to .00	sig.
B at TB_1	.10	.04	.21 to -.01	sig.
B at TB_2	.02	.04	.13 to -.09	n.s.
B at TB_3	.03	.04	.14 to -.08	n.s.

[a]Critical constant=2.89

Table 44

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Den Meaning	H_B Conn Meaning	H_{AB} Den X Conn Meaning
SCR-TISI-RAN-TB_1	-0.91	0.83	-0.28
SCR-TISI-RAN-TB_2	-0.87	0.19	-0.68
SCR-TISI-RAN-TB_3	-0.71	0.23	-0.16
Bartlett's Test Sig. df (χ^2)	13.09**	7.66*	2.94

*p<.05, df 3.0
**p<.01, df 3.0

The summaries for the multivariate analyses of variance, the analyses of simple contrasts, and the generalized discriminant function analyses for the eight dependent measures in experiment I are presented in Tables 45, 46, and 47, respectively.

Table 45

Summary of the Multivariate Analyses of Variance for the Dependent Measures in Experiment I, for Three Trial Blocks, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Denotative Meaning	H_B Connotative Meaning	H_{AB} Den X Conn Meaning
LAT_1	n.s.	*	n.s.
LAT_2	*	*	n.s.
SCL	*	n.s.	n.s.
SCR	n.s.	*	n.s.
SCR-TISI	n.s.	*	n.s.
SCL-RAN	*	n.s.	n.s.
SCR-RAN	*	*	n.s.
SCR-TISI-RAN	*	*	n.s.

*The multivariate hypothesis was rejected at the significance level α=.05 for one or more of the four multivariate criteria (λ,θ, U, V).

Table 46

Summary of the Analyses of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures in Experiment I, for Three Trial Blocks, for the Main Effects, Denotative and Connotative Linguistic Meaning

Hypotheses / Dependent Measure	H_A Denotative Meaning	H_B Connotative Meaning	H_{AB} Den X Conn Meaning
LAT_1	n.s.	TB_1	n.s.
LAT_2	TB_2	TB_1	n.s.
SCL	n.s.	n.s.	n.s.
SCR	n.s.	n.s.	n.s.
SCR-TISI	n.s.	TB_1	n.s.
SCL-RAN	TB_2	n.s.	n.s.
SCR-RAN	TB_1, TB_2, TB_3	TB_1	n.s.
SCR-TISI-RAN	TB_1, TB_2, TB_3	TB_1	n.s.

[a]The listing of a TB for an hypothesis indicates that the simple contrast was significant at the α=.05 level.

Table 47

Summary of the Generalized Discriminant Function Analyses for the Dependent Measures in Experiment I, to High and Low Denotative and High and Low Connotative Linguistic Meaningful Stimuli, Indicating the Contribution of the Three Trial Blocks[a] to the Rejection of the Hypothesis

Hypotheses / Dependent Measure	H_A Denotative Meaning	H_B Connotative Meaning	H_{AB} Den X Conn Meaning
LAT_1	n.s.	TB_1, TB_2, TB_3	n.s.
LAT_2	TB_2, TB_1, TB_3	$TB_1 (TB_2, TB_3)$	
SCL	(TB_2, TB_1, TB_3)	n.s.	n.s.
SCR	n.s.	$TB_1 (TB_2, TB_3)$	n.s.
SCR-TISI	n.s.	$TB_1 (TB_3, TB_2)$	n.s.
SCL-RAN	$TB_2 (TB_1, TB_3)$	n.s.	n.s.
SCR-RAN	$TB_1 (TB_2, TB_3)$	$TB_1 (TB_2, TB_3)$	n.s.
SCR-TISI-RAN	TB_1, TB_2, TB_3	$TB_1 (TB_2, TB_3)$	n.s.

[a]The importance of each TB to the rejection of the hypothesis is indicated by the order in which it is listed, with the most important starting from the left. When two or three TBs appear in brackets, this indicates that they contributed about equally to the rejection of the hypothesis.

B. The Effects of Word Concreteness and Connotative Linguistic Meaning on SC Habituation: Experiment II

The mean scores for the dependent measures, LAT_1, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 48, and the graphic representation of the cell means are given in Figure 10. The MANOVA results for the LAT_1 measure are given in Table 49.

Table 48

Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_1)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
LAT_1-TB_1	3.33	3.81
LAT_1-TB_2	3.86	4.29
LAT_1-TB_3	4.21	4.31
Average	3.80	4.14
	HA-C LConn	LA-C LConn
LAT_1-TB_1	3.67	4.09
LAT_1-TB_2	4.23	4.66
LAT_1-TB_3	4.52	4.66
Average	4.14	4.47

[a]LAT_1 is the latency of the first SCR following stimulus onset, up to and including five poststimulus seconds.

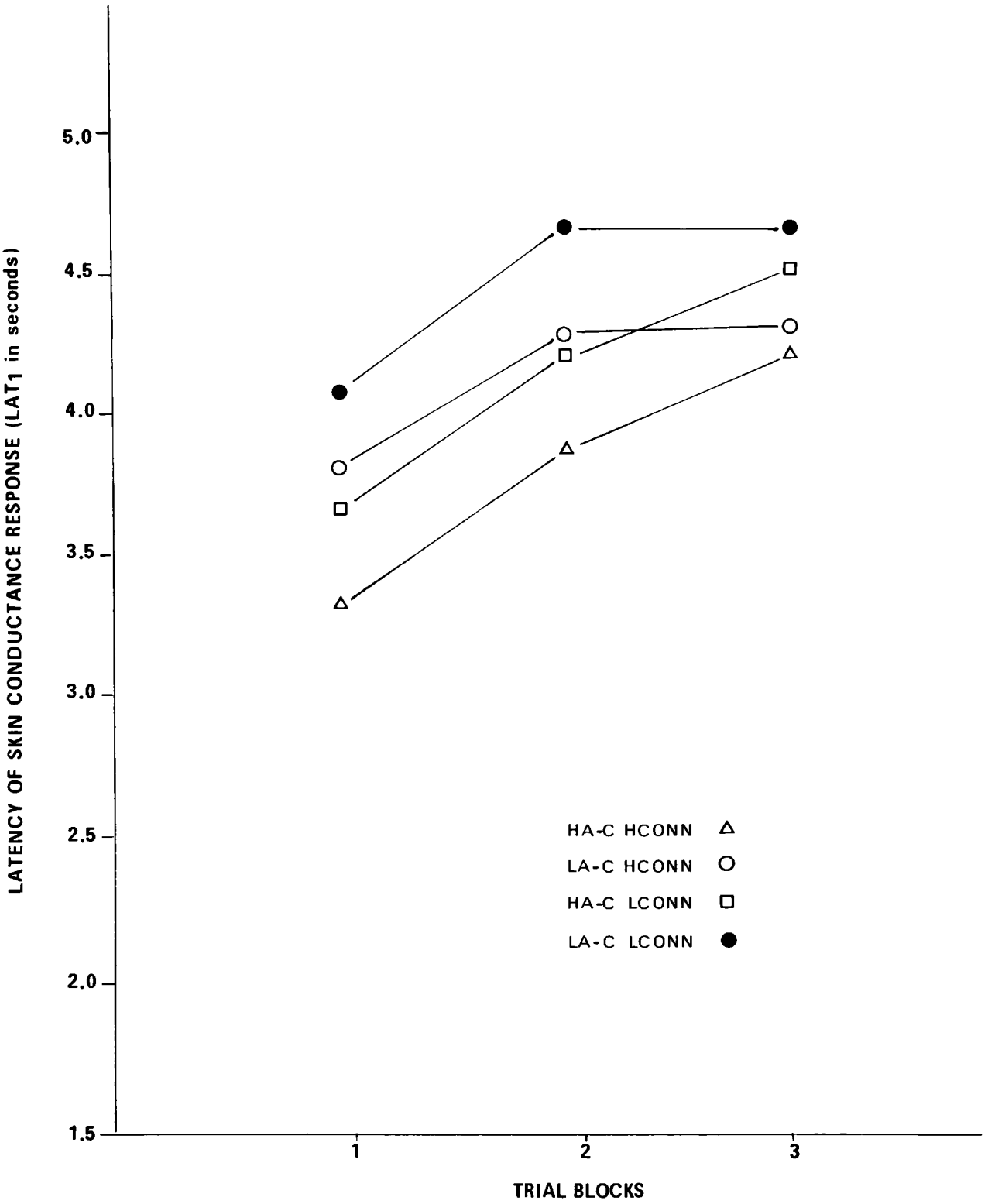


Fig. 10 — Mean latency of skin conductance response (LAT_1) to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 49

Multivariate Analysis of Variance for the Dependent Measures, LAT_1, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.850	.898	.999
Roy	.150	.102	.001
Lawley-Hotelling	.177	.114	.001
Pillai	.150	.102	.001

The mean scores for the dependent measures, LAT_2, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 50, and the graphic representation of the cell means is given in Figure 11. The MANOVA results for the LAT_2 measure are given in Table 51. The analysis of simple contrasts and the GDFA for the main effects, word concreteness and connotative linguistic meaning, are reported in Tables 52 and 53, respectively.

Table 50

Mean Scores for the Dependent Measures, Latency of Skin Conductance Response (LAT_2)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
LAT_2-TB_1	12.64	18.37
LAT_2-TB_2	16.68	23.29
LAT_2-TB_3	21.14	22.23
Average	16.82	21.30
	HA-C LConn	LA-C LConn
LAT_2-TB_1	16.65	21.62
LAT_2-TB_2	24.24	27.73
LAT_2-TB_3	26.28	28.72
Average	22.39	26.02

[a]LAT_2 is the onset latency of the first SCR following stimulus onset, up to and including the total inter-stimulus interval.

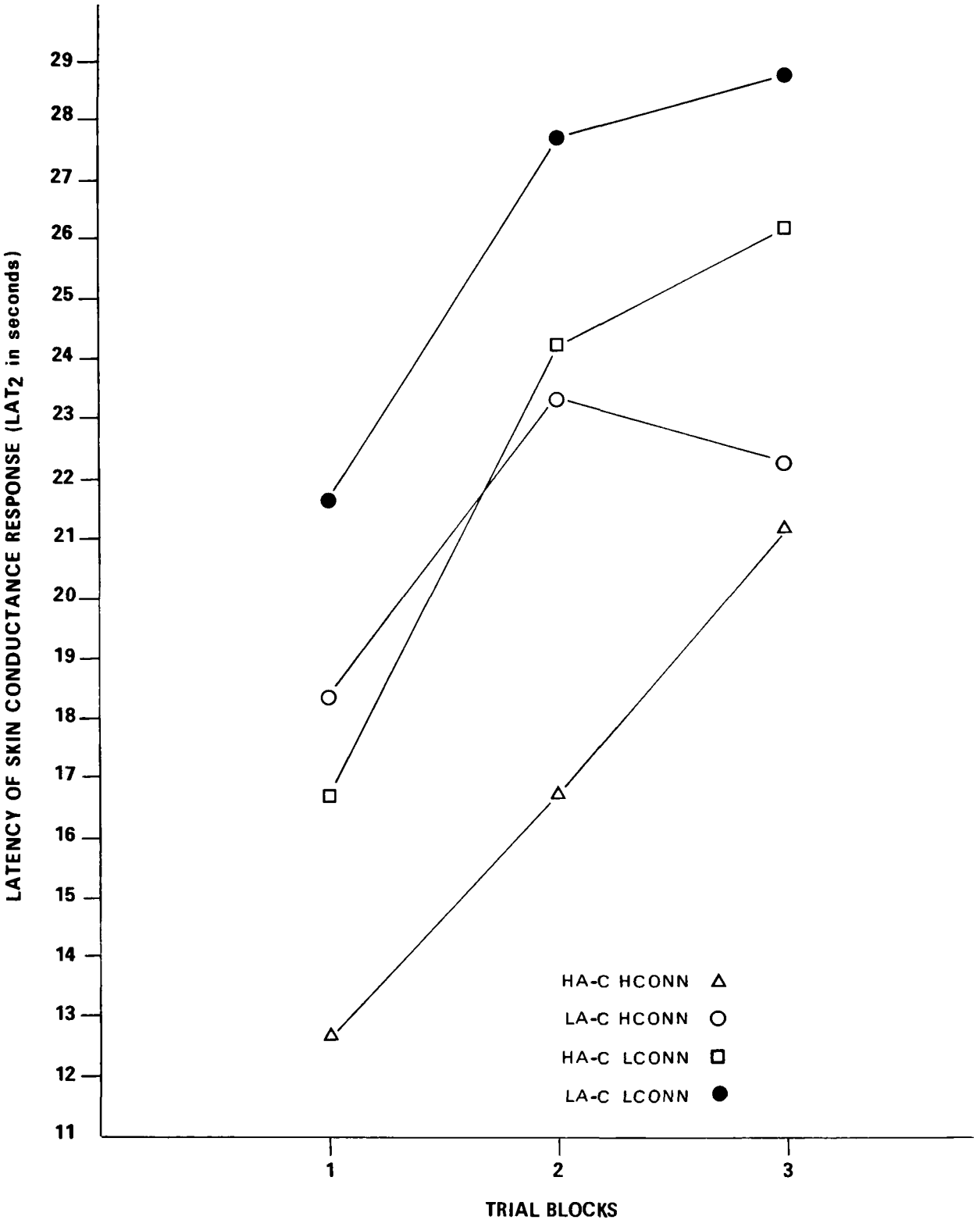


Fig. 11 — Mean latency of skin conductance response (LAT_2) to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 51

Multivariate Analysis of Variance for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.794*	.825*	.935
Roy	.206*	.175*	.065
Lawley-Hotelling	.259*	.212*	.069
Pillai	.206*	.175*	.065

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 52

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, LAT_2, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	-5.35	2.31	1.33 to -12.03	n.s.
A at TB_2	-5.05	1.99	.70 to -10.85	n.s.
A at TB_3	-1.76	2.20	4.61 to - 8.12	n.s.
B at TB_1	-3.63	2.31	3.05 to -10.31	n.s.
B at TB_2	-6.00	1.99	-.25 to -11.75	sig.
B at TB_3	-5.82	2.20	.54 to -12.18	n.s.

[a]Critical constant=2.89

Table 53

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, LAT_2, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
LAT_2-TB_1	-0.68	-0.51	-0.09
LAT_2-TB_2	-0.75	-0.99	-0.50
LAT_2-TB_3	-0.24	-0.87	0.18
Bartlett's Test Sig. df (χ^2)	9.79*	8.16*	2.85

*p<.05, df 3.0

The mean scores for the dependent measures, SCL, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 54, and the graphic representation of the cell means is given in Figure 12A. The MANOVA results for the SCL measures are given in Table 55. The graphic plot of the concreteness X connotative meaning interactions is given in Figure 12B. The analysis of simple contrasts, and the GDFA for the concreteness X connotative meaning interaction are reported in Tables 56 and 57, respectively.

Table 54

Mean Scores for the Dependent Measures, Skin Conductance Level (SCL)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
$SCL\text{-}TB_1$	13.18	12.70
$SCL\text{-}TB_2$	13.52	11.58
$SCL\text{-}TB_3$	12.47	11.93
Average	13.06	12.07
	HA-C LConn	LA-C LConn
$SCL\text{-}TB_1$	12.17	13.07
$SCL\text{-}TB_2$	10.87	12.77
$SCL\text{-}TB_3$	10.46	11.81
Average	11.17	12.55

[a]SCL is the average four-second prestimulus skin conductance level (tonic SC).

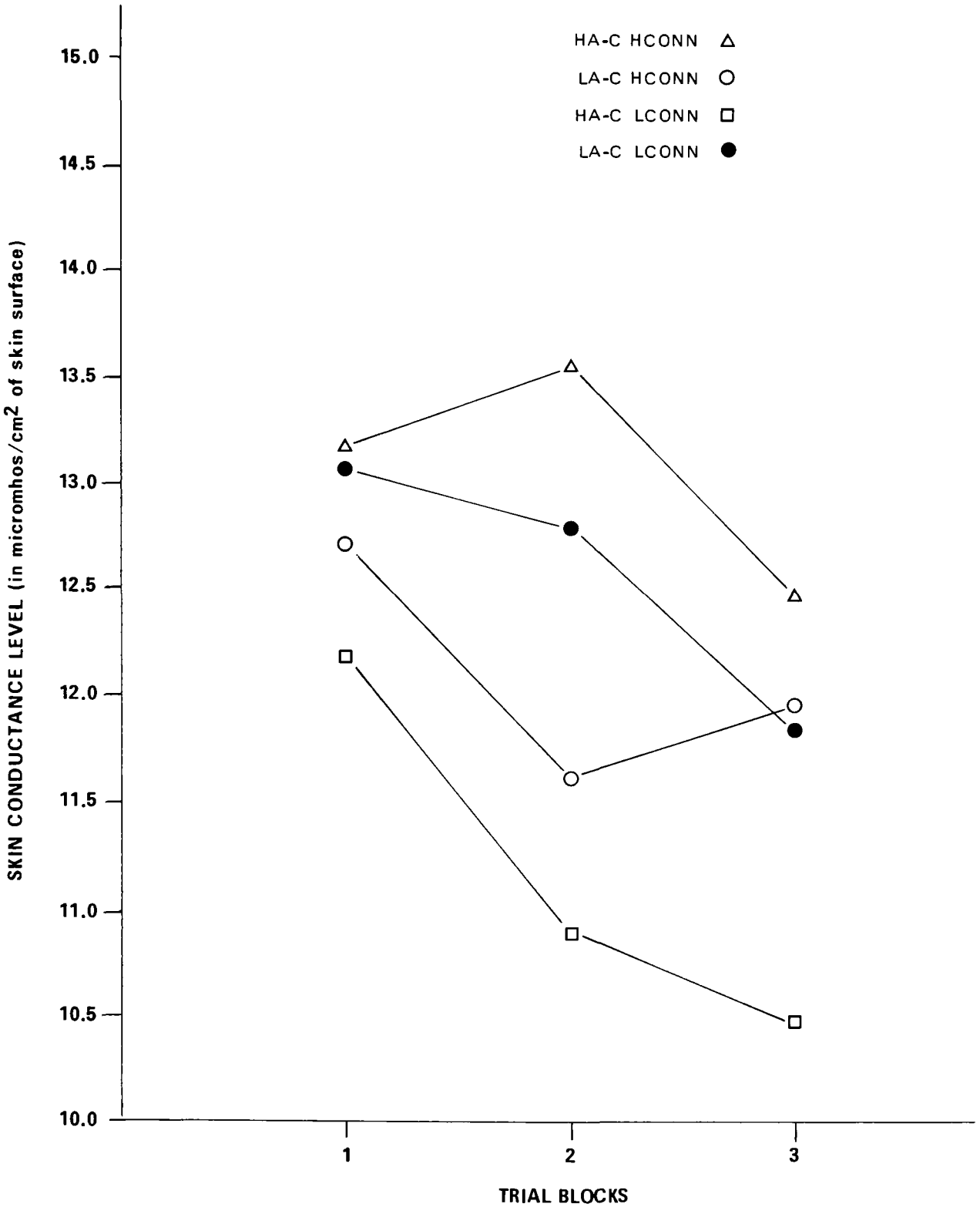


Fig. 12a — Mean skin conductance level to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 55

Multivariate Analysis of Variance for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

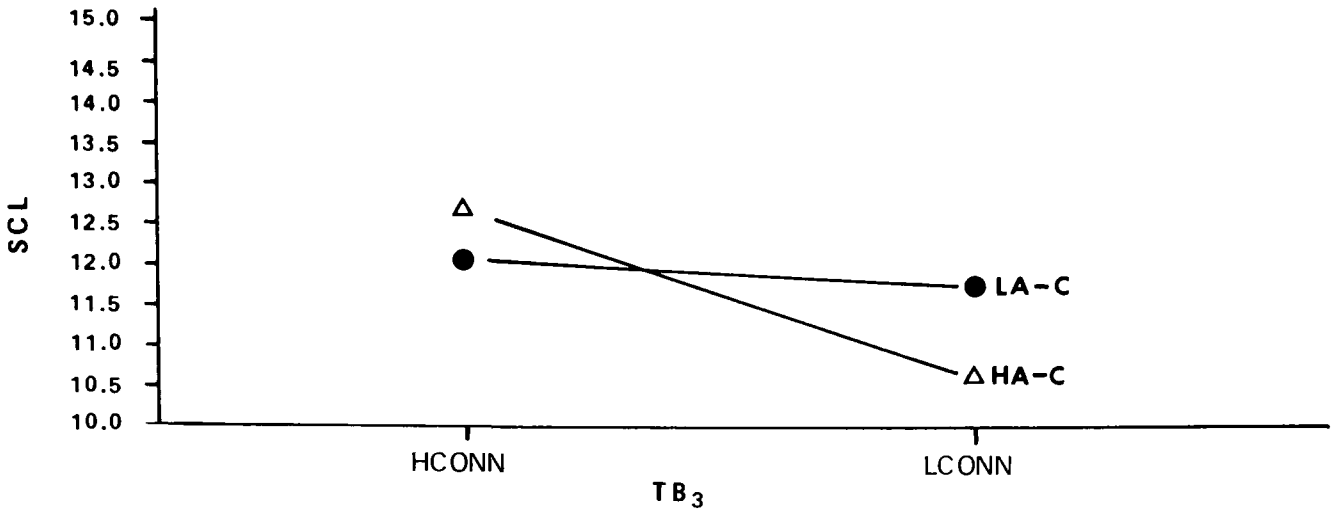
Criteria \ Hypotheses	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.954	.968	.719*
Roy	.046	.032	.281*
Lawley-Hotelling	.048	.033	.392*
Pillai	.046	.032	.281*

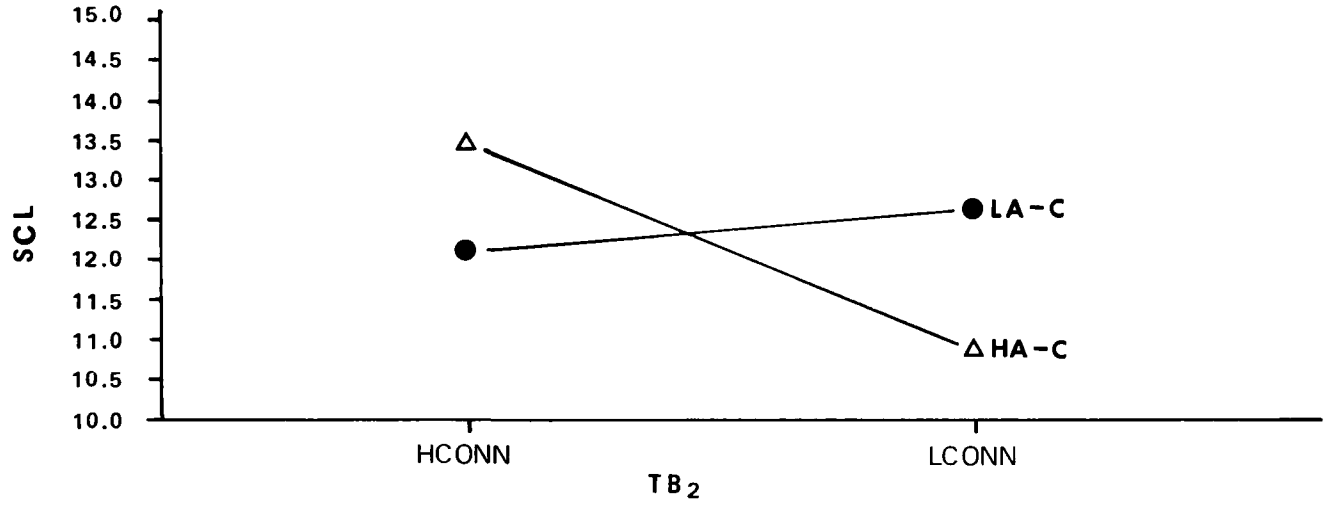
*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.





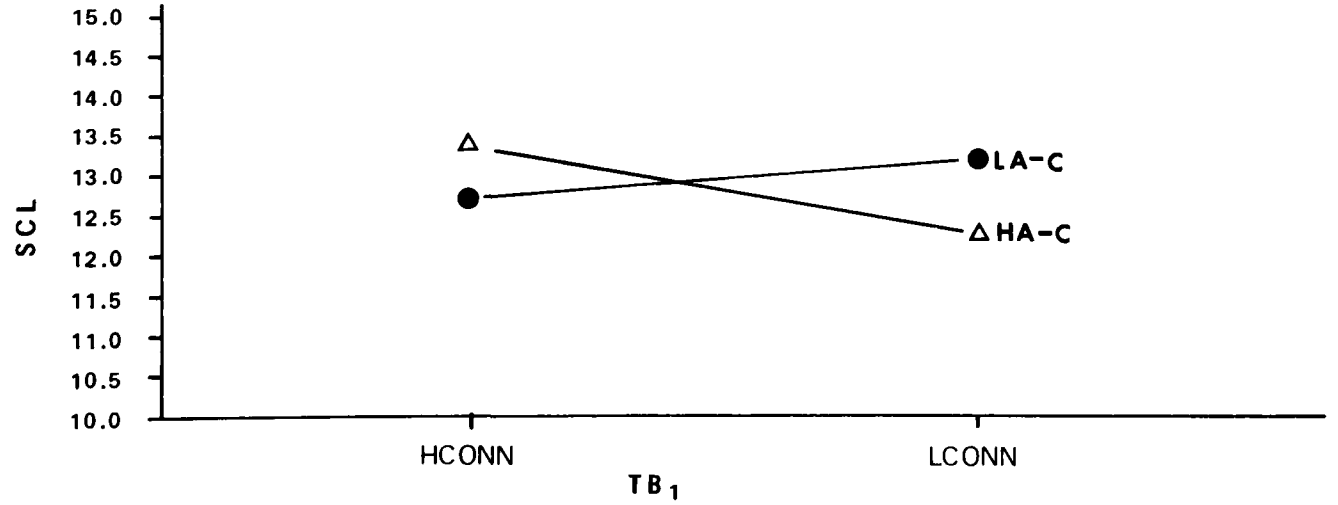


Fig. 12B — The interactions between word concreteness and connotative linguistic meaning for SCL-TB1, SCL-TB2, and SCL-TB3.

Table 56

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCL, for Three Trial Blocks for the Concreteness X Connotative Meaning Interaction (AXB)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	sig.
AXB at TB_1	1.38	2.98	9.99 to -9.10	n.s.
AXB at TB_2	3.84	3.15	12.94 to -5.26	n.s.
AXB at TB_3	1.90	3.24	11.24 to -7.44	n.s.

[a]Critical constant=2.89

Table 57

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
$SCL\text{-}TB_1$	0.10	0.18	-0.11
$SCL\text{-}TB_2$	-0.01	0.39	-0.29
$SCL\text{-}TB_3$	0.17	0.55	-0.14
Bartlett's Test Sig. df (χ^2)	2.01	1.37	14.04**

**$p<.01$, df 3.0

The mean scores for the dependent measures, SCR, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 58, and the graphic representation of the cell means is given in Figure 13. The MANOVA results for the SCR measure are given in Table 59.

Table 58

Mean Scores for the Dependent Measures, Skin Conductance Response (SCR)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
$SCR\text{-}TB_1$	1.31	1.22
$SCR\text{-}TB_2$	0.65	0.54
$SCR\text{-}TB_3$	0.46	0.74
Average	0.81	0.83
	HA-C LConn	LA-C LConn
$SCR\text{-}TB_1$	1.23	0.62
$SCR\text{-}TB_2$	0.51	0.14
$SCR\text{-}TB_3$	0.32	0.11
Average	0.69	0.29

[a]SCR is the first SCR change to peak, occurring from the moment of stimulus onset up to and including five post-stimulus seconds (phasic SC).

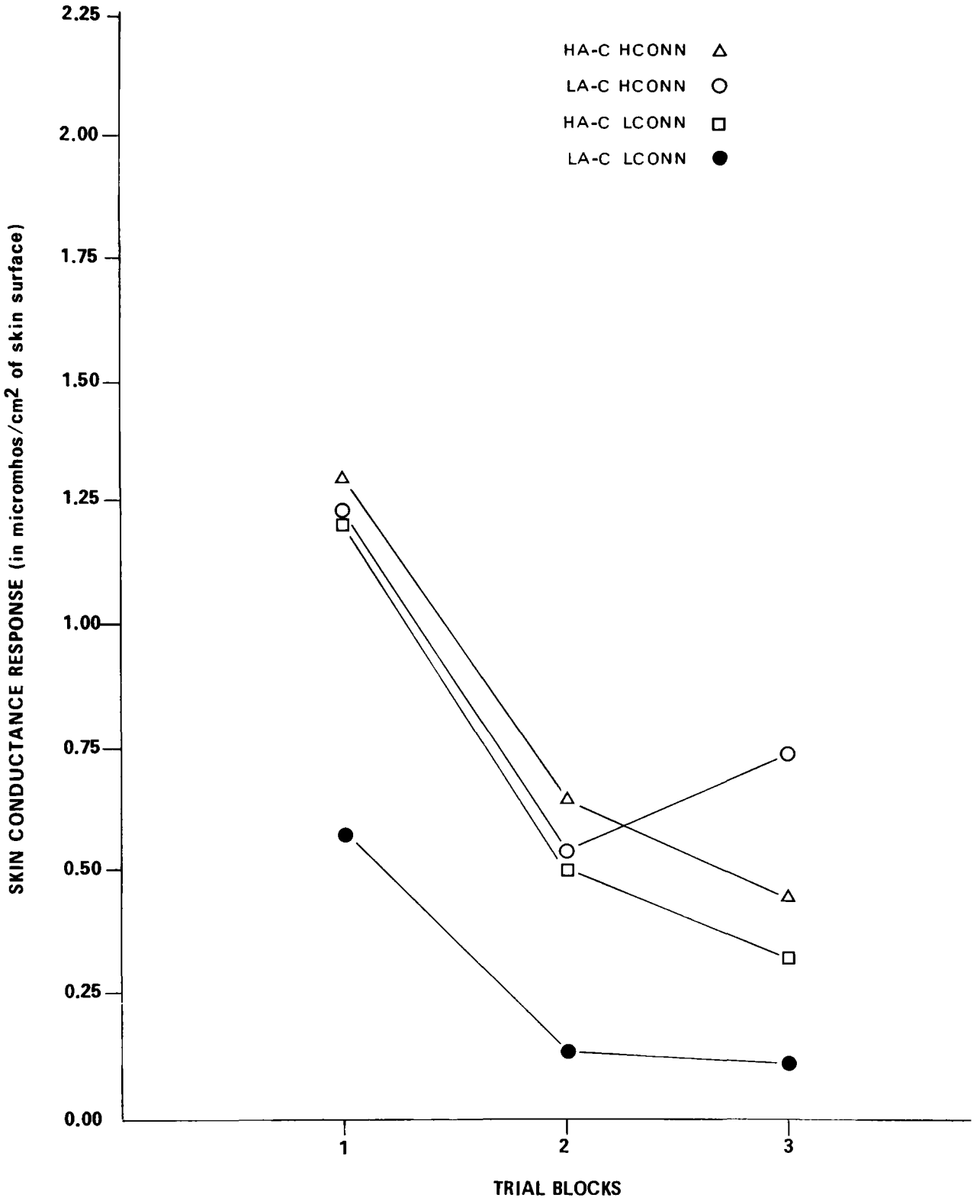


Fig. 13 – Mean skin conductance response to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 59

Multivariate Analysis of Variance for the Dependent Measures, SCR, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.909	.883	.943
Roy	.091	.117	.057
Lawley-Hotelling	.100	.132	.060
Pillai	.091	.177	.057

The mean scores for the dependent measures, SCR-TISI, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 60, and the graphic representation of the cell means is given in Figure 14. The MANOVA results for the SCR-TISI measure are given in Table 61.

Table 60

Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval (SCR-TISI)[a], for Three Trial Blocks, to High and Low Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
SCR-TISI-TB_1	1.54	1.43
SCR-TISI-TB_2	1.03	0.83
SCR-TISI-TB_3	0.72	1.04
Average	1.10	1.10
	HA-C LConn	LA-C LConn
SCR-TISI-TB_1	1.29	0.67
SCR-TISI-TB_2	0.67	0.22
SCR-TISI-TB_3	0.66	0.20
Average	0.87	0.36

[a]SCR-TISI is the first SCR change to peak, occurring from the moment of stimulus onset up to and including the total interstimulus interval.

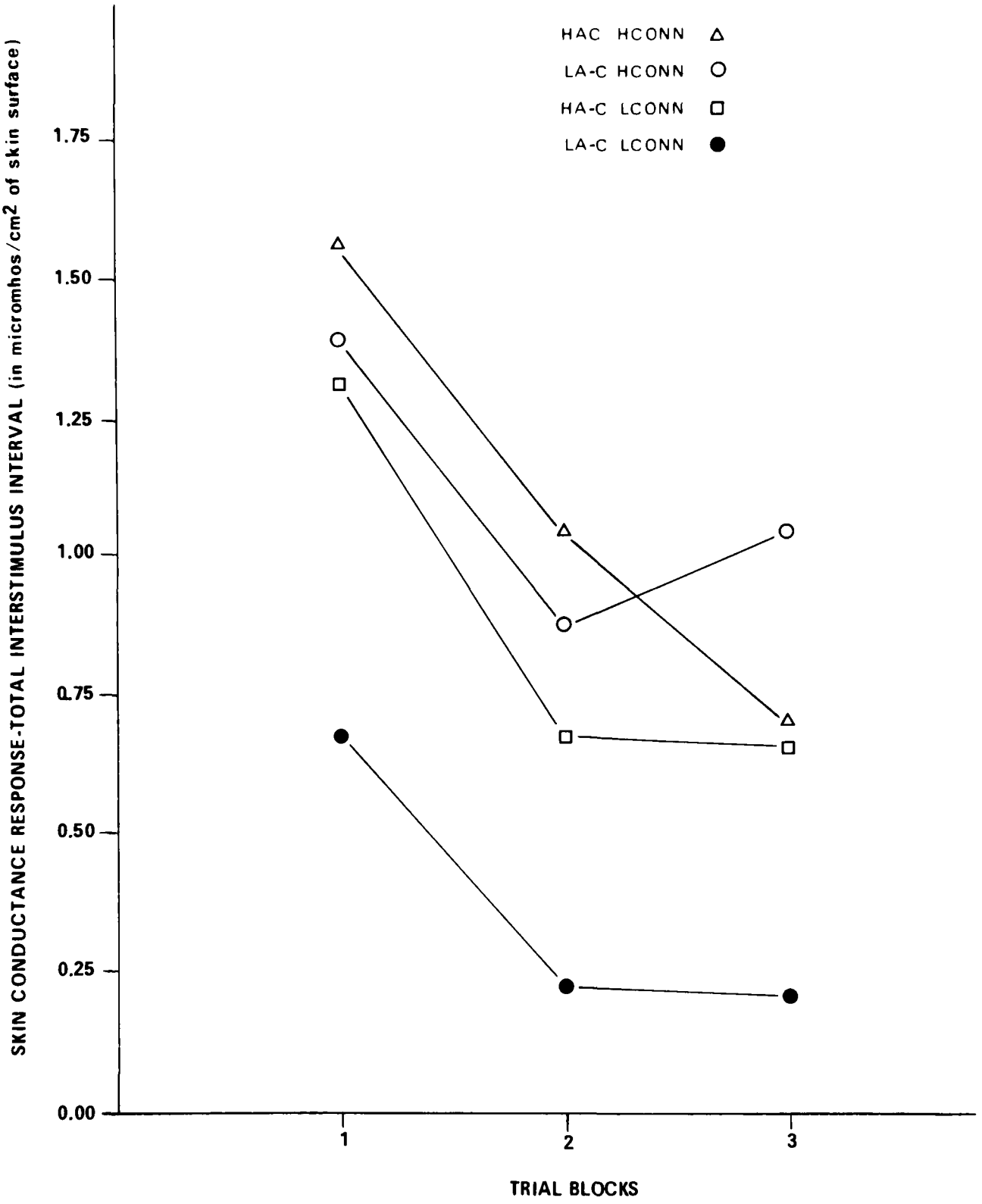


Fig. 14 – Mean skin conductance response-total interstimulus interval to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 61

Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.916	.850	.912
Roy	.084	.150	.088
Lawley-Hotelling	.092	.176	.097
Pillai	.084	.150	.088

The mean scores for the dependent measures, SCL-RAN, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaningful stimuli are presented in Table 62, and the graphic representation of the cell means is given in Figure 15A. The MANOVA results are given in Table 63. The graphic plot of the concreteness X connotative meaning interaction is given in Figure 15B. The analysis of simple contrasts and the GDFA for the main effect, connotative linguistic meaning and the concreteness X connotative meaning interaction are reported in Tables 64 and 65, respectively.

Table 62

Mean Scores for the Dependent Measures, Skin Conductance Level-Range Corrected (SCL-RAN)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
$SCL\text{-}RAN\text{-}TB_1$	0.52	0.48
$SCL\text{-}RAN\text{-}TB_2$	0.56	0.32
$SCL\text{-}RAN\text{-}TB_3$	0.37	0.34
Average	0.48	0.38
	HA-C LConn	LA-C LConn
$SCL\text{-}RAN\text{-}TB_1$	0.52	0.44
$SCL\text{-}RAN\text{-}TB_2$	0.33	0.38
$SCL\text{-}RAN\text{-}TB_3$	0.22	0.21
Average	0.36	0.34

[a]SCL-RAN is the SCL range corrected and expressed as a proportion of the subject's tonic range.

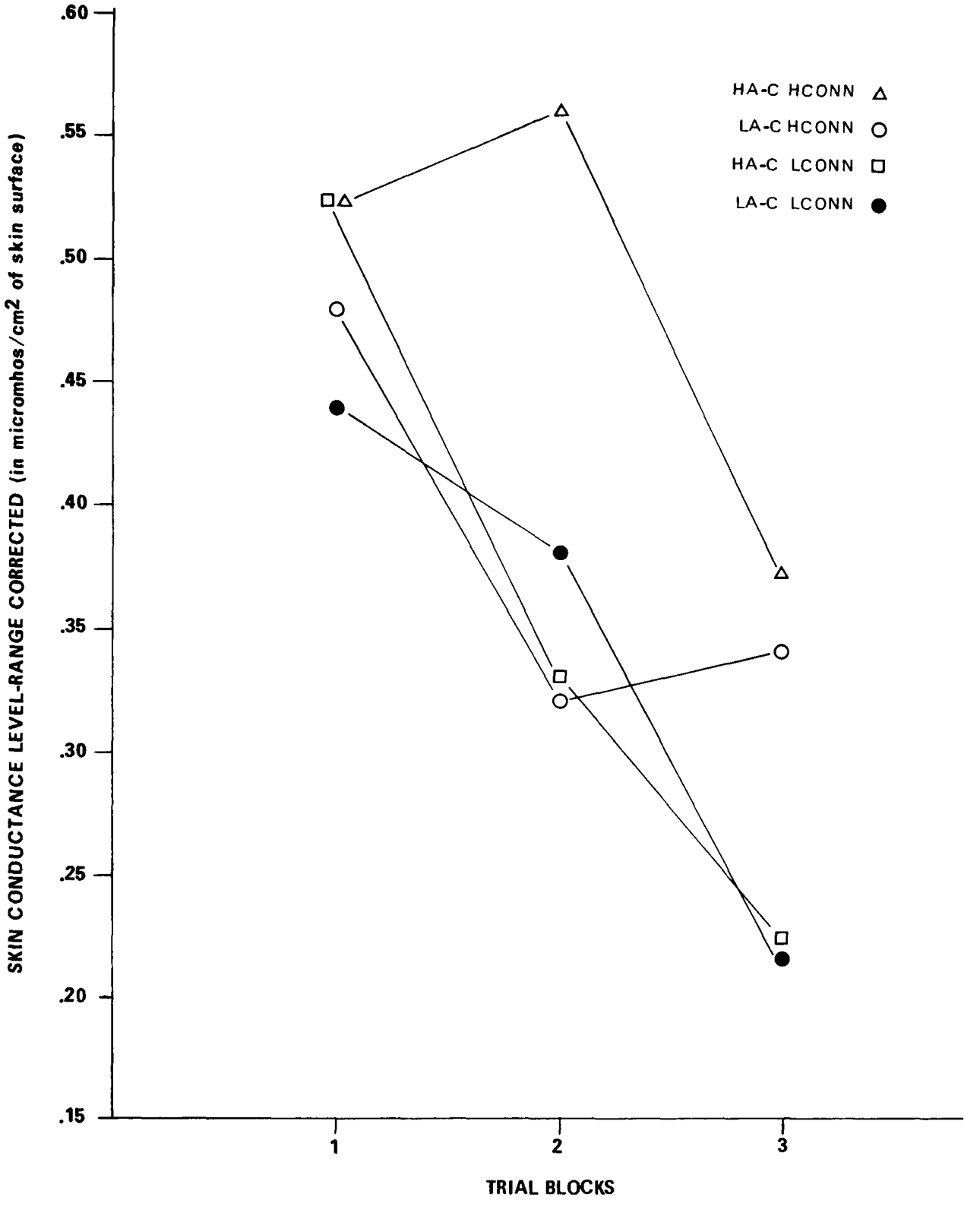


Fig. 15a— Mean skin conductance level-range corrected to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 63

Multivariate Analysis of Variance for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Word Concreteness, and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.895	.820*	.778*
Roy	.105	.180*	.222*
Lawley-Hotelling	.118	.220*	.286*
Pillai	.105	.180*	.222*

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

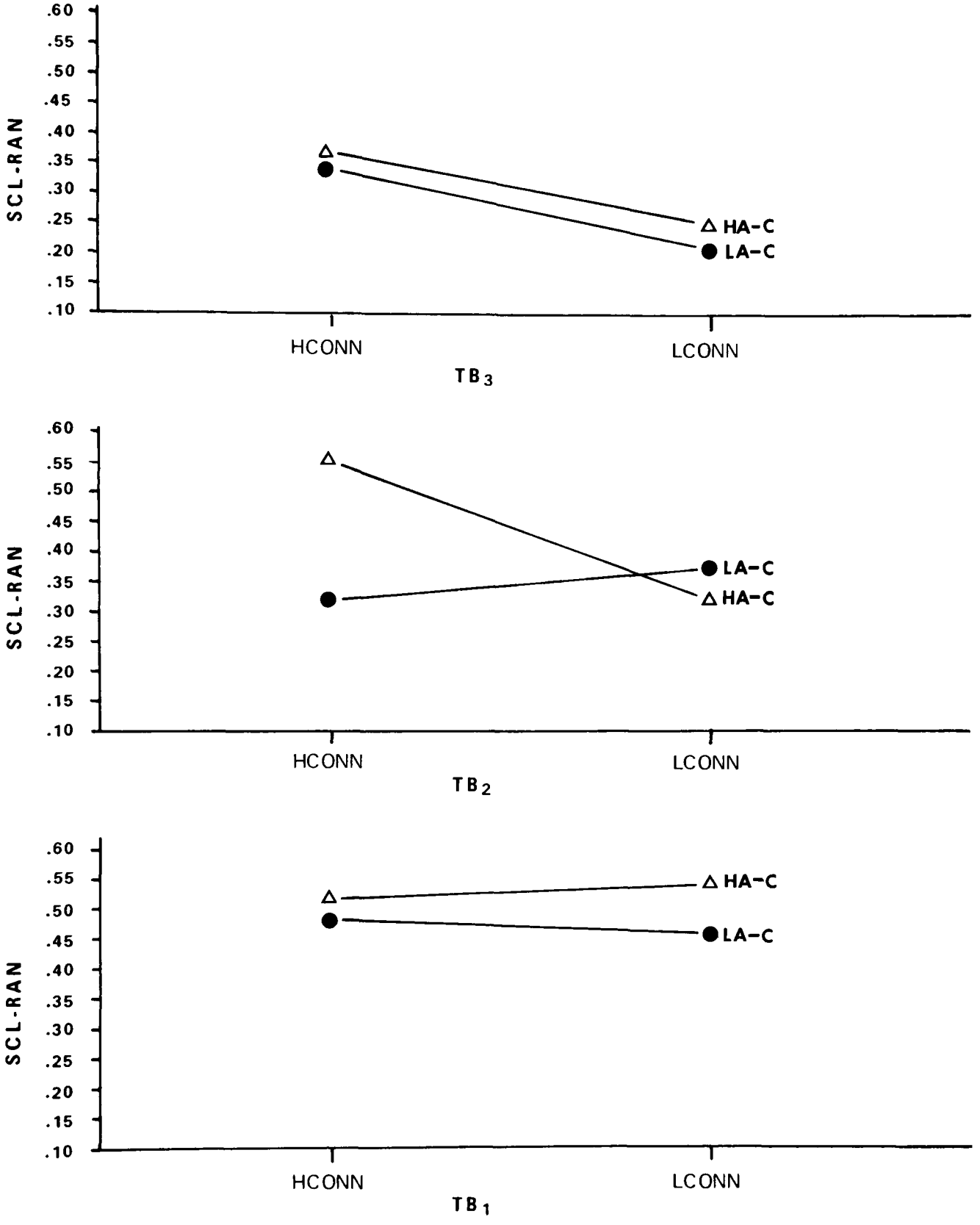


Fig. 15B – The interactions between word concreteness and connotative linguistic meaning for SCL-RAN-TB_1, SCL-RAN-TB_2, and SCL-RAN-TB_3.

Table 64

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCL-RAN, for Three Trial Blocks for the Main Effects, Connotative Linguistic Meaning (B) and the Concreteness X Connotative Meaning Interaction (AXB)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	sig.
B at TB_1	.02	.07	.21 to -.17	n.s.
B at TB_2	.08	.05	.21 to -.05	n.s.
B at TB_3	.14	.06	.30 to -.02	sig.
AXB at TB_1	-.04	.13	.42 to -.34	n.s.
AXB at TB_2	.29	.09	.55 to .03	sig.
AXB at TB_3	.02	.11	.34 to -.30	n.s.

[a]Critical constant=2.89

Table 65

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCL-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
SCL-RAN-TB_1	-0.42	0.08	0.08
SCL-RAN-TB_2	-0.92	-.59	-0.88
SCL-RAN-TB_3	-0.15	0.81	-0.05
Bartlett's Test Sig. df (χ^2)	4.74	8.44*	10.68**

* $p<.05$, df 3.0
** $p<.01$, df 3.0

The mean scores for the dependent measures, SCR-RAN, for three trial blocks, to high and low word concreteness and high and low connotative linguistic meaning stimuli are presented in Table 66, and the graphic representation of the cell means is given in Figure 16. The MANOVA results for the SCR-RAN measure are given in Table 67. The analysis of simple contrasts and the GDFA for the main effects, word concreteness and connotative linguistic meaning, are reported in Tables 68 and 69, respectively.

Table 66

Mean Scores for the Dependent Measures, Skin Conductance Response-Range Corrected (SCR-RAN)[a], for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure	HA-C HConn	LA-C HConn
$SCR\text{-}RAN\text{-}TB_1$	0.32	0.16
$SCR\text{-}RAN\text{-}TB_2$	0.18	0.07
$SCR\text{-}RAN\text{-}TB_3$	0.13	0.07
Average	0.21	0.10
	HA-C LConn	LA-C LConn
$SCR\text{-}RAN\text{-}TB_1$	0.17	0.06
$SCR\text{-}RAN\text{-}TB_2$	0.06	0.01
$SCR\text{-}RAN\text{-}TB_3$	0.04	0.01
Average	0.09	0.03

[a]SCR-RAN is the SCR range corrected and expressed as a proportion of the subject's phasic range.

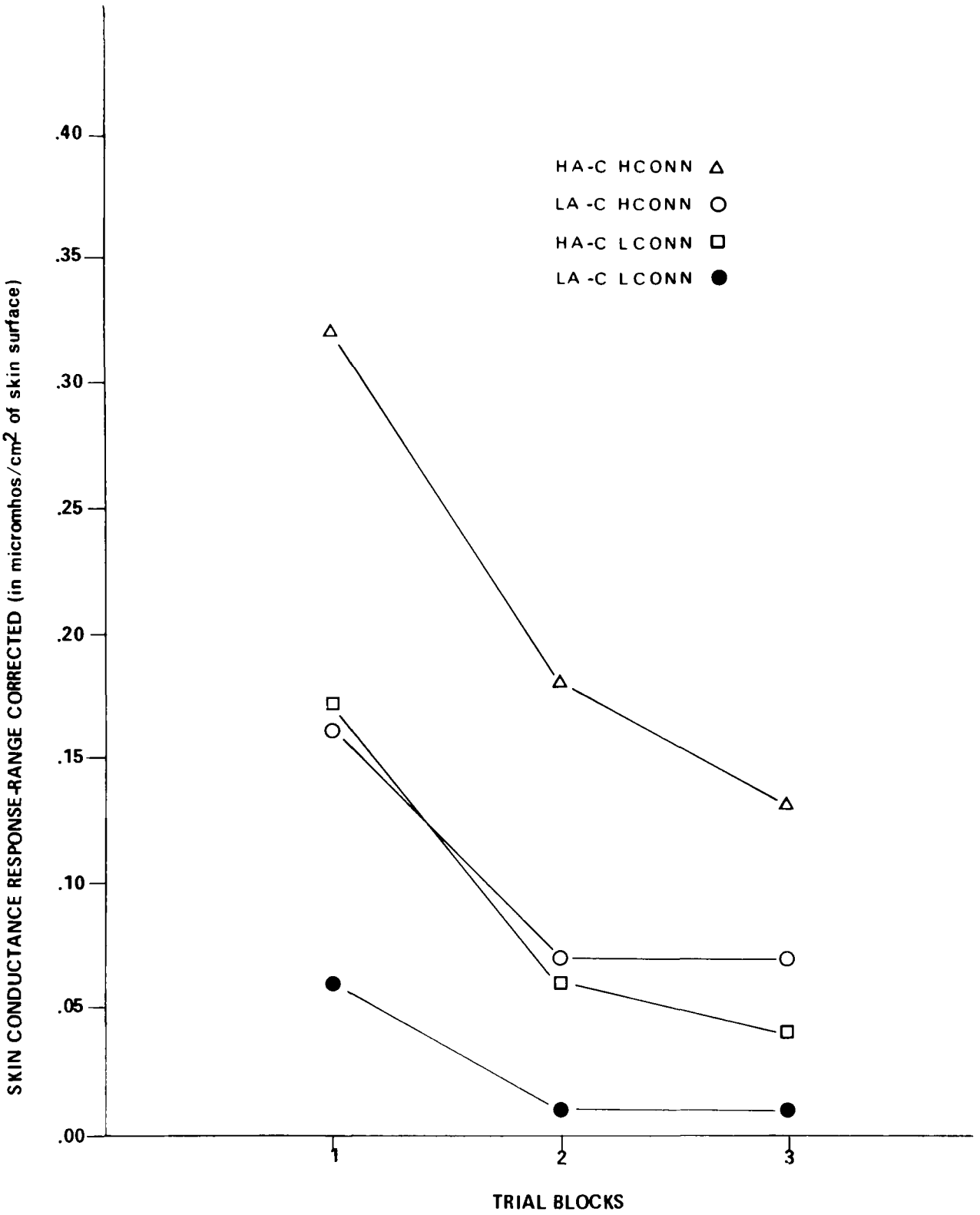


Fig. 16 — Mean skin conductance response-range corrected to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 67

Multivariate Analysis of Variance for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Word Concreteness, and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Criteria	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.696*	.683*	.953
Roy	.304*	.317*	.047
Lawley-Hotelling	.436*	.463*	.050
Pillai	.304*	.317*	.047

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 68

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR-RAN, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B)

Contrast Source	Estimate of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	.14	.03	.23 to .05	sig.
A at TB_2	.07	.03	.16 to -.02	sig.
A at TB_3	.04	.03	.13 to -.05	n.s.
B at TB_1	.13	.03	.22 to .04	sig.
B at TB_2	.09	.03	.18 to .00	sig.
B at TB_3	.08	.03	.17 to -.01	sig.

[a]Critical constant=2.89

Table 69

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
SCR-RAN-TB_1	-0.94	-0.84	-0.62
SCR-RAN-TB_2	-0.58	-0.71	-0.70
SCR-RAN-TB_3	-0.37	-0.62	-0.26
Bartlett's s_2 Test Sig. df (χ^2)	15.37**	16.18**	2.06

** $p<.01$, df 3.0

The mean scores for the dependent measures, SCR-TISI-RAN, for three trial blocks, to high and low word concreteness and high and low connotative meaningful linguistic stimuli are presented in Table 70, and the graphic representation of the cell means is given in Figure 17. The MANOVA results for the SCR-TISI-RAN measure are given in Table 71. The analysis of simple contrasts and the GDFA for the main effects, word concreteness and connotative linguistic meaning, are reported in Tables 72 and 73, respectively.

Table 70

Mean Scores for the Dependent Measures, Skin Conductance Response-Total Interstimulus Interval-Range Corrected (SCR-TISI-RAN) , for Three Trial Blocks, to High and Low Word Concreteness (HA-C, LA-C) and High and Low Connotative (HConn, LConn) Linguistic Meaningful Stimuli

Dependent Measure		
	HA-C HConn	LA-C HConn
SCR-TISI-RAN-TB_1	0.32	0.18
SCR-TISI-RAN-TB_2	0.27	0.12
SCR-TISI-RAN-TB_3	0.20	0.11
Average	0.26	0.14
	HA-C LConn	LA-C LConn
SCR-TISI-RAN-TB_1	0.17	0.06
SCR-TISI-RAN-TB_2	0.08	0.02
SCR-TISI-RAN-TB_3	0.08	0.02
Average	0.11	0.03

[a]SCR-TISI-RAN is the SCR-TISI range corrected and expressed as a proportion of each subject's phasic range.

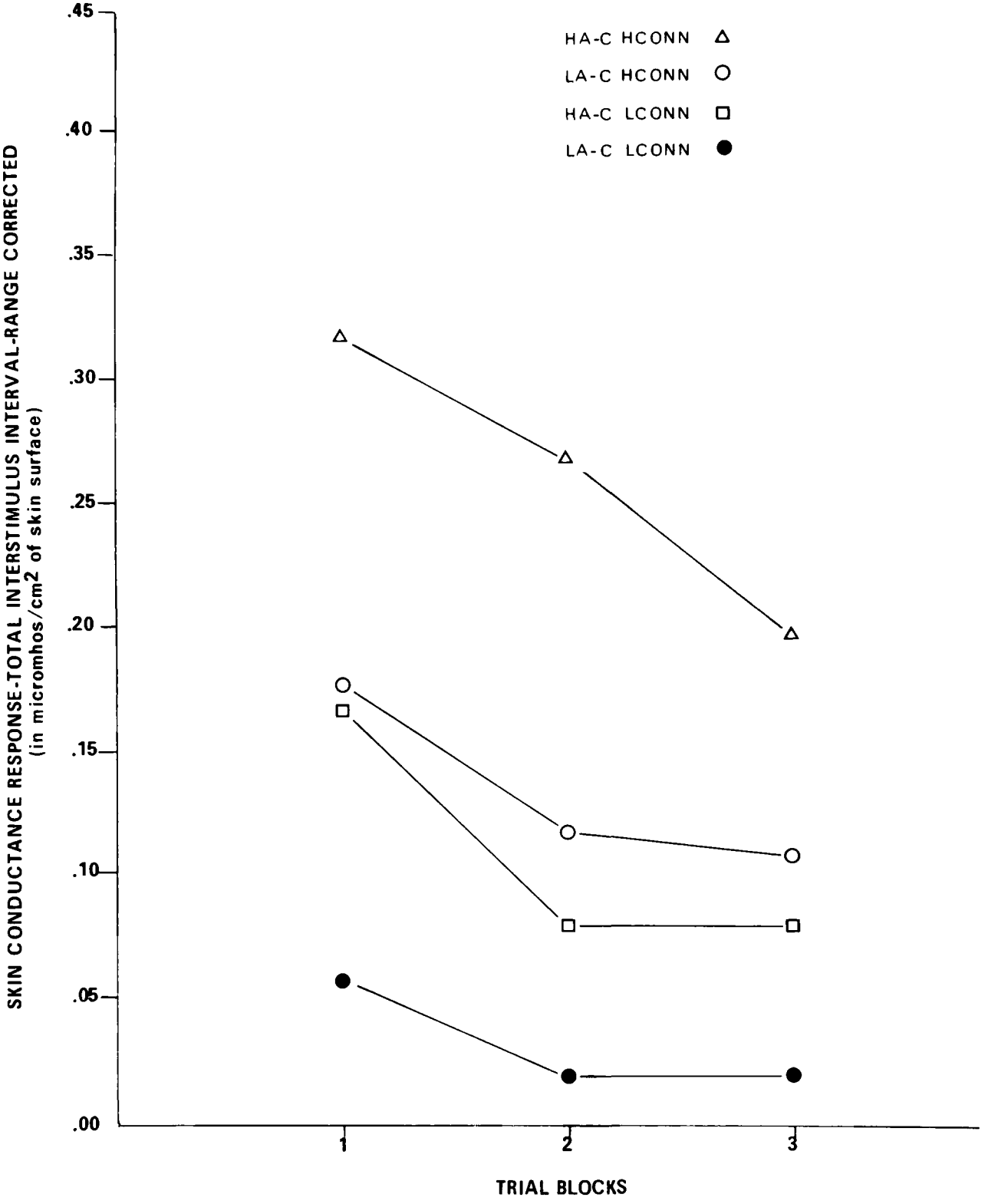


Fig. 17 — Mean skin conductance response-total interstimulus interval-range corrected to high and low word concreteness (HA-C, LA-C) and high and low connotative (HCONN, LCONN) linguistic meaningful stimuli.

Table 71

Multivariate Analysis of Variance for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Criteria \ Hypotheses	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
Wilks	.600*	.536*	.924
Roy	.400*	.464*	.076
Lawley-Hotelling	.667*	.867*	.082
Pillai	.400*	.464*	.076

*(Wilks) H_A, H_B, H_{AB} rejected at the significance level α=.05 if <.840, p=3, df 1,44.

*(Roy) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

*(Lawley-Hotelling) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.187, s=1, m=0.5, n=20.

*(Pillai) H_A, H_B, H_{AB} rejected at the significance level α=.05 if >.160, s=1, m=0.5, n=20.

Table 72

Analysis of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks for the Main Effects, Word Concreteness (A) and Connotative Linguistic Meaning (B)

Contrast Source	Estimates of Contrasts	Standard Errors of Contrasts	Intervals	Sig.
A at TB_1	.16	.03	.25 to .07	sig.
A at TB_2	.10	.04	.22 to -.02	sig.
A at TB_3	.07	.03	.16 to -.02	sig.
B at TB_1	.16	.03	.25 to .07	sig.
B at TB_2	.14	.04	.26 to .02	sig.
B at TB_3	.11	.03	.20 to .02	sig.

[a]Critical constant=2.89

Table 73

Generalized Discriminant Function Analysis (GDFA), Indicating the Correlation of Each Dependent Measure with the Discriminant Function for the Dependent Measures, SCR-TISI-RAN, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Conn Meaning	H_{AB} Concr.X Conn Meaning
SCR-TISI-RAN-TB_1	-0.93	-0.86	-0.81
SCR-TISI-RAN-TB_2	-0.51	-0.60	-0.66
SCR-TISI-RAN-TB_3	-0.44	-0.58	-0.23
Bartlett's Test Sig. df (χ^2)	21.73**	26.52**	3.36

**$p<.01$, df 3.0

The summaries for the multivariate analyses of variance, the analyses of simple contrasts, and the generalized discriminant function analyses for the eight dependent measures in experiment II are presented in Tables 74, 75, and 76, respectively.

Table 74

Summary of the Multivariate Analyses of Variance for the Dependent Measures in Experiment II, for Three Trial Blocks, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Connotative Meaning	H_{AB} Concr.X Conn Meaning
LAT_1	n.s.	n.s.	n.s.
LAT_2	*	*	n.s.
SCL	n.s.	n.s.	*
SCR	n.s.	n.s.	n.s.
SCR-TISI	n.s.	n.s.	n.s.
SCL-RAN	n.s.	*	*
SCR-RAN	*	*	n.s.
SCR-TISI-RAN	*	*	n.s.

*The multivariate hypothesis was rejected at the significance level α=.05 for one or more of the four multivariate criteria (λ,θ, U, V).

Table 75

Summary of the Analyses of Simple Contrasts (Roy's Criterion)[a] for the Dependent Measures in Experiment II, for Three Trial Blocks, for the Main Effects, Word Concreteness and Connotative Linguistic Meaning, and the Concreteness X Connotative Meaning Interaction (AXB)

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Connotative Meaning	H_{AB} Concr.X Conn Meaning
LAT_2	n.s.	TB_2	n.s.
SCL	n.s.	n.s.	n.s.
SCL-RAN	n.s.	TB_3	TB_2
SCR-RAN	TB_1,TB_2	TB_1,TB_2,TB_3	n.s.
SCR-TISI-RAN	TB_1,TB_2,TB_3	TB_1,TB_2,TB_3	n.s.

[a]The listing of a TB for an hypothesis indicates that the simple contrast was significant at the α=.05 level.

Table 76

Summary of the Generalized Discriminant Function Analyses for the Dependent Measures in Experiment II, to High and Low Word Concreteness and High and Low Connotative Linguistic Meaningful Stimuli, Indicating the Contribution of the Three Trial Blocks to the Rejection of the Hypothesis[a]

Hypotheses / Dependent Measure	H_A Word Concreteness	H_B Connotative Meaning	H_{AB} Concr.X Conn Meaning
LAT_2	$(TB_1, TB_2)TB_3$	TB_2, TB_3, TB_1	n.s.
SCL	n.s.	n.s.	$TB_2(TB_1, TB_3)$
SCL-RAN	n.s.	TB_3, TB_2, TB_1	$TB_2(TB_1, TB_3)$
SCR-RAN	TB_1, TB_2, TB_3	$TB_1(TB_2, TB_3)$	n.s.
SCR-TISI-RAN	$TB_1(TB_2, TB_3)$	TB_1, TB_2, TB_3	n.s.

[a]The importance of each TB to the rejection of the hypothesis is indicated by the order in which it is listed, with the most important starting from the left. When two TBs appear in brackets, this indicates that they contributed about equally to the rejection of the hypothesis.

C. The Physiological (Dependent) Measures of the Study

The descriptive statistics for the eight physiological measures (LAT_1, LAT_2, SCL, SCR, SCR-TISI, SCL-RAN, SCR-RAN, SCR-TISI-RAN) for the first trial block, and the four correlates of the primary dependent measures ($Spont_1$, $Spont_2$, E, N) are presented in Table 77. The descriptive statistics for the eight physiological measures (LAT_1, LAT_2, SCL, SCR, SCR-TISI, SCL-RAN, SCR-RAN, SCR-TISI-RAN) for the second and third trial blocks are reported in Tables 78 and 79, respectively. Three measures of central tendency (mean, mode, median), two measures of dispersion (SD, range), as well as estimates of kurtosis and skewness are reported in the three tables.

Table 77

The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the First Trial Block and the Four Correlates of the Dependent Measures in Experiments I and II Combined (n=96)

Dependent Measure	Mean	Mode	Median	SD	Range	Kurtosis[b]	Skewness[a]
LAT_1	3.54	4.04	3.58	0.86	1.4-4.9	-0.91	-0.24
LAT_2	15.89	30.70	14.80	8.86	1.4-31	-0.13	0.13
SCL	13.34	8.06	13.08	5.43	3.77-28.66	-0.32	0.51
SCR	1.29	0.87	1.01	1.07	.025-4.74	0.50	1.04**
SCR-TISI	1.42	1.84	1.29	1.09	.025-4.74	0.43	0.89**
SCL-RAN	0.47	0.46	0.44	0.23	0.09-0.91	-0.90	0.15
SCR-RAN	0.19	0.30	0.15	0.15	0.08-0.66	1.04	1.18**
SCR-TISI-RAN	0.21	0.30	0.18	0.16	0.08-0.69	0.42	0.92**
$Spont_1$	5.15	1.00	3.39	5.66	0-26	2.60**	1.69**
$Spont_2$	12.48	1.00	8.17	14.27	0-73	3.79**	1.87**
E (A+B)	26.74	24.00	26.83	6.52	11-43	-0.19	-0.13
N (A+B)	25.44	25.00	25.50	8.64	5-45	-0.65	-0.01

[a]Kurtosis values significant at the .01 level of confidence (**) if >1.3, n=96.

[b]Skewness values significant at the .01 level of confidence (**) if >.65, n=96.

Table 78

The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the Second Trial Block in Experiments I and II Combined (n=96

Dependent Measure	Mean	Mode	Median	SD	Range	Kurtosis[a]	Skewness[b]
LAT_1	4.04	5.00	4.22	0.86	1.6-5.0	-0.28	-0.77**
LAT_2	20.52	33.20	22.85	9.75	2.0-33.20	-1.21	-0.29
SCL	12.95	14.84	12.90	5.88	2.19-26.35	-0.71	0.25
SCR	0.66	0.00	0.37	.86	0.00-4.69	7.18**	2.38**
SCR-TISI	0.93	0.00	0.61	0.99	0.00-4.69	2.61**	1.53**
SCL-RAN	0.39	0.26	0.37	0.18	0.06-0.92	-0.27	0.31
SCR-RAN	0.10	0.00	0.05	0.12	0.00-0.66	6.31**	2.26**
SCR-TISI-RAN	0.14	0.00	0.08	0.15	0.00-0.75	3.03**	1.60**

[a]Kurtosis values significant at the .01 level of confidence (**) if >1.3, n=96.

[b]Skewness values significant at the .01 level of confidence (**) if >.65, n=96.

Table 79

The Descriptive Statistics for the Eight Dependent (Physiological) Measures for the Third Trial Block in Experiments I and II Combined (n=96)

Dependent Measure	Mean	Mode	Median	SD	Range	Kurtosis[a]	Skewness[b]
LAT_1	4.19	5.00	4.40	0.81	1.7-5.0	0.69	-1.11**
LAT_2	21.86	33.60	23.15	9.29	1.7-34.6	-0.98	-0.34
SCL	12.51	17.95	12.41	5.94	1.88-26.19	-0.75	0.29
SCR	0.62	0.00	0.28	0.95	0.00-4.99	7.48**	2.64**
SCR-TISI	0.91	0.00	0.62	1.02	0.00-4.99	4.47**	1.96**
SCL-RAN	0.30	0.38	0.29	0.19	0.02-0.89	0.15	0.68**
SCR-RAN	0.08	0.00	0.04	0.12	0.00-0.70	8.50**	2.60**
SCR-TISI-RAN	0.13	0.00	0.93	1.34	0.00-0.70	3.60**	1.63**

[a]Kurtosis values significant at the .01 level of confidence (**) if >1.3, n=96.

[b]Skewness values significant at the .01 level of confidence (**) if >.65, n=96.

D. The Correlations Between the Physiological (Dependent) Measures

The Pearson intercorrelation matrices for the eight physiological measures (LAT_1, LAT_2, SCL, SCR, SCR-TISI, SCL-RAN, SCR-RAN, SCR-TISI-RAN) and their correlates ($Spont_1$, $Spont_2$, E, and N) in experiments I and II combined for the first, second and third trial blocks are presented in Tables 80, 81, and 82, respectively. The Kendall (tau) intercorrelation matrices for the 12 measures, in experiments I and II combined for the first, second and third trial blocks are given in Tables 83, 84, and 85, respectively. The canonical correlation analysis between the E and N variables, and $SCL\text{-}TB_1$, $SCL\text{-}TB_2$, $SCL\text{-}TB_3$ is given in Table 86, and the canonical correlation between the E and N variables and the $Spont_1$ and $Spont_2$ variables is given in Table 87.

Table 80

Intercorrelation Matrix (Pearson Correlations) of the Dependent Measures for the First Trial Block in Experiments I and II Combined (n=96)

	Variables[a]											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.95*	1.00										
3	-.58*	-.59*	1.00									
4	-.76*	-.76*	.55*	1.00								
5	-.74*	-.75*	.59*	.98*	1.00							
6	.04	.06	.10	.07	.05	1.00						
7	-.70*	-.72*	.37*	.76*	.74*	.16	1.00					
8	-.66*	-.69*	.38*	.71*	.72*	.16	.97*	1.00				
9	-.53*	-.49*	.58*	.30*	.31*	-.01	.18	.17	1.00			
10	-.70*	-.63*	.57*	.43*	.42*	-.29*	.22*	.19	.75*	1.00		
11	.14	.14	-.21*	-.13	-.14	-.03	.10	.10	-.22*	-.29*	1.00	
12	-.02	.03	.01	-.02	-.01	.01	-.04	-.05	.05	.09	-.20*	1.00

[a] 1 LAT_1 — 5 SCR-TISI — 9 $Spont_1$
2 LAT_2 — 6 SCL-RAN — 10 $Spont_2$
3 SCL — 7 SCR-RAN — 11 E (A+B)
4 SCR — 8 SCR-TISI-RAN — 12 N (A+B)

*r=.20, p<.05 (n=100)

Table 81

Intercorrelation Matrix (Pearson Correlation) of the Dependent Measures for the Second Trial Block in Experiments I and II Combined (n=96)

	Variables[a]											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.93*	1.00										
3	-.61*	-.66*	1.00									
4	-.80*	-.76*	.57*	1.00								
5	-.77*	-.80*	.60*	.92*	1.00							
6	-.45*	-.47*	.47*	.39*	.40*	1.00						
7	-.77*	-.76*	.46*	.81*	.76*	.52*	1.00					
8	-.70*	-.76*	.46*	.70*	.78*	.54*	.93*	1.00				
9	-.41*	-.41*	.58*	.26*	.29*	.20*	.15	.16	1.00			
10	-.72*	-.70*	.66*	.62*	.63*	.25*	.40*	.36*		1.00		
11	.10	.08	-.19	-.07	-.06	.02	.15	.19			1.00	
12	-.05	-.03	-.01	-.03	-.03	-.03	-.08	-.09				1.00

[a] 1 LAT_1 5 SCR-TISI 9 $Spont_1$
2 LAT_2 6 SCL-RAN 10 $Spont_2$
3 SCL 7 SCR-RAN 11 E (A+B)
4 SCR 8 SCR-TISI-RAN 12 N (A+B)

*r=.20, p<.05 (n=100)

Table 82

Intercorrelation Matrix (Pearson Correlations) of the Dependent Measures for the Third Trial Block in Experiments I and II Combined (n=96)

	Variables[a]											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.91*	1.00										
3	-.52*	-.62	1.00									
4	-.80*	-.73*	.49*	1.00								
5	-.75*	-.75*	.60*	.94*	1.00							
6	-.43*	-.57*	.53*	.43*	.49*	1.00						
7	-.80*	-.76*	.44*	.83*	.76*	.54*	1.00					
8	-.68*	-.76*	.49*	.70*	.77*	.58*	.89*	1.00				
9	-.28*	-.32*	.56*	.23*	.31*	.15	.13	.17	1.00			
10	-.60*	-.65*	.68*	.55*	.58*	.34*	.40*	.37*		1.00		
11	.08	.08	-.18	-.16	-.19	.07	.09	.10			1.00	
12	-.01	-.04	-.01	.03	.02	-.05	-.06	-.09				1.00

[a] 1 LAT_1 5 SCR-TISI 9 $Spont_1$
2 LAT_2 6 SCL-RAN 10 $Spont_2$
3 SCL 7 SCR-RAN 11 E (A+B)
4 SCR 8 SCR-TISI-RAN 12 N (A+B)

*r=.20, p<.05 (n=100)

Table 83

Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the First Trial Block in Experiments I and II Combined (n=96)

	Variables[a]											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.84*	1.00										
3	-.45*	-.47*	1.00									
4	-.63*	-.63*	.47*	1.00								
5	-.59*	-.61*	.49*	.90*	1.00							
6	.03	.04	.05	.03	.04	1.00						
7	-.57*	-.56*	.33*	.62*	.60*	.13*	1.00					
8	-.52*	-.53*	.30*	.56*	.58*	.11*	.88*	1.00				
9	-.44*	-.39*	.46*	.35*	.34*	.00	.25*	.22*	1.00			
10	-.54*	-.52*	.50*	.43*	.43*	-.22*	.26*	.24*	.57*	1.00		
11	.09	.09	-.12*	-.08	-.09	-.02	.06	.05	-.16*	-.13*	1.00	
12	-.03	.01	-.01	.00	.00	-.01	-.04	-.05	.05	.09	-.13*	1.00

[a] 1 LAT_1 5 SCR-TISI 9 $Spont_1$
2 LAT_2 6 SCL-RAN 10 $Spont_2$
3 SCL 7 SCR-RAN 11 E (A+B)
4 SCR 8 SCR-TISI-RAN 12 N (A+B)

*Tau=.11, $p<.05$ (n=100)

Table 84

Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the Second Trial Block in Experiments I and II Combined

	Variables[a]											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.82	1.00										
3	-.48*	-.51*	1.00									
4	-.75*	-.75*	.50*	1.00								
5	-.67*	-.74*	.51*	.81*	1.00							
6	-.33*	-.33*	.34*	.32*	.29*	1.00						
7	-.75*	-.74*	.42*	.82*	.73*	.37*	1.00					
8	-.65*	-.72*	.41*	.70*	.78*	.34*	.80*	1.00				
9	-.32*	-.34*	.45*	.32*	.34*	.17*	.27*	.26*	1.00			
10	-.54*	-.56*	.58*	.53*	.53*	.25*	.43*	.40*		1.00		
11	.04	.04	-.10	-.06	-.03	-.02	-.01	.06			1.00	
12	-.05	-.03	.01	.05	.01	-.01	.01	-.02				1.00

[a] 1 LAT_1 5 SCR-TISI 9 $Spont_1$
2 LAT_2 6 SCL-RAN 10 $Spont_2$
3 SCL 7 SCR-RAN 11 E (A+B)
4 SCR 8 SCR-TISI-RAN 12 N (A+B)

*Tau=.11, $p<.05$ (n=100)

Table 85

Intercorrelation Matrix (Kendall Correlations) of the Dependent Measures for the Third Trial Block in Experiments I and II Combined (n=96)

	Variables											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00											
2	.79*	1.00										
3	-.44*	-.46*	1.00									
4	-.83*	-.76*	.49*	1.00								
5	-.66*	-.73*	.54*	.75*	1.00							
6	-.38*	-.43*	.41*	.45*	.47*	1.00						
7	-.76*	-.71*	.41*	.84*	.66*	.45*	1.00					
8	-.57*	-.66*	.42*	.63*	.76*	.46*	.71*	1.00				
9	-.28*	-.26*	.43*	.28*	.30*	.14*	.23*	.24*	1.00			
10	-.46*	-.49*	.58*	.47*	.49*	.32*	.39*	.38*		1.00		
11	.05	.05	-.10	-.06	-.07	.03	-.01	.01			1.00	
12	-.04	-.04	.00	.03	.02	.00	.01	-.01				1.00

[a]1 LAT_1 5 SCR-TISI 9 $Spont_1$
2 LAT_2 6 SCL-RAN 10 $Spont_2$
3 SCL 7 SCR-RAN 11 E (A+B)
4 SCR 8 SCR-TISI-RAN 12 N (A+B)

*Tau=.11, $\underline{p}<.05$ (n=100)

Table 86

Canonical Correlation Analysis Between the E and N Variables in the First Set, and the SCL-TB_1, SCL-TB_2, and SCL-TB_3 Variables in the Second Set

No.	Eigenvalue	Canonical Correlation	Wilks λ	χ^2	df	Significance
1	.05	.22	.950	4.79	6	.57 (n.s.)

Coefficients for the Canonical Variables (CANVAR 1)[a]

First Set		Second Set	
E	1.02	SCL-TB_1	-1.75
N	.19	SCL-TB_2	1.53
		SCL-TB_3	-.73

[a]When no canonical correlation is found at the .05 level of significance, only the first (nonsignificant) canonical correlation is printed. (SPSS subprogram CANCORR)

Table 87

Canonical Correlation Analysis Between the E and N Variables in the First Set, and the $Spont_1$ and $Spont_2$ Variables in the Second Set

No.	Eigenvalue	Canonical Correlation	Wilks λ	χ^2	df	Significance
1	.085	.29	.914	8.44	4	.08 (n.s.)

Coefficients for the Canonical Variables (CANVAR 1)[a]

First Set		Second Set	
E	-.98	$Spont_1$	.03
N	.10	$Spont_2$	.98

[a]When no canonical correlation is found at the .05 level of significance, only the first (nonsignificant) canonical correlation is printed. (SPSS subprogram CANCORR)

E. The Reliability of the Physiological Measures

The intrasession stability coefficients for adjacent trial blocks for the eight physiological measures in experiments I and II are given in Table 88. The overall mean stability coefficients for all adjacent trial blocks and all measures are .73 for experiment I and .62 for experiment II, yielding a final mean stability coefficient for both experiments combined of $\underline{r} = .68$.

Table 88

Estimates of the Intrasession Reliability Coefficients for Adjacent Trial Blocks for the Physiological Measures in Experiment I (n=48) and Experiment II (n=48)

Physiological Measures	Reliability Coefficients					
	Experiment I (TBs)			Experiment II (TBs)		
	1 with 2	2 with 3	Average	1 with 2	2 with 3	Average
LAT_1	.76*	.70*	.73*	.53*	.69*	.61*
LAT_2	.77*	.79*	.78*	.60*	.80*	.70*
SCL	.96*	.97*	.97*	.94*	.97*	.96*
SCR	.69*	.79*	.74*	.48*	.55*	.52*
SCR-TISI	.67*	.86*	.77*	.50*	.63*	.56*
SCL-RAN	.29*	.40*	.35*	.06	.42*	.24*
SCR-RAN	.70*	.80*	.75*	.51*	.88*	.70*
SCR-TISI-RAN	.69*	.82*	.76*	.55*	.81*	.68*
Means	.69*	.77*	.73*	.52*	.72*	.62*

*r=.28, p < .05 (n=48, each sample)

3. The Evaluation of the Null Hypotheses

The results of the statistical anlyses carried out on the physiological data in experiment I provided tests of the multivariate hypotheses for the effects of denotative and connotative linguistic meaning on the various habituation measures. Experiment II provided tests of the multivariate hypotheses for the effects of word concreteness and connotative linguistic meaning on the habituation measures. Therefore, the results of experiment I for connotative linguistic meaning (factor B) were replicated for the second factor (B) in experiment II. Finally, the correlational analyses provided tests of the various correlational hypotheses between the extraversion and neuroticism variables and the physiological measures.

The multivariate null hypotheses for denotative linguistic meaning (Ho 1.1 to 1.8), connotative linguistic meaning (Ho 2.1 to 2.8), and word concreteness (3.1 to 3.8) for the dependent measures in habituation experiments I and II are evaluated (rejected or not rejected) in Table 89.

The multivariate hypotheses for the A X B interactions in experiment I (denotative X connotative meaning) and experiment II (concreteness X connotative meaning), reported in Tables 45 and 74, will not be evaluated in this section of Chapter III. The reason for this is that the interaction

Table 89

The Evaluation of the Multivariate Null Hypotheses for Denotative Linguistic Meaning (Ho 1.1 to 1.8), Connotative Linguistic Meaning (Ho 2.1 to 2.8), and Word Concreteness (Ho 3.1 to 3.8) for the Dependent Measures in Experiments I and II

MANOVA Ho	Dependent Measures	Experiment I	Experiment II
1.1	LAT_1	N.R.	-
1.2	LAT_2	*	-
1.3	SCL	*	-
1.4	SCR	N.R.	-
1.5	SCR-TISI	N.R.	-
1.6	SCL-RAN	*	-
1.7	SCR-RAN	*	-
1.8	SCR-TISI-RAN	*	-
2.1	LAT_1	*	N.R.
2.2	LAT_2	*	*
2.3	SCL	N.R.	N.R.
2.4	SCR	*	N.R.
2.5	SCR-TISI	*	N.R.
2.6	SCL-RAN	N.R.	*
2.7	SCR-RAN	*	*
2.8	SCR-TISI-RAN	*	*
3.1	LAT_1	*	N.R.
3.2	LAT_2	-	*
3.3	SCL	-	N.R.
3.4	SCR	-	N.R.
3.5	SCR-TISI	-	N.R.
3.6	SCL-RAN	-	N.R.
3.7	SCR-RAN	-	*
3.8	SCR-TISI-PAN	-	*

*The multivariate hypothesis was rejected at the $\alpha.05$ level of significance
N.R.: The multivariate hypothesis was not rejected at the $\alpha.05$ level of significance.

hypothese were not made on an a priori basis in Chapter I as were the hypotheses for the main effects, but rather were logical consequences of the two factor (A, B) manipulations provided in both experiments. The significant concreteness X connotative meaning interactions reported in Table 74 for the SCL and SCL-RAN measures will be discussed in the appropriate section of Chapter IV.

The correlational (univariate) hypotheses between the extraversion (Ho 4.1 to 4.10) and neuroticism (Ho 5.1 to 5.10) variables and the physiological measures in experiments I and II combined are evaluated in Table 90. Because the writer adopts the position that any positive evidence is sufficient to reject a null hypothesis, the correlational analyses for all three trial blocks, and both the r and tau correlations were used to evaluate the correlational hypotheses for the extraversion and neuroticism variables. The importance of these (univariate) correlations, as well as the multivariate (canonical) correlations reported in Tables 86 and 87 for Eysenck's theory, will be discussed in Chapter IV.

Table 90

The Evaluation of the Correlational (Univariate) Hypotheses Between the Extraversion (Ho 4.1 to 4.10) and Neuroticism (Ho 5.1 to 5.10) Variables and the Physiological Measures in Experiments I and II Combined (n=96)

Correlational Ho	Dependent Measures	Experiments I and II Combined
4.1	LAT_1	N.R.
4.2	LAT_2	N.R.
4.3	SCL	*
4.4	SCR	N.R.
4.5	SCR-TISI	N.R.
4.6	SCL-RAN	N.R.
4.7	SCR-RAN	N.R.
4.8	SCR-TISI-RAN	N.R.
4.9	$Spont_1$	*
4.10	$Spont_2$	*
5.1	LAT_1	N.R.
5.2	LAT_2	N.R.
5.3	SCL	N.R.
5.4	SCR	N.R.
5.5	SCR-TISI	N.R.
5.6	SCL-RAN	N.R.
5.7	SCR-RAN	N.R.
5.8	SCR-TISI-RAN	N.R.
5.9	$Spont_1$	N.R.
5.10	$Spont_2$	N.R.

*The correlational hypothesis was rejected at the α=.05 level of significance for one or more of the three trial blocks.

REPORT OF RESULTS

The results of the study are discussed and interpreted in Chapter IV.

CSP-2

THE EFFECTS OF DENOTATIVE AND CONNOTATIVE LINGUISTIC MEANING AND WORD CONCRETENESS ON THE HABITUATION OF THE SKIN CONDUCTANCE RESPONSE: EXTRAVERSION AND NEUROTICISM AS SUBJECT VARIABLES

by Ernest C. Desjardins

Thesis presented to the School of Graduate Studies of the University of Ottawa as partial fulfillment of the requirements for the degree of Doctor of Philosophy

Université d'Ottawa BIBLIOTHÈQUES LIBRARIES University of Ottawa
ANNEXE DE LA BIBLIOTHÈQUE uOttawa LIBRARY ANNEX

Ottawa, Canada, 1976

© E.C. Desjardins, Ottawa, Canada, 1976

CHAPTER IV

DISCUSSION OF RESULTS

The last chapter is divided into five sections. The linguistic measures of the study are interpreted in section one. A discussion of the skin conductance habituation data in terms of its relevance for Sokolov's matching hypothesis is presented in section two. The interrelationships between the skin conductance measures are discussed in section three, and the interrelationships between the extraversion and neuroticism measures and the various skin conductance measures are discussed in section four. Some suggestions for additional research are given in the final section of the chapter.

1. The Linguistic Measures of the Study

The descriptive statistics for the six linguistic measures reported in Table 4 indicated that all the distributions are approaching normality. The distributions for the six linguistic measures demonstrated a minor degree of negative kurtosis (flatness), with the concreteness measure yielding the flattest and the m measure the least flat curves. The departure from symmetry (skewness) for the distributions was considerably less, reaching significance only for the

familiarity measure. The distribution characteristics for the linguistic measures suggest that the linearity assumption is reasonably well approximated and that the Pearson (r) correlations reported in Table 5 can be interpreted with a moderate degree of confidence.

The most important finding to emerge from Table 4 is the fact that the distribution characteristics for the denotative measure (m+I scores) are better than those of either the m or I scores taken alone. The theoretical justification for combining (summing) the m and I scores to define an index of denotative linguistic meaning was given in Chapter I, and some statistical support for this procedure is revealed in Table 4.

The m, I, and concreteness mean values obtained in the present study (6.49, 4.81, 4.37) are very similar to those reported by Pavio, Yuille and Madigan (1968) (5.81, 4.97, 4.95). The slightly higher mean value for the m measure reported in the present study can be explained as a function of minor procedural differences. Pavio et al. (1968) used a 30-second time interval for the word association items, while the present study employed the standard 60-second time interval (Nobel, 1952).

The correlations between the linguistic measures provide the most important data for the first part of this study. The Pearson correlations to be discussed here are

taken from the correlation matrix for the linguistic measures for subsamples I and II combined (Table 5).

It was pointed out in Chapter I that Pavio et al. (1968) reported correlations (r) of .72, .56, and .83 between I and m, A-C and m, and I and A-C, respectively. In the present study, the correlations between the same pairs of linguistic measures were .60, .51, and .59, respectively. It can be seen that the correlations between the I and m scores, and between the A-C and m scores, reported in the present study replicate well the earlier findings of Pavio et al. (1968). The present findings, then, provide some support for Pavio's (1971) hypothesis that imagery may be a primary causal factor responsible for the higher number of associations given to concrete versus abstract nouns. In addition, the moderate correlations between m and I (.60) and m and A-C (.51) obtained in the present study are consistent with Pavio's contention that abstract terms may attain their meaning from intraverbal experience, and concrete terms their meaning from both verbal and sensory experience.

The substantially lower correlation found in the present study between the imagery and concreteness measures (.59), as compared to the earlier correlation reported by Pavio et al. (1968) between the same measures (.83), remains somewhat problematic for Pavio's theory. In fact,

Pavio et al. (1968, p. 7) suggested that their obtained correlation of .83 between the I and A-C variables was somewhat lower than one would expect, if both instruments are measuring the same underlying variable. The discrepancy between the present correlation (.59) and their previous correlation (.83) may be due to the fact that in the present study only 60 words were used, as opposed to the 925 words used in the Pavio et al. study. Nevertheless, the correlation in the present study is moderately close to that reported earlier by Pavio and his coworkers and is clearly in the same direction. For this reason, the correlation between the imagery and concreteness measures reported in this paper is most appropriately interpreted as providing some difficulty for Pavio's hypothesis that both instruments are indexing the same psychological process.

The moderately high correlation obtained between the denotative measure and word concreteness (.60) can be readily explained on the basis of the (moderately high) correlations between the concreteness measure and both the I (.59) and m (.51) scores. (The sum of the I and m scores defined denotative linguistic meaning in the present study.) The low (but significant) correlation found between the denotative and connotative measures (.30) is consistent with the theoretical analysis developed in Chapter I, and provides substantial support for the hypothesis that these two classes of

linguistic meaning are relatively independent. This latter finding is also consistent with the position that the underlying psychological processes are different. That is, the connotative measure presumably reflects affective (evaluative) experience and the denotative measure presumably reflects both cognitive imagery and verbal associative processes.

The measure indexing connotative linguistic meaning (Conn) was also found to be relatively uncorrelated with Nobel's m (.23), imagery (.29), familiarity (.28), and particularly the concreteness measure (.06). This suggests that the high meaningful (denotative meaning) or high familiar word is not typically or necessarily also a high affective (evaluative) word. Secondly, the concreteness dimension is apparently not significantly related to the measure of connotative linguistic meaning used in the present study. These findings underscore the importance of controlling connotative (evaluative) linguistic meaning in those studies which manipulate the m, I, familiarity, or concreteness measures. The correlations between the connotative measure and the various measures indexing denotative meaning and word concreteness obtained for the words used in the present study, therefore, indicate that the denotative measures are relatively independent of affective meaning as indexed by the semantic differential (E) scales.

The moderate correlations obtained in the present study between the familiarity measure and the denotative measure (.68), and between the familiarity measure and m (.59), and I (.63), although not as high, are consistent with the previous findings of Nobel (1953) and Hall (1967), both of whom reported high positive correlations between the familiarity measure (f) and indices of word association. The present findings are also in line with the results of Frincke's (1968) factor analysis which indicated that the m, familiarity, and frequency measures all loaded highly on a "meaningful-familiarity" factor. Finally, these findings clearly indicate that any interpretations of the habituation outcome measures made on the basis of the word attribute familiarity will be substantially the same as those interpretations following from the manipulation of denotative linguistic meaning in the habituation experiments.

The between groups reliability coefficients were very high and acceptable for all six linguistic measures. The method employed to estimate the reliability of the linguistic measures would tend to yield high correlations, and any value below .90 would not have been acceptable. The findings for the reliability estimates for the m, I, and A-C measures are similar to those reported by Pavio et al. (1968, p. 6).

In general, then, the results of the statistical analyses performed on the linguistic measures and the words employed in the present study replicate well the findings of previous workers. Although there are no highly unique empirical findings reported in this part of the study, the relative independence obtained between the connotative measure and the indices of denotative meaning and word concreteness provide substantial support for the theoretical and operational distinctions developed in Chapter I. Moreover, with only minor exceptions, they support well Pavio's (1971) analysis of linguistic meaning. The writer concludes that the present results reported for the linguistic measures provide a solid empirical and psychological basis for the selection of the word stimuli used in the habituation experiments and the interpretation of the skin conductance habituation measures.

2. The Skin Conductance Habituation Measures and Sokolov's Theory

The multivariate analyses of variance obtained on the dependent measures in habituation experiments I (Tables 45, 46, 47) and II (Tables 74, 75, 76) provided empirical tests of the major hypotheses of interest to the present study. More specifically, these analyses tested the multivariate null hypotheses for the effects of (high and low) denotative

linguistic meaning, connotative linguistic meaning, and word concreteness on the various habituation measures. Three classes of skin conductance habituation measures, i.e., phasic response measures (SCR), latency of phasic response measures (LAT), and skin conductance level measures (SCL) were analyzed separately.

The results summarized in Table 45 indicate that the multivariate null hypotheses for the effects of denotative linguistic meaning were rejected for the LAT_2, SCL, SCL-RAN, SCR-RAN, and SCR-TISI-RAN measures. The mean values reported in Tables 17, 21, 33, 37, and 41, and the graphic representation of these means given in Figures 3, 4, 7, 8, and 9, respectively, clearly indicate that the high denotative linguistic meaningful stimuli are associated with a significantly larger skin conductance response, a faster latency of phasic response, and a higher tonic skin conductance level than the low denotative meaningful words. The results given in Table 45, therefore, suggest that the high denotative meaningful words demonstrated significantly less habituation than the low denotative meaningful words, for all three classes of skin conductance measures.

The multivariate null hypotheses 1.2, 1.3, 1.6, 1.7, 1.8 (Table 89) were all rejected on the basis of the results of the data analyses obtained for experiment I. Thus, the

prediction 1B, following from the arousal hypotheses (Chapter I, Section 5), that

> there will be significantly less skin conductance habituation in response to a high denotative linguistic meaningful stimulus, and significantly more habituation in response to a low denotative linguistic meaningful stimulus

received substantial support from all three classes of habituation measures, while no support was found for the prediction following from Sokolov's mismatch hypothesis.

The analyses of the simultaneous confidence intervals for the simple contrasts (Table 46) and the generalized discriminant function analyses (Table 47) both suggest that the skin conductance data for trial blocks 1 and 2 contributed most to the rejection of the multivariate null hypotheses for denotative linguistic meaning. There was one exception to this conclusion. The post hoc procedures indicated that, for the SCL measures, all three trial blocks contributed about equally to the rejection of the hypothesis.

The results presented in summary tables 45 and 74 indicate that the multivariate null hypotheses for the effects of connotative linguistic meaning were rejected for the LAT_1, LAT_2, SCR, SCR-TISI, SCR-RAN, and SCR-TISI-RAN measures (experiment I) and the LAT_2, SCL-RAN, SCR-RAN, and SCR-TISI-RAN measures (experiment II). The mean values reported in Tables 13, 17, 25, 29, 37, and 41, and plotted in Figures 2, 3, 5, 6, 8, and 9, respectively (experiment I),

as well as the means given in Tables 50, 66, and 70, and plotted in Figures 11, 16, and 17, respectively (experiment II), indicate that high connotative linguistic meaningful stimuli are associated with a significantly larger skin conductance response and a faster latency of phasic response than the low connotative meaningful words. In addition, the mean values reported in Tables 54 and 62, and plotted in Figures 12A and 15A, suggest that the high connotative meaningful words are also associated with significantly higher level of tonic skin conductance than the low connotative meaningful words. However, these main effects for connotative meaning on the SCL measures will be interpreted below in light of the concreteness X connotative meaning interactions obtained in experiment II (Figures 12B, 15B). These results, then, clearly indicate that the high connotative (affective) meaningful words demonstrated significantly less habituation than the low connotative words for the two (phasic and latency meausres), and with some qualifications, the three classes of skin conductance measures.

Therefore, the multivariate null hypotheses 2.2, 2.7, and 2.8 (Table 89) were rejected on the basis of the data analyses obtained for both habituation experiments I and II. In addition, the multivariate null hypotheses 2.1, 2.4, and 2.5 were rejected on the basis of the data analyses obtained for experiment I, and the multivariate hypothesis 2.6 was

rejected for the data in experiment II. Therefore, the prediction, 2B, following from the arousal hypothesis (Chapter I, Section 5), that

> there will be significantly less skin conductance habituation in response to a high connotative linguistic meaningful stimulus, and significantly more habituation in response to a low connotative linguistic meaningful stimulus

received consistent support from two of the three classes of habituation measures, and these latter findings were replicated in the second experiment (LAT_2 and SCR-RAN measures only). No support could be found for the prediction following from Sokolov's mismatch hypothesis.

The analyses of the simultaneous confidence intervals for the simple contrasts (Tables 46 and 75), and the genralized discriminant function analyses (Tables 47 and 76) indicate that the data for trial block 1 contributed most to the rejection of the multivariate hypotheses for connotative (affective) linguistic meaning. There are two minor exceptions to this general conclusion for the data in experiment II. Trial block 2 contributed most to the rejection of the multivariate hypothesis (connotative meaning) for the LAT_2 measure, and trial block 3 contributed most to the rejection of the hypothesis for the SCL-RAN measure (Tables 75 and 76).

The results summarized in Table 74 indicate that the multivariate null hypotheses for the effects of word

concreteness were rejected for the LAT_2, SCR-RAN, and SCR-TISI-RAN measures. The mean values reported in Tables 50, 66, and 70, and plotted in Figures 11, 16, and 17, indicate that the high concrete words are associated with a significantly larger skin conductance response and a faster latency of phasic response than the low concrete (abstract) words. The results further indicate that the high concrete words reliably demonstrated less habituation than the low concrete words for two of the three classes of skin conductance measures (LAT_2, SCR-RAN).

The multivariate null hypotheses 3.2, 3.7, and 3.8 (Table 89) were rejected on the basis of the analysis obtained for the data in experiment II. Therefore, the prediction, 3B, following from the arousal hypothesis (Chapter I, Section 5) that

> there will be significantly less skin conductance habituation in response to a high concrete word stimulus, and significantly more habituation in response to a low concrete word stimulus

received support from two of the three classes of habituation measures, and once again no support could be found for the prediction based on Sokolov's matching hypothesis.

The analyses of the simultaneous confidence intervals for the simple contrasts (Table 75), and the generalized discriminant function analyses (Table 76), suggest that the skin conductance data for trial blocks 1 and 2 contributed

most to the rejection of the multivariate null hypothesis for word concreteness.

The results presented in Table 74 also indicate that the multivariate null hypotheses for the effects of a word concreteness X connotative meaning interaction were rejected for the SCL and SCL-RAN measures. An examination of the interactions plotted in Figures 12B and 15B indicate that the high concrete words demonstrated less habituation than the low concrete (abstract) words under high connotative (affective) conditions. However, under the low connotative conditions, the opposite was true. That is, the low concrete words gave less (SCL) habituation than the high concrete words, under the low affective conditions. These results suggest that affective (connotative) linguistic meaning modified the effects that word concreteness had on the tonic SCL habituation measures.

The analyses of the simultaneous confidence intervals for the simple contrasts (Table 75) and the generalized discriminant function analyses (Table 76) indicate that the SCL data for trial block 2 contributed most to the rejection of the multivariate null hypothesis for the concreteness X connotative meaning interactions.

The overall findings obtained from the series of statistical analyses performed on the various skin conductance measures are strikingly consistent for the two habituation

experiments. The phasic skin conductance measure range corrected (SCR-RAN) emerged as the most important and reliable of the habituation measures. The phasic measure (range corrected) demonstrated significantly less habituation for high denotative, high connotative, and high concrete word stimuli as opposed to the low denotative, low connotative, and low concrete words. Similar results were obtained for the latency of phasic response measure (LAT_2), and the phasic measure range corrected, whose latency criterion was extended to include the entire interstimulus interval (SCR-TISI-RAN). Furthermore, the results for connotative linguistic meaning were replicated in the second habituation experiment for the LAT_2 and SCR-RAN measures. The tonic skin conductance measures were not found to be as consistently sensitive to the linguistic variable manipulations, although high denotative meaningful words produced significantly higher tonic levels than the low denotative meaningful words, and there was a significant concreteness X connotative meaning interaction for the tonic measures (SCL, SCL-RAN).

Thus, even a conservative interpretation of the results from the present habituation experiments indicates clearly that the high meaningful and high concrete words (as opposed to the low meaningful and low concrete words) reliably produced less skin conductance habituation.

Further, the same general trends were observed in the data for those skin conductance habituation measures which did not demonstrate statistical significance for the MANOVA hypotheses (i.e., the LAT_1 and SCR measures).

The results of the two habituation experiments reported in this paper do not support Sokolov's mismatch theory for habituation of the OR. The empirical findings reported here are, in fact, quite the opposite to what was predicted from Sokolov's stimulus-model-comparator theory. On the other hand, the present findings support well the predictions made on the basis of the implicit-arousal hypothesis for linguistic meaning (Pavio, 1971).

No evidence, therefore, could be found in the present experiments to support Sokolov's claim that the OR is essentially a response to an information deficit, and that habituation will take place once the stimulus has been identified. Indeed, consistent contrary evidence was found to indicate that the high meaningful (more familiar) words produced less habituation than the low meaningful (novel) words.

Sokolov's theory is predicated upon a hypothetical matching assumption which clearly states that the matching process alone is sufficient to explain (predict) habituation phenomena. However, the results of the present habituation experiments, in addition to the habituation studies reviewed

in Chapter I (the stimulus change, stimulus significance, and information theory studies) suggest that the matching hypothesis alone cannot account for much of the habituation data. O'Gorman (1973), in his critical review of the stimulus change studies, succinctly pointed out that the matching assumption implies that the nervous system is responding to differences between stimuli, rather than to the arousal properties of the orienting stimulus. No provision is made in Sokolov's habituation theory to account for the arousal properties of the evoking stimulus. Indeed, Sokolov's theory implies that once the stimulus has been identified, the various OR components habituate.

There is, therefore, now a wealth of evidence to indicate that a simple matching process, and ensuing stimulus recognition alone, are not sufficient to account for a major portion of the available habituation data. In short, Sokolov's habituation theory in any of its present forms can be seriously questioned on the basis of many empirical (parametric) findings. O'Gorman (1973, p. 468) raised two important questions which have critical relevance for Sokolov's theory: (1) Can Sokolov's theory be revised to square with the available experimental findings? (2) Is the matching process necessary to explain the "facts"?

The findings from the habituation experiments reported in this paper would not appear to require a matching assumption.

It was pointed out above that the present findings support well the predictions following from the arousal-response hypothesis advanced for linguistic meaning. That is, the high imagery, associative and affective value words (high denotative and connotative linguistic meaning) demonstrated reliably less skin conductance habituation than the low meaningful words. Therefore, it may be argued that these findings do not require an additional matching assumption. There are, however, some difficulties with such an argument.

The non-supportive evidence for the matching hypothesis obtained in the present habituation experiments does not necessarily indicate that a matching process was not involved. The present findings only indicate that the matching hypothesis along could not predict the present habituation data. Secondly, Sokolov (1960, 1963a) has repeatedly and rather convincingly argued that it would be difficult if not impossible to formulate any neuropsychological theory of learning or memory without positing some kind of neural-matching procedure. That is, through an experiential encounter with objects, events, and language something is recorded in the nervous system (the neural trace) which is used as a frame of reference against which to compare (and contrast) new objects, events, and language (new afferent impulses). Thirdly, it would be difficult to explain the results of the present habituation experiments without allowing some

kind of stimulus identification or recognition procedure as part of the habituation process. That is, the more physiologically arousing words (less habituation) were "identified" as having more meaning. It was, of course, argued that the linguistic meaning was mediated through imaginal, associative, and affective responses, but this in no way invalidates the matching hypothesis.

The writer adopts the position that all the above considerations do not demonstrate the invalidity of the matching assumption. They do, however, suggest that any general theory of habituation predicated primarily and essentially on the basis of a mismatch hypothesis will prove grossly inadequate to account for many of the experimental "facts." Furthermore, these considerations indicate that one of the major flaws in Sokolov's theory is the contention that the OR components habituate and stimulus processing ceases once the stimulus has been identified, or the OR components continue to operate and processing continues until the stimulus is recognized. The present findings, as well as much of the evidence reported in the habituation literature, simply will not support such a theoretical position. Altogether, the present results, along with the findings from the three classes of studies reviewed in Chapter I (the stimulus change, stimulus significance, and information theory studies) suggest that Sokolov's theory is in need of major revisions.

It was pointed out in Chapter I that Bernstein (1969) proposed a two-stage model for the habituation process. In the first stage the matching procedure would take place, followed by a second stage which would evaluate the "significance" of the stimulus information. A stimulus evoked response (OR) would then occur only if the stimulus is perceived as significant. O'Gorman (1973) criticized Bernstein's "significance" hypothesis on the grounds that it is difficult to operationally define significance. Nevertheless, the experimental work of Bernstein and his associates has demonstrated the importance of including a central-evaluation component as a necessary part of the habituation process. The results of the present habituation experiments, although generated from a different theoretical perspective, are clearly in line with the empirical findings of Bernstein and his coworkers.

One of the major obstacles to the development of a truly comprehensive habituation theory has been the failure to clearly distinguish and study the psychological as well as the neurological events. The neuro-structural and neuro-functional aspects of habituation, typically, have been well elaborated, while the psychological aspects of the theory were left in a relatively primitive state. In particular, a consideration of Sokolov's (1963a, 1963b, 1969) most complete statements indicates that his habituation theory

is conceptualized almost entirely in terms of neurophysiological variables (e.g., the role of sensory neurons, the properties of the neuronal-memory trace, the different kinds of neurons in the memory trace, the function of the glia, the RNA changes in the neuron, EEG and ANS changes in the modeling process, the neuronal trace as a biological filter, the neuronal model as a regulator of "behavior," etc.). Indeed, the genius of Sokolov can be seen in the way that he has been able to integrate many of the most important findings from modern neuroscience into his theory. Nevertheless, Sokolov's (1969) most recent statement clearly indicates the importance of "cognitive" variables for his theory.

> The theory of reflex activity, which regards behavior as a system of regular responses by an organism to environmental agents, has become an established part of the literature dealing with learning theory. Unfortunately, some analyses of the reflex principles of behavior amount to highly oversimplified accounts of reflex activity. It thus happens that ideas fundamental to a dialectical materialistic theory of learning (such as the concepts of an image of the external world, of reflection) are not fully developed in certain cases, but are equated with the simple reflex. One reason for this state of analysis is that writers have failed to deal adequately with that part of the reflex which Sechenov (1863) termed the central part of the reflex arc. Yet the neurophysiological processes which take place in the central divisions of the nervous system are of primary importance in all reflex activity. Study of these is necessary if we are to discover the processes through which images are formed, and to demonstrate the laws that govern the way in which the human mind mirrors the external world (p. 672).

Thus Sokolov's 1969 statement is replete with such terms as "image," "meaning," "information," "novelty," "reflection," "familiarity," "behavior." He has not, however, suggested any defining operations with which to specify and measure these psychological constructs. In addition, as Velden (1974, p. 683) has made quite clear, Sokolov's (1969) information theory interpretation of the orienting response is at best ambiguous and only addressed to the "structural" aspects of the orienting stimulus.

The obvious conclusion is that the psychological aspects of habituation theory will have to be developed apart from the present Soviet zeitgeist which, because of philosophical and political considerations, remains restricted to physiological and physical (structural) realities. A similar critique of Sokolov's theory was made a few years ago by Bernstein (1969).

> The present study, therefore, suggests that the OR may reflect a more complex interaction of cognitive and motivational variables than has been considered so far in Sokolov's conception of an automatic "reflex receptor mechanism" (p. 349).

The linguistic habituation data brought forth in the present study is consistent with a multi-component, neuropsychological processing theory of habituation. One component would include the neural-matching process resulting in possible (perceptual) stimulus identification. The other components would include neuronal processing, accompanied

by cognitive-affective (evaluative) responses (processing). Thus, for the high meaningful word stimulus, the neural matching-perceptual identification processes would take place very rapidly (instantaneously), accompanied by additional neural processing and the elicitation of many imagery, associative and affective responses. Therefore, even though the matching process occurred very rapidly, the skin conductance habituation would be less. The neural matching-perceptual identification processes would occur very slowly (or not at all) for the low meaningful word, and would be accompanied by additional neural processing, and few, if any, imagery, associative and affective responses. The low meaningful word, then, even though a mismatch was present, would predict significantly more habituation.

The neuropsychological processing model, which includes provisions for both the neural-matching (recognition responses) and the neural processing (imagery, associative, and affective responses) components would predict a very different habituation outcome than the matching hypothesis taken alone (i.e., Sokolov's theory). Although, admittedly somewhat speculative and more complex than Sokolov's theory, it appears that the processing model would be able to account for much of the available habituation data.

The model would predict dishabituation on a "test trial" to a stimulus change on the grounds that the changed

stimulus becomes more meaningful, eliciting new images, associations, and possibly affective responses and not on the basis of the mismatch alone. The model would explain why a "perceived" stimulus change does not always produce dishabituation. This explanation is essentially the same as Bernstein's (1969, p. 348) earlier contention that dishabituation occurs only when the change is judged to be "significant" by the subject.

A critical examination of these issues, therefore, suggests that neither the mismatch hypothesis, nor the arousal-response hypothesis advanced for linguistic meaning, taken separately, would make an adequate habituation theory. The arousal response hypothesis alone would not be able to account for any of the positive evidence from the stimulus change studies. O'Gorman (1973) and Groves and Thompson (1970) have pointed out that any positive effects demonstrated for stimulus change would create serious difficulties for a habituation theory that did not include a matching assumption. On the other hand, the matching assumption alone did not predict the results of the present experiments, nor could the matching theory account for many of the other experimental findings reviewed in this paper.

It is not the intention of the present writer to advance a "new," fully elaborated habituation construct, but to suggest trends that future research may more

profitably follow. Critical experiments are necessary which will more directly investigate the psychological impact of all the stimulus conditions on habituation outcome. Such an approach would not require the many a priori distinctions that have been so important in Soviet theorizing (e.g., "signal" versus "nonsignal" stimulus, see Bernstein's (1973) critique of the distinction). It would certainly be a mistake at this time to pursue further habituation research which was generated exclusively on the basis of the matching hypothesis, while so many nonsupportive findings exist in the literature. Clearly, future studies will need to pay more attention to cognitive, affective, motivational, and subject variables. (The issue of subject variables will be treated in a section below.)

The habituation outcome data for the effects of word concreteness indicated that high concrete words gave significantly less skin conductance habituation than the low concrete (abstract) words for the phasic measures--range corrected (SCR-RAN, SCR-TISI-RAN), and the LAT_2 measure. If a reasonably high (positive) correlation is assumed between pupillary and skin conductance phenomena, then it would appear that the present findings contradict the report of Pavio and Simpson (1968) that abstract words produce greater pupillary response (less "habituation")

than concrete words. However, the results of the Pavio and Simpson study were obtained under imagery task instructions. That is, subjects were required to generate images to abstract versus concrete words, while each stimulus word was presented and pupillary activity was recorded. Pavio and his associates have conclusively demonstrated that it is more difficult to generate images to abstract versus concrete words. Therefore, the greater "task demands" for the abstract word, under imagery task instructions, are presumably accompanied by greater neurophysiological involvement which, in turn, reflects a larger pupillary response for the abstract as opposed to the concrete word. The results of the Pavio and Simpson study, then, are quite correctly interpreted by Pavio (1971) as being consistent with his theory.

> It is simply more difficult (cognitively effortful) to generate images to abstract words than to concrete words, and this is reflected in the pupillary-dilation response just as it is reflected in reaction time and learning data (p. 527).

The most important difference between the Pavio and Simpson study and the present habituation study were the experimental task instructions given to the subjects. In the present experiment (experiment II), the standard habituation instructions were given to the subjects, which required them to merely sit up and look attentively at the projector screen.

The significantly less skin conductance habituation obtained for the concrete (high concrete) words as opposed to the abstract (low concrete) words in the present experiment (experiment II) is interpreted as a function of the higher imagery value for the concrete words, and their greater degree of "directness of sensory reference." The present results would be consistent with the inference that the high concrete words spontaneously elicited more imagery responses during the habituation trials and were, therefore, accompanied by more skin conductance responses (less habituation) than the abstract words.

Thus the same "causal" explanation is brought forth to explain the seemingly contradictory results obtained between the Pavio and Simpson experiment and experiment II reported in this paper. The results of the Pavio and Simpson study are explained by the greater cognitive-energy-task demands necessary to generate an image to an abstract word, and the results of the present experiment are explained by the relative difficulty with which an abstract word would spontaneously evoke an imagery response. In short, a hypothesis which holds that images can be formed with relative difficulty to an abstract as opposed to a concrete word could predict the apparent contradictory results of both experiments, if interpreted in terms of the very different motivating instructions given to the subjects.

The skin conductance habituation data for the concreteness dimension (experiment II) supported well the tentative predictions that followed from the implicit-arousal response hypothesis for linguistic meaning. Furthermore, the results predicted for word concreteness in experiment II were quite similar to the results for denotative linguistic meaning in experiment I, and are clearly consistent with Pavio's theory of linguistic meaning. Altogether, the results of the two habituation experiments reported in this paper, although not "proving" Pavio's theory, nevertheless provide good supportive (validating) evidence based on physiological dependent measures.

It was pointed out in Chapter I (Section 4) that within the context of the habituation experiment, moderately high intrasession reliability coefficients of about $\underline{r} = .75$ are optimum. The intrasession reliability estimates for adjacent trial blocks obtained for the dependent measures in experiment I and experiment II (Table 88) indicated acceptable reliability for most of the habituation measures. In general, the reliability coefficients obtained between the measures in trial blocks 2 and 3 were higher than those coefficients obtained for trial blocks 1 and 2, and this was true for both habituation experiments. These results are consistent with the analysis offered in Chapter I for the reliability of habituation measures, and suggests

clearly that higher coefficients will be expected when the measures change least (from trial block to trial block), and lower coefficients will be expected when the measures change most.

The reliability estimates for the phasic skin conductance measures (SCR, SCR-TISI, SCR-RAN, SCR-TISI-RAN) are quite adequate for both experiments, although the coefficients for these measures are slightly lower in experiment II. It is interesting to note that the range correction procedure increased the reliability (stability) of the phasic measures for both experiments, but particularly for the measures in experiment II. Similar adequate to optimum reliability coefficients were obtained for the latency of phasic response measures (LAT_1, LAT_2) with the LAT_2 measures yielding the higher coefficients for both experiments.

The most interesting findings to emerge from Table 88 were the reliability coefficients obtained for the tonic skin conductance measures (SCL, SCL-RAN). The SCL measures easily yielded the highest coefficient values of all the measures ($\underline{r}$ = .95 and above). Once again, this suggests that those habituation measures demonstrating the least change across trial blocks will give the highest coefficients. Most important of all, the range correction procedure carried out on the tonic measures (SCL-RAN) reduced the coefficient values to an unacceptable level.

The reliability estimates obtained for the SCL-RAN measures, therefore, strongly suggest that these measures may not be reliable indices of the habituation process in both habituation experiments. Furthermore, these results indicate that the range correction procedures carried out on the tonic measures in the two experiments may not have been effective. It follows, then, that the results of the multivariate analyses carried out on the SCL-RAN measures in the two experiments should be interpreted with considerable caution. Actually, these negative reliability findings for the SCL-RAN measures have little relevance for the interpretations offered above, because it was already pointed out that the tonic measures in general were much less sensitive to the linguistic variable manipulations than either the phasic or latency measures.

It is interesting to speculate why the range correction procedure was effective for the phasic measure (SCR) and may not have been effective for the tonic (SCL) measures in the present experiments. The startle procedure employed at the end of the habituation trials in the present experiments was obviously sufficient to give a reasonably precise estimate of the subject's maximum skin conductance response (SCR_{max}). It will be recalled that the experimenter's voice on the intercom was followed by a large SCR. It was also observed, however, that the polygraph pen began to return

rapidly to the subject's previous tonic level. Therefore, in the present experiments, it is quite probable that the estimate of the subject's maximum tonic level (SCL_{max}) was inadequate and lacking precision. Lykken and Venables (1971) recommend the use of some aversive stimulus (e.g., blow up a balloon until it bursts) to obtain adequate estimates of the subject's maximum tonic level. However, in the present experiments such an aversive procedure was clearly contraindicated because it would have "contaminated" the habituation process, and the subjects were not available for additional experimental sessions.

There are other issues to consider when weighing the advantages and disadvantages of a range correction procedure applied to habituation measures. Additional insight into the relationships between the various habituation measures can be gained by an examination of the intercorrelations between these measures. A discussion of the correlations between the dependent measures follows in the section immediately below.

3. The Relationships Between the Dependent (Habituation) Measures

The descriptive statistics for the eight habituation measures for trial block 1 (Table 77) indicated that the distributions for the eight measures demonstrated a minor

(nonsignificant) degree of kurtosis, and significant positive skewness for the four phasic measures (SCR, SCR-TISI, SCR-RAN, SCR-TISI-RAN). It was also observed that the distributions for the four phasic measures became increasingly pathological (positive skewness and kurtosis) for trial blocks 2 (Table 78) and 3 (Table 79), respectively. The LAT_2 measure and the tonic measures (SCL, SCL-RAN) demonstrated essentially normal distribution characteristics across the three trial blocks (Tables 77, 78, 79). Finally, the distributions for the two estimates of spontaneous skin conductance activity ($Spont_1$, $Spont_2$) demonstrated significant positive kurtosis and skewness (Table 77), while the E and N variables gave essentially normal distributions (Table 77).

An examination of the distribution characteristics for the eight physiological measures for the first trial block, therefore, indicated that the linearity assumption was reasonably approximated, and that the Pearson coefficients reported in Table 80 can be interpreted with confidence. The distribution characteristics for the four phasic measures (SCR, SCR-TISI, SCR-RAN, SCR-TISI-RAN) for trial blocks 2 and 3 indicated that the linearity assumption may not be satisfied and, therefore, the Pearson correlations for these measures (Tables 81, 82) should be interpreted with caution. In particular the $\underline{r}$ coefficients between the

$Spont_1$ and $Spont_2$ measures and the four phasic measures for trial blocks 2 and 3 (Tables 81, 82) should be interpreted with great caution. The Pearson correlations between the E and N variables and all the physiological measures may be interpreted with confidence because the E and N variables were found to be normally distributed. (A discussion of the relationships between the E and N variables and the physiological measures is given in Section four of this chapter.)

The phenomenon of increased kurtosis and skewness for the variable distributions in the later trial blocks (TB_2, TB_3), particularly for the four phasic measures, is quite predictable and expected for habituation experiments. Therefore, it appears that, as the habituation process advances, the phasic skin conductance response-amplitude decreases and the distributions become leptokurtic (peaked) and positively skewed. A somewhat similar change takes place in the tonic skin conductance level measures during the habituation process and, as the tonic levels decrease, the resulting data distributions become platykurtic (flat) and positively skewed. A different change occurs for the latency of phasic response measures, and ensuing habituation is characterized by an increase in latency of response, with the resulting distributions becoming flat and negatively skewed. A consideration, then, of the mean values

and their distribution characteristics across the three trial blocks (Tables 77, 78, 79) indicates clearly that skin conductance habituation is distinguished by a decrease in phasic response, an increase in the latency of phasic response, and a fall (decrease) in the tonic level. These considerations further suggest that the correlational analyses will yield significant positive correlations between the phasic and tonic measures and inverse (negative) correlations between the latency measures and both the phasic and tonic measures.

The present worker adopted the position that it would not be advisable to seek appropriate "normalizing" transformation for the various habituation measures prior to correlation analyses, because the transformation procedures would likely distort the natural (and quite predictable) distribution characteristics of the variables, and render the interpretation problem more difficult and complex. Neither was it practical nor necessary in the present experiments to obtain scattergram analyses for the 189 correlations reported in Tables 80, 81, 82. Finally, previous habituation research suggests that the most important correlations between the habituation measures are obtained on the data from the first trial block (or first trial if a trials analysis is carried out). It was pointed out above that the linearity assumption was reasonably

approximated for the measures from the first trial block. Therefore, the interpretation of the correlations between the habituation measures in the present experiments will be based primarily on the coefficients reported in Table 80, although some discussion of the coefficients in Tables 81 and 82 will also be necessary. Whenever the linearity assumption is seriously in question (e.g., the correlations with the phasic measures in TB_2 and TB_3), the Kendall coefficients in Tables 83, 84, and 85 can be consulted in place of the Pearson correlations.

The 12 X 12 correlation matrix reported in Table 80 indicated that the two latency measures (variables 1, 2) and the four phasic measures (variables 4, 5, 7, 8) intercorrelated significantly within their own class of variables. The two latency measures (LAT_1, LAT_2) were very highly and positively correlated (r = .95). The four phasic measures (SCR, SCR-TISI, SCR-RAN, SCR-TISI-RAN) also yielded moderate to high positive intercorrelation as follows: SCR with SCR-TISI (r = .98), SCR with SCR-RAN (r = .76), SCR with SCR-TISI-RAN (r = .71), SCR-TISI with SCR-RAN (r = .74), SCR-TISI with SCR-TISI-RAN (r = .72), and SCR-RAN with SCR-TISI-RAN (r = .97). The findings that the latency and phasic measures intercorrelated highly and positively within their own class of variables is in line with expectations. Of particular importance is the finding

that the range correction procedure carried out on the raw phasic scores, although obviously changing the score values, did not eliminate the relationship between the SCR and SCR-RAN measures (r = .76).

However, the correlation between the SCL and SCL-RAN scores (Table 80) was not significantly different from zero (r = .10). This finding clearly indicates that the range correction procedure carried out on the raw tonic measures changed the score values to such a degree that they no longer had any relationship with the original scores. In other words, a new variable was created which had little, if any, relationship with its parent variable. It follows from this finding that inferences about skin conductance habituation, based on the tonic measures-range corrected, will be of questionable validity. This conclusion is strikingly consistent with the unacceptable reliability estimates obtained for the SCL-RAN measures in both habituation experiments and again suggests that the habituation outcome data for these measures should be interpreted with caution.

The correlations between phasic skin conductance (SCR) and tonic-prestimulus level (SCL) measures for trial blocks 1, 2, and 3 (Tables 80, 81, 82) were r = .55, .57, .49, and (Tables 83, 84, 85) tau = .47, .50, .49, respectively. These findings indicate that the LIV was not operating for

the skin conductance data obtained in the present experiments. Wilder's (1962, 1965) "Law of Initial Value" states that there is an inverse relationship (negative correlation) between the response amplitude and the prestimulus level of the variable under study. The present findings indicate the converse of the LIV phenomenon. It was found that the higher tonic-prestimulus levels were associated with larger SCRs (and vice versa) and this relationship was maintained across the various trial blocks. Furthermore, the correlations hold, whether one appeals to the Pearson correlations or the Kendall correlations, which do not require the linearity assumption. These results are consistent with the findings of Hord, Johnson and Lubin (1964) and Bull and Gale (1973) who also reported that the opposite of the LIV held for their skin conductance data. In general, then, the findings of the present experiments would support the argument that the LIV concept is not applicable to skin conductance habituation data.

The range correction procedures carried out on the phasic and tonic measures effectively reduced the significant correlation between these measures for the data in the first trial block. That is, the correlation between the SCL and SCR measures was $\underline{r} = .55$ ($p < .05$), and the correlation between the SCL-RAN and SCR-RAN scores was $\underline{r} = .16$ ($p > .05$) (Table 80). However, the range correction

procedures did not consistently reduce the correlations between phasic and tonic measures for the data in trial blocks 2 and 3. The correlations between the SCL-RAN and the SCR-RAN scores for trial blocks 1 and 2 were $\underline{r}$ = .52, .54, $p < .05$, respectively (Table 80). Although these findings are somewhat complex and difficult for theoretical analysis, there are at least two ways to explain the apparent ineffectiveness of the range correction procedures for the data in the later two trial blocks. Firstly, it could be argued that the major proportion of variance in the habituation measures was accounted for by the data from the first trial block. The post hoc procedures employed for the multivariate analyses in experiment I (Tables 46, 47) and experiment II (Tables 75, 76) would offer limited support for this argument for the SCR-RAN measures, but not for the SCL-RAN measures. A simpler argument would be that the range correction procedures were not effective for either the tonic and/or phasic measures.

However, a comparison of the MANOVA results between the SCR and SCR-RAN measures in experiment I (Tables 26 and 38) and experiment II (Tables 59 and 67) indicates that such a conclusion is not supported for the phasic measures. It can be seen that, in general, the range correction procedures carried out on the phasic data in both experiments increased the significance levels for the various multivariate

criteria. In addition, a comparison of the plotted means between the SCR and SCR-RAN measures in experiment I (Figures 5 and 8) and experiment II (Figures 13 and 16) indicates clearly that the range corrected data provided a better separation between the experimental groups than the raw (SCR) data. These results are consistent with Lykken's (1972) report that the range correction procedure performed on the phasic skin conductance data significantly reduced the proportion or error variance in the SCR scores.

Conversely, a similar comparison of the MANOVA results between the SCL and SCL-RAN habituation measures in experiment I (Tables 22 and 34) and experiment II (Tables 55 and 63) indicates that the range correction procedures carried out on the tonic measures actually decreased the significance levels for the various multivariate criteria. These considerations, therefore, support the inference advanced in earlier sections of this chapter that the range correction procedure was not effective for the tonic measures.

In summary, these findings would support the validity of the range correction procedure recommended by Lykken and Venables (1971) but only for the phasic skin conductance measures. No support could be found in the present habituation experiments for the effectiveness of the range correction applied to the tonic skin conductance level measures.

The correlations between the phasic skin conductance (SCR) and the two latency of phasic response measures (LAT_1, LAT_2) for trial blocks 1, 2, and 3 (Tables 80, 81, 82) were all moderately high and negative, yielding a mean Pearson coefficient for the six correlations of $\underline{r}$=-.77. These results indicate that for skin conductance habituation there is an inverse relationship between the amplitude of phasic response and the onset latency of response. These findings support well Sokolov's (1963a, p. 118) statement that "GSR" habituation is distinguished not only by a decrease in amplitude of response, but also by a shift from a shorter to a longer latency of response. The present results are also in line with and extend O'Gorman's (1971) finding of high inverse correlations ($\underline{r}$=-.65, -.73, $p<.01$) between the latency of "GSR" to the initial stimulus and a trials-to-criterion estimate of habituation.

The correlations between tonic skin conductance (SCL) and the two latency of phasic response measures (LAT_1, LAT_2) for trial blocks 1, 2, and 3 (Tables 80, 81, 82) were moderate and negative, yielding a mean Pearson coefficient for the six correlations of $\underline{r}$=-.60. These results indicate that there is also an inverse relationship between the prestimulus skin conductance level and the onset latency of phasic response. That is, the higher tonic levels were associated with shorter latency of phasic response and vice

versa. Although the present findings of significant inverse correlations between the tonic and latency of phasic response measures are quite consistent with the analyses of the means, and the analyses of the relationship between the tonic and phasic measures (as discussed above), they are, generally speaking, without precedent in the habituation literature.

The studies by Coles, Gale and Kline (1971) and Bull and Gale (1973) reported the results of correlational analyses between various similar skin conductance measures, and with some restrictions can be compared directly to the present findings. Both the Coles et al. and Bull and Gale studies recorded skin resistance which was transformed to conductance in response to auditory (tone) stimuli.

Coles et al. intercorrelated (rank-order correlations) five skin conductance measures as follows: (1) latency of first response, (2) total number of responses to stimuli, (3) a trials-to-criterion measure, (4) total number of spontaneous responses (similar to the sum of the present $Spont_1$ and $Spont_2$ measures), (5) prestimulus tonic conductance (similar to the present SCL measure). They reported that measures 2, 3, and 4 were positively intercorrelated, and all inversely related to the latency of first response. The results thus far, then, generally agree with the present findings. However, Coles et al.

also reported that their tonic measure (5) did not significantly correlate with any of the other measures, and this latter finding is inconsistent with the present results. Furthermore, it was particularly difficult for them to explain why their tonic measure (5) did not correlate with "spontaneous activity" (p. 62), which is also at odds with the present findings (to be discussed below) and the findings of Bull and Gale (1973).

Bull and Gale, in what was both a reliability and construct validity study, reported intercorrelations (Spearman rank-order correlations) between 10 electrodermal measures (conductance and resistance). Five of these measures have direct relevance to the present findings and are numbered using their own numerical notation as follows: (2) average tone-response magnitude in conductance units (a mean phasic SCR measure), (3) number of spontaneous responses (similar to the present $Spont_2$ measure), (4) number of tone responses (trials-to-criterion measure), (5) average pre-tone conductance level (mean tonic, SCL, level), (7) average tone-response latency (similar to the present LAT_1 measure). They found that all the measures significantly intercorrelated except the mean pre-tone conductance level (5) with the trials-to-criterion measure (4), and with the latency of response measure (7). Moreover, the latency measure correlated highly

and inversely with various SCR measures (2, 3, and 4). The results of the present experiments, therefore, are virtually identical to the Bull and Gale findings with the exception that in the present study significant inverse correlations were also found between tonic SCL and the two latency measures (LAT_1, LAT_2). It is also very interesting to note that in the Bull and Gale study the correlation between the tonic and latency measures was rho = -.44, which did not quite reach significance, but is clearly in line with the present findings. The very high degree of consistency between the present findings and the results of the Bull and Gale study is even more surprising when one considers that Bull and Gale only used 12 subjects in their experiments.

In the present study both the results of the correlation analyses and the results of the MANOVA analyses discussed in the previous section of this chapter provide support for the conclusion that skin conductance habituation was characterized by a decrease in phasic response, an increase in latency of response, and a fall in the tonic level. An examination of the correlations between the estimates of spontaneous skin conductance activity ($Spont_1$, $Spont_2$) and the three classes of habituation measures only serves to reinforce the above conclusion, but more

importantly it sheds some light on the "construct validity" of the single score estimates of SC habituation.

The correlations between the two estimates of spontaneous skin conductance activity ($Spont_1$, $Spont_2$) (Tables 80, 83) were $\underline{r}$ = .75 and tau = .57. It will be recalled from Chapter II that the $Spont_1$ measures were taken during the resting prestimulus period and the $Spont_2$ measures were taken during the habituation trials. The moderately high positive correlation between these measures suggests that they were both indexing a similar phenomenon.

The average (mean) correlations between the $Spont_1$ measure and SCL, and between the $Spont_2$ measure and SCL for the three trial blocks (Tables 80, 81, 82) were $\underline{r}$ = .57 and $\underline{r}$ = .64, respectively. Similarly, the average correlations between $Spont_1$ and SCR, and between the $Spont_2$ and SCR measures for the three trial blocks (Tables 80, 81, 82 and 83, 84, 85) were $\underline{r}$ = .26, tau = .32, and $\underline{r}$ = .53, tau = .48, respectively. (The reader will recall that the Kendall coefficients are required for the correlations between the estimates of spontaneous SCR and the phasic measures.) Finally, the average correlations for the three trial blocks between the $Spont_1$ and LAT_1 and LAT_2 measures (Tables 80, 81, 82) were $\underline{r}$ = -.41 and $\underline{r}$ = -.41, respectively, and the average correlations between the $Spont_2$ and LAT_1

and LAT_2 measures (Tables 80, 81, 82) were $\underline{r}$ = -.67 and $\underline{r}$ = -.66, respectively.

These findings indicate that the two estimates of spontaneous skin conductance activity correlated moderately highly and positively with tonic skin conductance (SCL), but they also correlated less highly and positively with the phasic measures (SCR). Furthermore, consistent with the high inverse correlations obtained between both the tonic (SCL) and phasic (SCR) measures and the latency measures (LAT_1, LAT_2), the two estimates of spontaneous skin conductance activity ($Spont_1$, $Spont_2$) also correlated moderately and inversely with both latency measures (LAT_1, LAT_2).

These results clearly indicate that the present, single score estimates of spontaneous skin conductance activity are significantly related to all three classes of skin conductance habituation measures. Thus the higher $Spont_1$ and $Spont_2$ scores were reliably associated with higher tonic levels, larger amplitude of phasic response, and shorter latency of phasic response. It, therefore, appears that the single score estimates of spontaneous SC activity obtained in the present habituation experiments are complex-hybrid measures which covary with the other habituation measures. If this hypothesis is correct as the present data suggest, then, indeed the $Spont_1$ and $Spont_2$

measures, and possibly the other single score estimates of skin conductance habituation (i.e., trials-to-criterion and total number of response measures) may be better interpreted as general indices of skin conductance responsiveness, which reflect the joint effects of both stimulus and subject variables.

Such an argument would be consistent with the findings of Crider and Lunn (1971), Coles et al. (1971), and Bull and Gale (1973), all of whom reported significant positive correlations between estimates of spontaneous electrodermal activity and the trials-to-criterion habituation measure. Furthermore, the present results would support Averill's (1974) suggestion that the single-score estimates of electrodermal habituation are more validly interpreted as mean reactivity indicators.

Altogether, the analyses of the correlations between the physiological measures in the present experiments indicate that skin conductance habituation is characterized by changes in the amplitude of phasic response, the latency of phasic response, the tonic level, and the number of spontaneous responses. Although the present results for the most part replicate well earlier findings, they nevertheless remain unique in the sense that significant intercorrelations were found

between all four classes of skin conductance measures (phasic, tonic, latency, and spontaneous). The writer concludes that the present skin conductance data "held together" with remarkable consistency across the various trial blocks.

4. The Relationship of Extraversion and Neuroticism to the Skin Conductance Measures

The descriptive statistics for the extraversion and neuroticism measures (Table 77) indicated that both distributions were normal in terms of kurtosis and skewness. The means and standard deviations (raw scores, forms A and B combined) for the extraversion scores were 26.74 and 6.52, respectively, and for the neuroticism scores were 25.44 and 8.64, respectively. These statistics for the extraversion scores are very similar to the norms given by Eysenck and Eysenck (1968, p. 10) for American student nurses. However, the present mean for the neuroticism scores is considerably higher than the mean (21.7) reported by Eysenck and Eysenck for student nurses. The difference between the present mean and the mean reported by Eysenck and Eysenck for the neuroticism variable most probably reflects sampling differences.

The distribution characteristics for the extraversion and neuroticism variables, as well as the distribution characteristics for the various skin conductance measures,

suggest that, for the most part, the Pearson correlations between the E and N measures and the SC measures (Tables 80, 81, 82) can be interpreted with confidence. However, once again, whenever the linearity assumption is suspect, the Kendall rank-order coefficients (Tables 83, 84, 85) can be used in place of the Pearson correlations.

The Pearson correlations between the extraversion measure and the skin conductance variables (Tables 80, 81, 82) indicated that the E variable correlated significantly and inversely with the tonic skin conductance measure (SCL) for the first trial block. The E variable also correlated significantly and inversely with the two estimates of spontaneous skin conductance activity ($Spont_1$, $Spont_2$). Furthermore, an examination of the tau correlations between the E and skin conductance measures leads to the same conclusion.

While, on the other hand, a consideration of both the Pearson and Kendall correlations between the neuroticism measure and the various skin conductance measures indicated clearly that the N variable was not related to any of the skin conductance measures. In fact, the N variable alone, among the 12 measures, consistently failed to correlate with any other variable. The only exception to this general conclusion was the inverse correlation obtained between the E and N measures, which undoubtedly reflected specific trends in the personality makeup of the student nurses.

These results offer excellent support for Eysenck's (1967) argument that skin conductance measures are measures of extraversion and not neuroticism. The present results further support the prediction that introverted, as opposed to extraverted, subjects will demonstrate significantly less tonic skin conductance (SCL) habituation and will give significantly more spontaneous skin conductance responses both during the resting ($Spont_1$) and stimulation ($Spont_2$) phases of the habituation experiment.

The hypothesis that skin conductance (habituation) measures are measures of extraversion, and not neuroticism, was further investigated in the present study by means of (two) multivariate correlational analyses. The canonical correlation between the E and N variables in the first set, and the $SCL\text{-}TB_1$, $SCL\text{-}TB_2$, and $SCL\text{-}TB_3$ variables in the second set (Table 86) was not significant. Similarly, the canonical correlation between the E and N variables in the first set and the $Spont_1$ and $Spont_2$ variables in the second set (Table 87) was also not significant. These results indicated that the composite (joint) effects of the E and N variables taken together were not significantly related to either tonic skin conductance or spontaneous skin conductance activity. The present canonical correlations, then, provided additional support for the hypothesis that extraversion, and extraversion alone, among the E and N

variables was significantly associated with the skin conductance (habituation) measures in the present experiments.

The results of the present habituation experiments, therefore, provide two major sources of empirical data to support Eysenck's predictions about habituation outcome as a function of the extraversion and neuroticism dimensions. Firstly, the significant inverse correlations obtained between the E variable and both the tonic and spontaneous skin conductance response measures support the argument that the more introverted subjects (LE) were in a state of higher tonic skin conductance arousal throughout the entire experiment than the more extraverted subjects (HE). Secondly, the failure to find any significant correlations between the N variable and the various skin conductance measures would be consistent with the argument that neuroticism is essentially unrelated to skin conductance habituation. It will be recalled from Chapter I that both of these predictions were clearly stated in Eysenck's 1967 work.

The present results are also consistent with the findings of Coles et al. (1971) who reported significantly more spontaneous skin conductance responses for introverted, as opposed to extraverted, subjects, and the findings of Crider and Lunn (1971) who obtained a significant inverse correlation between the MMPI extraversion variable (-R) and

"spontaneous skin potential fluctuations." In addition, the present inverse correlation obtained between the extraversion measure and tonic skin conductance (SCL) is in line with the findings of Stelmack and Mandelzys (1975) who found a significantly higher level of "pupillary arousal" (larger mean pupil size) for introverted, as opposed to extraverted, subjects throughout the entire experiment. Furthermore, if one accepts the assumption that the present $Spont_2$ measure (number of spontaneous SCRs during the habituation trials) is similar to the trials-to-criterion habituation measure, then the present results are also consistent with the findings of Mangan and O'Gorman (1969), Bourgeois (1972), and Desjardins (1973), all of whom reported that introverts, as opposed to extraverts, required significantly more trials to reach the habituation criterion.

It is interesting to speculate why none of the other studies reviewed in Chapter I (see Table 1) reported a significant relationship between the extraversion variable and tonic skin conductance. The two most important studies, which have relevance for the present analysis, are those of Coles et al. (1971) and Sadler, Mefferd and Houck (1971). Both studies employed "tonic prestimulus" or "basal" electrodermal measures in their statistical analyses. However, a consideration of the methods used to quantify and define their "tonic" measures indicates that they used

tonic measures which not only differed from each other, but also differed from the SCL measures used in the present experiments.

In the Coles et al. (1971) study, a "mean prestimulus level" measure was used, which was the mean of 24 tonic readings taken for each subject before, during, and after stimulation, while in the Sadler et al. (1971) study, two "basal skin resistance" measures were taken, one just before the first stimulus and the other three minutes after the last stimulus. There are difficulties with the procedures used in both studies to define "tonic" electrodermal level. The method used by Coles et al. would average out any important differences which may have occurred particularly in the early trials. It would have been better to use a trials or trial blocks analysis of the tonic measures. The method used by Sadler et al. would lead to a very inadequate sampling of "basal skin resistance" levels, since both measures were taken essentially apart from the stimulation phase of their experiment. Once again, a trials or trial blocks analysis would have provided an adequate sample of tonic measures for the statistical analyses.

This later analysis suggests that some of the inconsistent results reported in the habituation literature may be due to inappropriate defining procedures for the physiological (dependent) measures. Finally, these considerations

add a good deal of support to Averill's (1974, p. 240) statement that all habituation measures are not alike. Indeed, it was demonstrated immediately above that measures bearing a similar label (e.g., "tonic") are often products of very different defining procedures and are, in fact, different measures.

The writer concludes that the correlation data obtained in the present study between the extraversion and neuroticism variables and the various skin conductance measures provides excellent support for Eysenck's (1967) theory.

5. Suggestions for Future Work

The results of the present experiments, in addition to the habituation studies reviewed in this paper, suggest that there are three major classes of variables which may differentially affect skin conductance habituation, i.e., stimulus variables, subject variables, and motivational variables. It was pointed out repeatedly above that Sokolov's matching theory, which is addressed essentially to the "novelty" or "uncertainty" aspects of the orienting stimulus and which predicts habituation outcome on the basis of stimulus identification, cannot even effectively deal with the class of "stimulus" variables. His theory clearly was not able to predict the skin conductance

habituation data obtained in the present experiments. It seems reasonable, therefore, that future habituation research will need to consider, in more comprehensive psychological terms, all three classes of variables.

More specifically, the results of the present experiments can be extended by studying the effects of high and low meaningful linguistic stimuli on skin conductance habituation, but within the context of a stimulus change study. One group of subjects, for example, would receive a high meaningful word for the first 10 trials which would change on the "test trial" (i.e., trial 11) to a low meaningful word stimulus. A second group would receive a low meaningful word stimulus for the first 10 trials, and on the test trial would receive a high meaningful word. The results of the present experiments would predict significantly less skin conductance habituation to the high meaningful linguistic stimuli both during the pretest and posttest habituation trials.

In a similar manner, the present habituation findings can be extended by studying the effects of high and low word concreteness on skin conductance habituation within the context of a stimulus change study. However, in this latter study, the stimuli would not change on the test trial, but the motivating task instructions would change. One group of subjects, for example, would receive a high concrete

word for the first 10 trials, under standard habituation task instructions (i.e, remain quiet and attentive, etc.), then just before the test trial imagery task instructions would be given as in the Pavio and Simpson (1968) study. A second group would receive a low concrete (abstract) word for the pretest trials and on the test trial also receive the imagery task instructions. The results of the present experiments taken together with the findings of Pavio and Simpson would predict significantly less skin conductance habituation for the concrete words during the pretest trials, but significantly less skin conductance habituation for the abstract words during the posttest trials.

More work is required to further investigate the effects of the extraversion and neuroticism variables on skin conductance habituation. In particular, a critical experiment studying Eysenck's E X N interaction hypothesis employing skin conductance measures similar to those used in the present experiments would extend the present findings. A test of the interaction hypothesis was not possible in the present experiments because the personality variables were not manipulated. The results of the present experiments suggest that the tonic skin conductance level measures (SCL-TB_1, TB_2, TB_3) and the spontaneous skin conductance response measures ($Spont_1$, $Spont_2$) would

be the dependent measures of choice to research the E X N interaction.

The use of a phasic-latency measure as a separate dependent variable clearly deserves more study. The LAT_2 measure was found in the present experiments to be as reliable and sensitive an index of the habituation process as the phasic change scores (SCR) and, in addition, the LAT_2 measure demonstrated superior distribution characteristics compared to the phasic measures. However, this latter finding may have been a function of the scoring technique used for the LAT_2 measure. It can be recalled that when no SCR was observed during the interstimulus interval, the maximum latency for the interval was the score given for that particular trial. This would tend to keep the variance of the LAT_2 scores high, particularly in the later trial blocks (Tables 77, 78, 79) and the distribution characteristics relatively normal. Additional work is required to explore the relative merits of the method to quantify the present latency scores as compared to, for example, the "missing score" procedure used by some other authors.

The range correction procedure used with the phasic measures in the present habituation experiments was found to be a valuable tool to reduce that proportion of the variance in the SCR measures which was a function of the subject's individual differences in range of response.

Therefore, when an experimenter is interested in studying the effects of stimulus variables on skin conductance habituation, the phasic range correction procedure can be used with advantage. However, if the experimenter is interested in studying the effects of various subject variables (e.g., extraversion, neuroticism) on skin conductance habituation, the range correction procedure is contra-indicated because it will remove that proportion of the variance in the skin conductance measures which is attributed to the individual differences in the subject's responsiveness.

A repeated measures (trials or trial blocks) analysis of the habituation measures clearly gives more information about the habituation process, even if more difficult to handle statistically than the single-score habituation measures. The single or mean score habituation measures can also be used, but they must be interpreted as mean reactivity indicators. It is critically important that experimenters realize that significant but transient differences can be "masked" or "absorbed" in the mean score "habituation" measures. In the present study, for example, when the habituation measures were averaged across all 30 trials, and a series of 2 X 2 ANOVAs performed on the measures, most of the significance disappeared. (These analyses were not reported in the present paper.)

The present writer cannot emphasize enough how important it is for workers to state in precise and unambiguous terms the procedures used to define their physiological (dependent) measures. The writer has reviewed a number of habituation studies which violated this most basic rule of psychophysiological research. This makes replication or between studies comparisons difficult, if not impossible. The suggestions offered by Lykken and Venables (1971) for the standardization of electrodermal measures would, if accepted, go a long way in correcting this continuing problem.

Finally, more attention should be given to the study of electrocortical response habituation, because all habituation research is ultimately interested in brain (cortical) events. This statement underscores the obvious advantages of indexing brain phenomena directly rather than taking an indirect route through the autonomic nervous system. It was pointed out in Chapter I that there are serious difficulties in defining EEG habituation as proposed by Sokolov, and this explains why most workers have used electrodermal measures. Therefore, a number of open-ended, exploratory studies are necessary, which would investigate and hopefully be able to define the phenomenon of EEG habituation. Such a research project represents a potentially outstanding contribution to the habituation literature, and to psychophysiology in general.

SUMMARY AND CONCLUSIONS

The present research investigated the hypothesis deduced from Sokolov's model-mismatch theory for habituation of the orienting response, that habituation may be related to the meaning (meaningfulness) of the orienting stimulus. Following Pavio's analysis of linguistic meaning, both a theoretical position and an operational strategy were conceptualized which distinguished denotative linguistic meaning, connotative linguistic meaning, and word concreteness. It was, therefore, further hypothesized that habituation to a word stimulus may be related to the denotative meaning, the connotative meaning, and the concreteness of the word stimulus. Alternative sets of contrary predictions were formulated for the three hypotheses based on (a) Sokolov's matching assumption, and (b) the implicit arousal assumption developed for linguistic meaning.

The present research also investigated the relationship between habituation outcome and individual differences in subject variables. Eysenck's personality theory predicts that the more psychologically sensitive and more tonically "aroused" introvert, as opposed to the extravert, will demonstrate significantly longer skin conductance habituation than the extravert. His theory

therefore, predicts a significant inverse correlation between the extraversion variable and the skin conductance habituation measures, and no correlation between the neuroticism variable and the skin conductance measures. In the present experiments, the extraversion and neuroticism measures were analyzed as correlates of the skin conductance (dependent) habituation measures.

These predictions were tested within the context of two skin conductance habituation experiments. The frist experiment manipulated (high and low) denotative and connotative linguistic meaning. The second experiment manipulated (high and low) word concreteness and connotative linguistic meaning. The Eysenck Personality Inventory was also given to the subjects so that the relationships between the extraversion and neuroticism variables and the skin conductance measures could be analyzed.

The analyses of the skin conductance habituation measures provided no support for Sokolov's matching hypothesis, while consistent support was found for the arousal hypothesis. That is, the high meaningful (familiar) words consistently demonstrated significantly less habituation than the low meaningful (novel) words. Furthermore, these results were demonstrated for two of the three classes of habituation measures (phasic and latency of phasic response measures),

and the results of experiment I were in general replicated in experiment II.

It was concluded that Sokolov's matching theory could not account for the present habituation data. It was also concluded that his theory could not predict many of the other findings reported in the habituation literature (Chapter I). Sokolov's theory was criticized on the basis that it is addressed only to the stimulus-matching aspect of the stimulus conditions, and makes no provision for the effects of other psychological variables on habituation outcome. Thus Sokolov's theory clearly states that the neurophysiological processes habituate, once the stimulus has been identified (mismatch ceases), even if the stimulus continues to operate. Overall, it was concluded that Sokolov's theory fails to consider at least three major classes of variables (i.e., stimulus, subject and motivational variables), all of which may significantly affect habituation outcome, in addition to the hypothetical matching process. Some general suggestions for the revision of Sokolov's habituation theory were offered.

An examination of the intercorrelations between the skin conductance measures indicated that all four classes of measures (i.e., phasic, latency, tonic, and spontaneous SC measures) were significantly interrelated. In general, the findings of previous researchers were replicated and

extended to include the class of tonic skin conductance measures. The present significant results for the tonic skin conductance measures, in contrast to the generally nonsignificant findings of other workers, were attributed to a more precise defining operation and a more appropriate analysis of the tonic measures employed in the present habituation experiments.

The results of the correlation analyses between the extraversion and neuroticism measures and the various skin conductance measures indicated that the extraversion variable was significantly and inversely related to tonic skin conductance, and estimates of spontaneous skin conductance activity. The neuroticism variable did not significantly correlate with any of the skin conductance measures. The present findings were interpreted as providing support for Eysenck's (1967) prediction that skin conductance habituation measures are related to extraversion and not neuroticism.

Suggestions were made for additional research.

REFERENCES

Averill, J. R. Reply to O'Gorman. Journal of Research in Personality, 1974, 8, 203-205.

Bargmann, R. E. Interpretation and use of a generalized discriminant function. In R. C. Bose et al. (Eds.), Essays in probability and statistics. Chapel Hill: University of North Carolina, 1970.

Bartlett, M. S. The goodness of fit of a single hypothetical discriminant function in the case of several groups. Annals of Eugenics, 1951, 16, 199-214.

Benjamin, L. S. Statistical treatment of the law of initial values (LIV) in autonomic research: A review and recommendations. Psychosomatic Medicine, 1963, 25, 556-566.

Benjamin, L. S. Facts and artifacts in using analysis of covariance to "undo" the law of initial values. Psychophysiology, 1967, 4, 187-206.

Bernstein, A. S. The orienting reflex as a research tool in the study of psychotic populations. In I. Ruttkay-Nedecky et al. (Eds.), Mechanisms of orienting reaction in man. Bratislava: Slovak Academy of Sciences, 1967.

Bernstein, A. S. To what does the orienting response respond? Psychophysiology, 1969, 6(3), 338-350.

Bernstein, A. S. Electrodermal lability and the OR: Reply to O'Gorman and further exposition of the "significance hypothesis." Australian Journal of Psychology, 1973, 25(2), 147-154.

Bernstein, A. S., Taylor, K., Austin, B. G., Nathanson, M., & Scarpelli, A. Orienting response and apparent movement toward or away from the observer. Journal of Experimental Psychology, 1971, 87(1), 37-45.

Bernstein, A. S. Taylor, K. W., & Weinstein, E. The phasic electrodermal response as a differential complex reflecting stimulus significance. Psychophysiology, 1975, 12(2), 158-169.

Bloch, V., & Bonvallet, N. Interactions des formations réticulaires méséncephalique et bulboire. Journal de physiologie, 1961, 53, 280-281.

Bock, R. D. Multivariate analysis of variance of repeated measures. In C. W. Harris (Ed.), Problems of measuring change. Madison: University of Wisconsin Press, 1963.

Bourgeois, R. P. Introversion-extraversion and the role of the orienting reaction habituation rate to the apparent size of hue. Unpublished doctoral dissertation, University of Ottawa, Ontario, 1972.

Box, G. E. P. Nonnormality and tests on variances. Biometrika, 1953, 40, 318-335.

Box, G. E. P. Some theorems on quadratic forms applied in the study of analysis of variance problems. II. Effects of inequality of variance and of correlation between errors in the two-way classification. Annals of Mathematical Statistics, 1954, 25, 484-498.

Brown, R. W. Words and things. Glencoe, Ill.: Free Press, 1958.

Bull, R. H. C., & Gale, M. A. The reliability of and interrelationships between various measures of electrodermal activity. Journal of Experimental Research in Personality, 1973, 6, 300-306.

Carlson, J. E., & Timm, N. H. Program manuals: FRULM and FRMLM computer programs. University of Pittsburg, 1974.

Cattell, R. B., & Scheier, I. H. The nature of anxiety: A review of thirteen multivariate analyses comprising 814 variables. Psychological Reports, 1958, 4, 351-388.

Coles, M. G. H., Gale, A., & Kline, P. Personality and habituation of the orienting reaction: Tonic and response measures of electrodermal activity. Psychophysiology, 1971, 54-63.

Cooley, W. W., & Lohnes, P. R. Multivariate data analysis. New York: Wiley, 1971.

Cowles, M. P. The latency of the skin resistance response and reaction time. Psychophysiology, 1973, 10, 177-183.

Creelman, M. B. The experimental investigation of meaning. New York: Springer, 1966.

Crider, A., & Lunn, R. Electrodermal lability as a personality dimension. Journal of Experimental Research in Personality, 1971, 5, 145-150.

Darrow, C. W. The significance of the galvanic skin reflex in the light of its relation to quantitative measures of perspiration. Psychological Bulletin, 1934, 31, 697-698.

Darrow, C. W. Neural mechanisms controlling the palmar galvanic skin reflex and palmar sweating. Archives of Neurology and Psychiatry, 1937, 37, 641-663.

Darrow, C. W. The rationale for treating the change in galvanic skin response as a change in conductance. Psychophysiology, 1964, 1, 31-38.

Davis, M., & Wagner, A. R. Habituation of startle response under incremental sequence of stimulus intensities. Journal of Comparative Physiological Psychology, 1969, 67, 486-492.

Dayhaw, L. T. Manuel de statistique (3ième éd.). Ottawa: Editions de l'Universite d'Ottawa. 1966.

Desjardins, E. C. The effects of verbal stimulus meaning and introversion-extraversion on the habituation of the orienting reaction. Unpublished research, University of Ottawa, Ontario, 1973.

DiVesta, F. J. A normative study of 202 concepts rated on the semantic differential by children in grades 2 through 7. The Journal of Genetic Psychology, 1966, 109, 205-229.

DiVesta, F. J., & Walls, R. T. Factor analysis of the semantic attributes of 487 words and some relationships to the conceptual behavior of fifth-grade children. Journal of Educational Psychology, 1970, 61(6, Pt. 2), 1-39.

Duffey, G. Activation and behavior. London: Wiley, 1962.

Ebbinghaus, H. Memory: A contribution to experimental psychology. New York: Dover, 1964. (Originally published Leipzig: Duncker & Humblot, 1885).

Edelberg, R. Independence of galvanic skin response amplitude and sweat production. Journal of Investigative Dermatology, 1964, 42, 443-448.

Edelberg, R. Electrical properties of the skin. In C. C. Brown (Ed.), Methods in psychophysiology. Baltimore: Williams & Wilkins, 1967.

Edelberg, R. The information content of the recovery limb of the electrodermal response. Psychophysiology, 1970, 6, 527-539.

Edelberg, R. Electrical activity of the skin. Its measurement and uses in psychophysiology. In N. S. Greenfield & R. A. Sternbach (Eds.), Handbook of psychophysiology. New York: Holt, Rinehart & Winston, 1972.

Edwards, D. C. Stimulus intensity and recency contrasts and orienting response strength. Psychophysiology, 1974, 11(5), 543-547.

Edwards, D. C. Stimulus intensity reduction following habituation. Psychophysiology, 1975, 12(1), 12-14.

Epstein, S., & Fenz, W. D. Habituation to a loud sound as a function of manifest anxiety. Journal of Abnormal Psychology, 1970, 75, 189-194.

Eysenck, H. J. The Maudsley personality inventory. San Diego, California: Educational and Industrial Testing Service, 1962.

Eysenck, H. J. Foreword. In R. Lynn. Attention, arousal and the orientation reaction. New York: Pergamon, 1966.

Eysenck, H. J. The biological basis of personality. Springfield: Thomas, 1967.

Eysenck, H. J. Personal (written) communication to the writer. Ottawa, Ontario, 1974.

Eysenck, H. J., & Eysenck, S. B. G. Manual for the Eysenck personality inventory. San Diego, California: Educational and Industrial Testing Service, 1968.

Eysenck, S. B. G., & Eysenck, H. J. On the dual nature of extraversion. British Journal of Social and Clinical Psychology, 1963, 2, 46-55.

Farley, F. H. On the independence of extraversion and neuroticism. Journal of Clinical Psychology. 1967, 2, 154-156.

Fisher, L. C., & Kotses, H. Race differences and experimenter race effect in galvanic skin response. Psychophysiology, 1973, 10, 578-582.

Fisher, R. A., & Yates, F. Statistical tables for biological, agricultural and medical research. Edinburgh: Oliver & Boyd, 1963.

Fox, R., & Lippert, W. Spontaneous GSR and anxiety level in sociopathic delinquents. Journal of Consulting Psychology, 1963, 27, 368.

Fried, R., Friedman, M., & Welch, L. High and low anxiety and GSR adaptation. Psychonomic Science, 1967, 9, 635-636.

Frinke, G. Word characteristics, associative-relatedness and the free-recall of nouns. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 366-372.

Gale, A., Coles, M., & Blaydon, J. Extraversion-introversion and the EEG. British Journal of Psychology, 1969, 60, 209-223.

Gale, A., Coles, M., Kline, P., & Penfold, V. Extraversion-introversion, neuroticism and the EEG: Basal and response measures during habituation of the orienting response. British Journal of Psychology, 1971, 62, 533-543.

Gale, M. A., & Bull, R. H. C. The reliability of and interrelationships between various measures of electrodermal activity. Journal of Experimental Research in Personality, 1973, 6, 300-306.

Gastaut, H. The role of the reticular formation in establishing conditioned reactions. In Reticular formation of the brain, Boston: Jasper, Little & Brown, 1957.

Geer, J. H. Effect of interstimulus intervals and rest-period length upon habituation of the orienting response. Journal of Experimental Psychology, 1969, 72(4), 617-619.

Geisser, S., & Greenhouse, S. W. An extension of Box's results on the use of the F distribution in multivariate analysis. Annals of Mathematical Statistics. 1958, 29, 885-891.

Gellhorn, E. Prolegomena to a theory of emotions. In Perspectives in biology and medicine (Vol. 4). Chicago: University of Chicago Press, 1961.

Gellhorn, E., & Loofbourrow, G. N. Emotions and emotional disorders. New York: Harper, 1963.

Gerow, J. G., & Pollio, H. R. Word association, frequency of occurrence, and semantic differential norms for 360 words. Technical Report No. 1. Contract MH 08903. Knoxville: University of Tennessee, 1965.

Gildemeister, M., & Ellinghaus, J. Zur physiologie der menschlichen haut: III. Uber die abhänqigkeit des galvanischen hautreflexes von der temperatur des haut. Pflügers Archiv. für die gesamte physiologie, 1923, 200, 262-277.

Ginsberg, S., & Furedy, J. J. Stimulus repetition, change, and assessments of sensitivities of and relationships among one electrodermal and two plethysmographic components of the orienting reaction. Psychophysiology, 1974, 11(1), 35-43.

Glaze, J. A. The association value of nonsense syllables. Journal of Genetic Psychology, 1928, 35, 225-267.

Graham, F. K. Habituation and dishabituation of responses innervated by the autonomic nervous system. In H. V. S. Peeke & M. J. Herz (Eds.), Habituation. New York & London: Academic Press, 1973.

Graham, F. K., Berg, K. M., Berg, K. W., Jackson, J. C., Hatton, H. M., & Kantowitz, S. R. Cardiac orienting responses as a function of age. Psychonomic Science, 1970, 19, 363-365.

Graham, F. K., & Clifton, R. K. Heart-rate change as a component of the orienting response. Psychological Bulletin, 1966, 65, 305-320.

Grastyan, E. The hypocampus and higher nervous activity. In M. A. Brazier (Ed.), The central nervous system and behavior. New York: Moon, 1960.

Gray, J. A. Strength of nervous system, introversion, conditionability and arousal. Behavior Research and Therapy, 1967, 5, 151-169.

Gray, J. A. The psychophysiological basis of introversion-extraversion. Behavior Research and Therapy, 1970, 8, 249-266.

Groves, P. M., & Thompson, R. F. Habituation: A dual-process theory. Psychological Review, 1970, 77(5), 419-450.

Guilford, J. P. Psychometric methods. New York: McGraw-Hill, 1954.

Guilford, J. P. Fundamental statistics in psychology and education. New York: McGraw-Hill, 1965.

Hall, J. F. Relationships among a number of measures of meaningfulness. American Journal of Psychology, 1967, 80, 291-293.

Hall, J. F. Verbal learning and retention. New York: Lippincott, 1971.

Harding, G. B., Stevens, E. E., & Marston, P. T. Rate of information processing and skin resistance. Journal of Experimental Psychology, 1973, 99, 306-313.

Hare, R. D. Temporal gradient of fear arousal in psychopaths. Journal of Abnormal Psychology, 1965, 70, 442-445.

Hare, R. D. Orienting and defensive responses to visual stimuli. Psychophysiology, 1973, 10, 453-464.

Hare, R., Wood, K., Britain, S., & Frazelle, J. Autonomic responses to affective visual stimulation: Sex differences. Journal of Experimental Research in Personality, 1971, 5, 14-22.

Hatton, H. M., Berg, W. K., & Graham, F. K. Effects of acoustic rise time on heart rate response. Psychonomic Science, 1970, 19, 101-103.

Heck, D. L. Charts of some upper percentage points of the distribution of the largest characteristic root. Annals of Mathematical Statistics, 1960, 31, 625-642.

Heise, D. R. Semantic differential profiles for 1,000 most frequent English words. Psychological Monographs: General and Applied, 1965, 79(8), 1-31.

Hernandez-Peon, R. Neurophysiological correlates of habituation and other manifestations of plastic inhibition (internal inhibition). In H. H. Jasper & G. D. Smirnov (Eds.), The Moscow colloquium on electroencephalography and clinical neurophysiology. EEG Clinical Neurophysiology, 1960 (Suppl. 13),

Hord, D. J., Johnson, L. C., & Lubin, A. Differential effect of the law of initial value (LIV) on autonomic variables. Psychophysiology, 1964, 1, 79-87.

Hotelling, H. A generalized t-test and measure of multivariate dispersion. Proceedings of the Second Berkeley Symposium on Mathematics and Statistics. 1951, 23-41.

Hull, C. L. The meaningfulness of 320 selected nonsense syllables. American Journal of Psychology, 1933, 45, 730-734.

Hull, C. L. Principles of behavior. New York: Appleton-Century, 1943.

Huynh, H., & Feldt, L. S. Conditions under which mean square ratios in repeated measurements designs have exact F distributions. Journal of the American Statistical Association, 1970, 65, 1582-1589.

Isamat, F. Galvanic skin responses from stimulation of limbic cortex. Journal of Neurophysiology, 1961, 24, 176-181.

Jackson, B. T., & Barry, W. F. The vasomotor component of the orientation reaction as a correlative of anxiety. Perceptual and Motor Skills, 1967, 25, 514-516.

Jackson, J. C. Amplitude and habituation of the orienting reflex as a function of stimulus intensity. Psychophysiology, 1974, 11(6), 647-659.

Jenkins, J. J., & Russell, W. A. Basic studies on individual and group behavior. Annual Technical Report. Contract No. N8 ONR-66216 between Office of Naval Research and the University of Minnesota, Minneapolis, 1956.

Jenkins, J. J., Russell, W. A., & Suci, G. J. An atlas of semantic profiles for 360 words. American Journal of Psychology, 1958, 71, 688-699.

Jensen, D. R., & Howe, R. B. Tables of Hotelling's T^2 distribution. Technical Report No. 9. Virginia Polytechnic Institute, 1968.

Johnson, L. C. & Lubin, A. Spontaneous electrodermal activity during sleeping and waking. Psychophysiology, 1966, 3, 8-17.

Jouvet, M. Recherches sur les mécanismes neurophysiologiques du sommeil et de l'apprentissage négatif. In A. Fessord et al. (Eds.), Brain mechanisms and learning. Oxford: Blackwell, 1961.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, California: Brooks-Cole, 1968.

Koch, G. G. Some aspects of the statistical analysis of "split-plot" experiments in completely randomized layouts. Journal of the American Statistical Association, 1969, 64, 485-505.

Koepke, J. E., & Pribram, K. H. Habituation of the vasoconstriction response as a function of stimulus duration and anxiety. Journal of Comparative and Physiological Psychology, 1967, 64, 502-504.

Koriat, A., Averill, J. R., & Malmstrom, E. J. Individual differences in habituation: Some methodological and conceptual issues. Journal of Research in Personality, 1973, 7, 88-101.

Krueger, W. C. F. The relative difficulty of nonsense syllables. Journal of Experimental Psychology, 1934, 17, 145-153.

Lacey, J. I. The evaluation of autonomic responses: Toward a general solution. Annals of the New York Academy of Sciences, 1956, 67, 123-164.

Lader, M., & Wing, L. Habituation of the psycho-galvanic reflex in patients with anxiety states and in normal subjects. Journal of Neurological Neurosurgical Psychiatry, 1964, 27, 210-218.

Lang, H., Tuovinen, T., & Valleala, P. Amygdaloid after discharge and galvanic skin response. Electroencephalography and Clinical Neurophysiology, 1964, 16, 366-374.

Langworthy, O. R., & Richter, C. P. The influence of efferent cerebral pathways upon the sympathetic nervous system. Brain, 1930, 53, 178-193.

Lawley, D. N. A generalization of Fisher's z-test. Biometrika, 1938, 30, 180-187.

Libby, W. L., Lacey, B. C., & Lacey, J. I. Pupillary and cardiac activity during visual attention. Psychophysiology, 1973, 10, 279-287.

Lovibond, S. H. Habituation of the orienting response to multiple stimulus sequences. Psychophysiology, 1969, 5(4), 435-439.

Lykken, D. T. Neuropsychology and psychophysiology in personality research. In E. F. Borgatta & W. W. Lambert (Eds.), Handbook of personality theory and research. New York: Rand-McNally, 1968.

Lykken, D. T. Square-wave analysis of skin impedance. Psychophysiology, 1970, 7, 262-275.

Lykken, D. T. Range correction applied to heart rate and GSR data. Psychophysiology, 1972, 9, 373-379.

Lykken, D. T., Macindoe, I., & Tellegen, A. Preception: Autonomic response to shock as a function of predictability in time and locus. Psychophysiology, 1972, 9, 318-333.

Lykken, D. T., Miller, R., & Strahan, R. Some properties of skin conductance and potential. Psychophysiology, 1968, 5, 253-268.

Lykken, D. T., Rose, R., Luther, B., & Maley, M. Correcting psychophysiological measures for individual differences in range. Psychological Bulletin, 1966, 66, 481-484.

Lykken, D. T., & Venables, P. H. Direct measurement of skin conductance: A proposal for standardization. Psychophysiology, 1971, 8, 656-672.

Lynn, R. Attention, arousal and the orienting reaction. New York: Pergamon, 1966.

MacLean, P. D. Limbic system ("visceral brain") in relation to central gray and reticulum of brain stem: Evidence of interdependence in emotional process. Psychosomatic Medicine, 1955, 17, 355-366.

MacLean, P. D. Contrasting functions of limbic and neocortical system of the brain and their relevance to psychophysiological aspects of medicine. American Journal of Medicine, 1958, 25, 611-626.

MacLean, P. D. Psychomatics. In Handbook of Physiology. Washington: American Physiological Society, 1960.

Mangan, G. L., & O'Gorman, J. G. Initial amplitude and rate of habituation of orienting reaction in relation to extraversion and neuroticism. Journal of Experimental Research in Personality, 1969, 3, 275-282.

Martin, I., & Venables, P. H. Mechanisms of palmar skin resistance and skin potential. Psychological Bulletin, 1966, 65, 347-357.

Marton, M., & Urban, I. An electroencephalographic investigation of individual differences in the processes of conditioning. In V. D. Nebylitsyn (Organizer), Symposium 9, Physiological bases of individual psychological differences. Moscow: 18th International Symposium, 1966.

Maulsby, R. L., & Edelberg, R. The interrelationship between the galvanic skin response, basal resistance and temperature. Journal of Comparative and Physiological Psychology, 1960, 53, 475-479.

McDonald, D. G., Johnson, L. C., & Hord, D. J. Habituation of the orienting response in alert and drowsy subjects. Psychophysiology, 1964, 1, 163-173.

McReynolds, P., Acker, M., & Brackbill, G. On the assessment of anxiety: IV. By measures of basal conductance and palmar sweat. Psychological Reports, 1966, 19, 347-354.

Mino, T., & Miyata, Y. Effects of the range of stimulus-variation upon habituation of the orienting response. Psychophysiology, 1975, 12(3), 136-140.

Moruzzi, G. Synchronizing influences of the brain stem and the inhibitory mechanisms underlying the production of sleep by sensory stimulation. In H. H. Jasper & G. D. Smirnov (Eds.), Moscow Colloquium on electroencephalography of higher nervous activity. EEG Clinical Neurophysiology, 1960, Supplement 13.

Myers, I. L. Fundamentals of experimental design. Boston: Allyn & Bacon, 1966 (1971).

Nil, N. H., Hull, C. H., Jenkins, J. G., Steinbrenner, K., & Bent, D. H. Statistical package for the social sciences (2nd ed.). New York: McGraw-Hill, 1975.

Nobel, C. E. An analysis of meaning. Psychological Review, 1952, 59(6), 421-430.

Nobel, C. E. The meaning-familiarity relationship. Psychological Review, 1963, 60, 89-98.

Nobel, C. E., & Parker, G. V. C. The Montana scale of meaningfulness. Psychological Reports, 1960, 7, 325-331.

O'Gorman, J. G. Overextinction of the orienting reaction. Conditional Reflex, 1970, 5, 27-35.

O'Gorman, J. G. Habituation of the orienting reaction as a function of stimulus information. Psychonomic Science, 1971, 22, 331-332.

O'Gorman, J. G. Electrodermal lability and recovery of habituated OR. Australian Journal of Psychology, 1972, 24, 241-244.

O'Gorman, J. G. Change in stimulus conditions and the orienting response. Psychophysiology, 1973, 10(5), 465-470.

O'Gorman, J. G. A comment on Koriat, Averill, and Malmstrom's "individual differences in habituation." Journal of Research in Personality, 1974, 8, 198-202.

Olson, C. L. Comparative robustness of six tests in multivariate analysis of variance. Journal of the American Statistical Association, 1974, 69, 894-908.

Orr, W. C., & Stern, J. A. The relationship between stimulus information, reaction time, and cortical habituation. Psychophysiology, 1971, 7(3), 475-484.

Osgood, C. E. Method and theory in experimental psychology. New York: Oxford University Press, 1953.

Osgood, C. E., & Suci, G. J. Factor analysis of meaning. Journal of Experimental Psychology, 1955, 50, 325-338.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. The measurement of meaning. Urbana, Ill.: University of Illinois Press, 1957.

Paintal, A. S. A comparison of the galvanic skin responses of normals and psychotics. Journal of Experimental Psychology, 1951, 41, 425-428.

Pavio, A. Learning of adjective-noun paired-associates as a function of adjective-noun word order and noun abstractness. Canadian Journal of Psychology, 1963, 17, 370-379.

Pavio, A. Latency of verbal associations and imagery to noun stimuli as a function of abstractness and generality. Canadian Journal of Psychology, 1966, 20, 378-387.

Pavio, A. A factor-analytic study of word attributes and verbal learning. Journal of Verbal Learning and Verbal Behavior, 1968, 7, 41-49.

Pavio, A. Imagery and verbal processes. New York: Holt, Rinehart & Winston, 1971.

Pavio, A., & Simpson, H. M. Magnitude and latency of the pupillary response during an imagery task as a function of stimulus abstractness and imagery ability. Psychonomic Science, 1968, 12, 45-46.

Pavio, A., Yuille, J. C., & Madigan, S. Concreteness, imagery and meaningfulness values for 925 nouns. Journal of Experimental Psychology Monograph Supplement, 1968, 76.

Papez, J. W. A proposed mechanism of emotion. Archives of Neurology and Psychiatry, 1937, 38, 725-743.

REFERENCES

Passingham, R. E. The neurological basis of introversion-extraversion: Gray's theory. Behavior Research and Therapy, 1970, 8, 353-366.

Pavlov, I. P. Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex. New York: Dover, 1927.

Peeke, H. V. S., & Hertz, M. J. (Eds.). Habituation. Vol. I. Behavioral studies. New York: Academic, 1973.

Pillai, K. C. S. Statistical tables for tests of multivariate hypotheses. Manila: Statistical Center, University of the Philippines, 1960.

Porebski, O. R. Discriminatory and canonical analysis of technical college data. British Journal of Mathematical and Statistical Psychology, 1966, 19, 215-236.

Pribram, K. H. The limbic systems, efferent control of neural inhibition and behavior. In W. R. Adey & T. Tokizane (Eds.), Progress in brain research. Vol. 27. Structure and function of the limbic system. Amsterdam: Elsevier, 1967.

Rachman, S. Reliability of galvanic skin response measures. Psychological Reports, 1960, 6, 326.

Raskin, D. C., Kotses, H., & Bever, J. Cephalic vasomotor and heart rate measures of orienting and defensive reflexes. Psychophysiology, 1969, 6, 149-159.

Razran, G. The observable unconscious and the inferable conscious in current Soviet psychophysiology: Interoceptive conditioning, semantic conditioning, and the orienting reflex. Psychological Review, 1961, 68, 81-145.

Richter, C. P. Galvanic skin reflex from animals with complete transection of the spinal cord. American Journal of Physiology, 1930, 93, 468-472.

Rocklyn, E. H., Hessert, R. B., & Braun, H. W. Calibrated materials for verbal learning with middle- and old-aged subjects. American Journal of Psychology, 1957, 70, 628-630.

Roy, S. N. Some aspects of multivariate analysis. New York: Wiley, 1957.

Roy, S. N., & Bose, R. C. Simultaneous confidence interval estimation. Annals of Mathematical Statistics, 1953, 24, 513-536.

Sadler, T. G., Meffered, R. B., & Houck, R. L. The interaction of extraversion and neuroticism in orienting response habituation. Psychophysiology, 1971, 8, 312-318.

Savage, R. D. Electro-cerebral activity, extraversion and neuroticism. British Journal of Psychiatry, 1964, 110, 98-100.

Scheffé, H. A method for judging all contrasts in the analysis of variance. Biometrika, 1953, 40, 87-104.

Scott, E. D., & Wilkinson, D. Adaptation as related to the introversion-extraversion dimension. U.S. Public Health Service, N.I.M.H. Report, Grant No. MH 06956-01, 1962.

Sechenov, I. M. Reflexes of the brain. Moscow: 1863. (English translation by S. Belsky, published by M.I.T. Press, Cambridge, 1965).

Shaknovich, A. R. On the pupillary component of the orienting reflex during action of stimuli specific for vision and nonspecific (extraneous) stimuli. In L. G. Voronin, A. N. Leontiev, A. R. Luria, E. N. Sokolov, & O. S. Vinogradova (Eds.), Orienting Reflex and Exploratory Behavior. Baltimore, Md.: Garmond Pridemark, 1958.

Shannon, C. R. A mathematical theory of communication. Bell System Technical Journal, 1948, 27, 379-423, 623-656.

Sharpless, S., & Jasper, H. Habituation of the arousal reaction. Brain, 1956, 79, 655-680.

Shimamura, M., & Fujimori, B. Studies on effects of brainstem stimulation upon motor and autonomic reflexes, with special reference to interrelationship between effects. Japanese Journal of Physiology, 1961, 11, 238-251.

Skinner, B. F. Verbal behavior. New York: Appleton-Century-Crofts, 1957.

Smith, D. B. D., & Strawbridge, P. J. The heart rate response to a brief auditory and visual stimulus. Psychophysiology, 1969, 6, 217-229.

Snedecor, G. W., & Cochran, W. G. Statistical methods. Ames, Iowa: The Iowa State University Press, 1971.

Sokolov, E. N. Neuronal models and the orienting reflex. In M. A. B. Brazier (Ed.), The central nervous system and behavior. New York: Moon, 1960.

Sokolov, E. N. Perception and the conditioned reflex. New York: Pergamon, 1963a.

Sokolov, E. N. Higher nervous functions: The orienting reflex. Annual Review of Psychology, 1963b, 25, 545-580.

Sokolov, E. N. The modeling properties of the nervous system. In Michael Cole & Irving Maltzman (Eds.), A handbook of contemporary Soviet psychology. New York: Basic Books, 1969.

Spreen, O., & Schulz, R. W. Parameters of abstraction, meaningfulness, and pronunciability for 329 nouns. Journal of Verbal Learning and Verbal Behavior, 1956, 5, 459-468.

Staats, A. W., & Staats, C. K. Meaning and (m): Correlated but separate. Psychological Review, 1959, 66, 136-144.

Stelmack, R. M., & Mandelzys, N. Extraversion and pupillary response to affective and taboo words. Psychophysiology, 1975,

Surwillo, W. W. The influence of some psychological factors on latency of the galvanic skin reflex. Psychophysiology, 1967, 4, 223-228.

Taylor, J. A. A personality scale of manifest anxiety. Journal of Abnormal and Social Psychology, 1953, 48, 285-290.

Timm, N. H. Multivariate analysis with applications in education and psychology. Belmont, California: Wadsworth, 1975.

Tizard, B. Evoked changes in EEG and electrodermal activity during the waking and sleeping states. EEG Clinical Neurophysiology, 1966, 20, 122-128.

Thompson, R. F., & Spencer, W. A. Habituation: A model phenomenon for the study of neuronal substrates of behavior. Psychological Review, 1966, 1, 16-43.

Thorndike, E. L., & Lorge, I. The teacher's word book of 30,000 words. New York: Bureau of Publications, Teachers College, 1944.

Underwood, B. J., Ekstrand, B. R., & Keppel, G. An analysis of intralist similarity in verbal learning with experiments on conceptual similarity. Journal of Verbal Learning and Verbal Behavior, 1965, 4, 447-462.

Van Egeren, L. F. Multivariate statistical analysis. Psychophysiology, 1973, 10, 517-530.

Velden, M., An empirical test of Sokolov's entropy model of the orienting response. Psychophysiology, 1974, 11(6), 682-691.

Venables, P. H. The relationship between PGR scores and temperature and humidity. Quarterly Journal of Experimental Psychology, 1955, 7, 12-18.

Venables, P. H., & Martin, I. Skin resistance and skin potential. In P. H. Venables & I. Martin (Eds.), A manual of psychophysiological methods. New York: Wiley, 1967.

Venables, P. H., & Sayer, E. On the measurement of the level of skin potential. British Journal of Psychology, 1963, 54, 251-260.

Voronin, L. G., & Sokolov, Y. N. Cortical mechanisms of the orienting reflex and its relation to the conditioned reflex. The Moscow colloquim on electroencephalography of higher nervous activity. EEG Clinical Neurophysiology Supplement, 1960, 13, 335-346.

Wall, F. J. The generalized variance ratio of the U-statistic. Albuquerque: The Dikewood Corporation, 1968.

Wang, G. H. The neural control of sweating. Madison: University of Wisconsin Press, 1964.

Wang, G. H., & Lu, T. W. On the intensity of the GSR induced by stimulation of postganglionic sympathetic nerve fibers with single induction shocks. Chinese Journal of Psychology, 1930, 4, 393-400.

Wang, G. H., & Richter, C. P. Action currents from the pad of the cat's foot produced by stimulation of the tuber cinerium. Chinese Journal of Psychology, 1928, 2, 279-284.

Welsh, G. S. Factor dimensions A and R. In G. S. Welsh & W. G. Dahlstrom (Eds.), Basic readings on the MMPI in psychology and medicine. Minneapolis: University of Minnesota Press, 1956.

Wenger, M. A., & Cullen, T. D. Some problems in psychophysiological research: III. The effects of uncontrolled variables. In R. Roessler & N. S. Greenfield (Eds.), Psychophysiological correlates of psychological disorder. Madison: University of Wisconsin Press, 1962.

Wilcott, R. C. Electrical stimulation of the anterior cortex and skin-potential responses in the cat. Journal of Comparative and Physiological Psychology, 1969, 69, 465-472.

Wilder, J. The law of initial value. Psychosomatic Medicine, 1950, 12, 392.

Wilder, J. Adrenaline and the law of initial value; A critical survey. Journal of Experimental Medicine and Surgery, 1957, 15, 47.

Wilder J. Basimetric approach (law of initial value) to biological rhythms. Annals of the New York Academy of Sciences, 1962, 98, 1211-1228.

Wilder, J. Pitfalls in the methodology of the "law of initial value." American Journal of Psychotherapy, 1965, 19, 577-584.

Wilks, S. S. Certain generalizations in the analysis of variance. Biometrika, 1932, 24, 471-494.

Witmer, L. R. The association value of three-place consonant syllables. Journal of Genetic Psychology, 1935, 47, 337-359.

Wolfensberger, W., & O'Connor, N. Relative effectiveness of galvanic skin response latency, amplitude and duration scores as measures of arousal and habituation in normal and retarded adults. Psychophysiology, 1967, 3, 345-350.

APPENDIX 1

IMAGERY RATING SCALE

IMAGERY RATING SCALE

NAME : _____ DATE: _____

PHONE: _____

Nouns differ in their capacity to arouse mental images of things or events. Some words arouse a sensory experience, such as a mental picture or sound, very quickly and easily, whereas others may do so only with difficulty (i.e., after a long delay) or not at all. The purpose of this test is to rate a list of words as to the ease or difficulty with which they arouse mental images. Any word which, in your estimation, arouses a mental image (i.e., a mental picture, or sound, or other sensory experience) very quickly and easily should be given a high imagery rating; any word that arouses a mental image with difficulty or not at all should be given a low imagery rating. Think of the words "apple" or "fact." Apple would probably arouse an image relatively easily and would be rated as high imagery; fact would probably do so with difficulty and would be rated as low imagery. Since words tend to make you think of other words as associates, e.g., knife-fork, it is important that you note only the ease of getting a mental image of an object or an event to the word.

Your ratings will be made on a seven-point scale, where one is the low imagery end of the scale and seven is the high imagery end of the scale. Make your rating by putting a circle around the number from 1 to 7 that best indicates your judgment of the ease or difficulty with which the word arouses imagery. The words that arouse mental images most readily for you should be given a rating of 7; words that arouse images with the greatest difficulty or not at all should be rated 1; words that are intermediate in ease or difficulty of imagery, of course, should be rated appropriately between the two extremes. Feel free to use the entire range of numbers, from 1 to 7; at the same time, don't be concerned about how often you use a particular number as long as it is your true judgment. Work fairly quickly but do not be careless in your ratings.

Below are four sample items. Indicate the ease of getting an image by circling the appropriate number.

APPENDIX 1

SAMPLE ITEMS

AUTOMOBILE:

Low Imagery 1 2 3 4 5 6 7 High Imagery

WRITER:

Low Imagery 1 2 3 4 5 6 7 High Imagery

DEMOCRACY:

Low Imagery 1 2 3 4 5 6 7 High Imagery

VAPOR:

Low Imagery 1 2 3 4 5 6 7 High Imagery

If necessary, refer back to these instructions when rating the words on the following pages.

DO NOT BEGIN UNTIL THE EXAMINER GIVES THE SIGNAL.

APPENDIX 1

PENCIL:

Low Imagery 1 2 3 4 5 6 7 High Imagery

AMOUR:

Low Imagery 1 2 3 4 5 6 7 High Imagery

WATER:

Low Imagery 1 2 3 4 5 6 7 High Imagery

TROUBLE:

Low Imagery 1 2 3 4 5 6 7 High Imagery

APPENDIX 2

WORD ASSOCIATION TEST

APPENDIX 2

WORD ASSOCIATION TEST

NAME : _____ DATE: _____

PHONE: _____

This is a test to see how many words you can think of and write down in a short time.

You will be given a key word and you are to write down as many other words which the key word brings to mind as you can. These other words which you write down may be things, places, ideas, events, or whatever you happen to think of when you see the key word.

For example, think of the word KING. Some of the words or phrases which KING might bring to mind are written below:

queen	kingdom
King Cole	England
ruler	imperial
Sky-king	kingfish

Turn now to the sample item.

APPENDIX 2

SAMPLE ITEM

HAM

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

HAM _____

APPENDIX 2

No one is expected to fill in all the spaces on a page, but write as many words as you can which each key word calls to mind. Be sure to think back to the key word after each word you write down because the test is to see how many other words the key word makes you think of. A good way to do this is to repeat each key word over and over to yourself as you write.

DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL.

APPENDIX 2

COTTON

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

COTTON _____

APPENDIX 3

THE SEMANTIC DIFFERENTIAL RATING SCALES

APPENDIX 3

THE SEMANTIC DIFFERENTIAL RATING SCALES

NAME : _____ DATE: _____

PHONE: _____

The purpose of this test is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales. In taking this test, please make your judgments on the basis of what these things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.

Here is how you are to use these scales:

If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

good __X__:_____:_____:_____:_____:_____:_____ bad

good _____:_____:_____:_____:_____:_____:__X__ bad

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

good _____:__X__:_____:_____:_____:_____:_____ bad

good _____:_____:_____:_____:_____:__X__:_____ bad

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

good _____:_____:__X__:_____:_____:_____:_____ bad

good _____:_____:_____:_____:__X__:_____:_____ bad

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

APPENDIX 3

If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, then you should place your check-mark in the middle space

clean _____:_____:_____:__X__:_____:_____:_____ dirty

IMPORTANT: (1) Place your check-marks in the middle of spaces, not on the boundaries:

This Not this
_____:_____:__X__:_____X_____:_____:_____

(2) Be sure you check every scale for every concept--do not omit any.

(3) Never put more than one check-mark on a single scale.

Please turn to the sample items.

APPENDIX 3

Sample Item

APPLE

good _____:_____:_____:_____:_____:_____:_____ bad

clean _____:_____:_____:_____:_____:_____:_____ dirty

beautiful _____:_____:_____:_____:_____:_____:_____ ugly

sweet _____:_____:_____:_____:_____:_____:_____ sour

nice _____:_____:_____:_____:_____:_____:_____ awful

happy _____:_____:_____:_____:_____:_____:_____ sad

pleasant _____:_____:_____:_____:_____:_____:_____ unpleasant

kind _____:_____:_____:_____:_____:_____:_____ cruel

valuable _____:_____:_____:_____:_____:_____:_____ worthless

fair _____:_____:_____:_____:_____:_____:_____ unfair

Sample Item

CAUSE

good _____:_____:_____:_____:_____:_____:_____ bad

clean _____:_____:_____:_____:_____:_____:_____ dirty

beautiful _____:_____:_____:_____:_____:_____:_____ ugly

sweet _____:_____:_____:_____:_____:_____:_____ sour

nice _____:_____:_____:_____:_____:_____:_____ awful

happy _____:_____:_____:_____:_____:_____:_____ sad

pleasant _____:_____:_____:_____:_____:_____:_____ unpleasant

kind _____:_____:_____:_____:_____:_____:_____ cruel

valuable _____:_____:_____:_____:_____:_____:_____ worthless

fair _____:_____:_____:_____:_____:_____:_____ unfair

APPENDIX 3

Sometimes you may feel as though you've had the same item before on the test. This will not be the case, so do not look back and forth through the items. Do not try to remember how you checked similar items earlier in the test. Make each item a separate and independent judgment. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impressions.

DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL.

APPENDIX 3

MERCY

good _____:_____:_____:_____:_____:_____:_____ bad

clean _____:_____:_____:_____:_____:_____:_____ dirty

beautiful _____:_____:_____:_____:_____:_____:_____ ugly

sweet _____:_____:_____:_____:_____:_____:_____ sour

nice _____:_____:_____:_____:_____:_____:_____ awful

happy _____:_____:_____:_____:_____:_____:_____ sad

pleasant _____:_____:_____:_____:_____:_____:_____ unpleasant

kind _____:_____:_____:_____:_____:_____:_____ cruel

valuable _____:_____:_____:_____:_____:_____:_____ worthless

fair _____:_____:_____:_____:_____:_____:_____ unfair

APPENDIX 4

WORD CONCRETENESS RATING SCALE

WORD CONCRETENESS RATING SCALE

NAME : _____ DATE: _____

PHONE: _____

Nouns may refer to persons, places, and things that can be seen, heard, felt, smelled, or tasted, or to more abstract concepts that cannot be experienced by the senses. The purpose of this test is to rate a list of words with respect to abstractness-concreteness. Any word that refers to objects, materials, or persons should receive a high concreteness rating; any word that refers to an abstract concept that cannot be experienced by the senses should receive a high abstractness rating. Think of the words "chair" and "independence." Chair can be experienced by our senses and therefore should be rated as Highly Concrete; independence cannot be experienced by the senses as such and therefore should be rated as Highly Abstract.

Your ratings will be made on a seven-point scale, where one is the Highly Abstract end of the scale, and seven in the Highly Concrete end of the scale. Make your rating by putting a circle around the number from 1 to 7 that best indicates your judgment. Feel free to use the entire range of numbers from 1 to 7, and don't be too concerned about how often you use a number, as long as it is your true judgment. Work fairly quickly but don't be careless in your ratings.

DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL.

EVENT:

Highly Abstract 1 2 3 4 5 6 7 Highly Concrete

MATTER:

Highly Abstract 1 2 3 4 5 6 7 Highly Concrete

DANGER:

Highly Abstract 1 2 3 4 5 6 7 Highly Concrete

GADFLY:

Highly Abstract 1 2 3 4 5 6 7 Highly Concrete

APPENDIX 5

WORD FAMILIARITY RATING SCALE

WORD FAMILIARITY RATING SCALE

NAME : _____ DATE: _____

PHONE: _____

This is a test to find out how often you have come in contact with certain words.

You will be given a list of nouns and you are to rate each one as to the number of times you have experienced it by simply placing an (X) in one of the five spaces provied for your rating.

The five possible ratings are described by the words NEVER, RARELY, SOMETIMES, OFTEN, and VERY OFTEN. This means that you have seen or heard or used the particular word (in writing or in speech) either:

1. NEVER (You have never seen or heard or used the word in your life.)

or

2. RARELY (You have seen or heard or used the word at least once before, but only rarely.)

or

3. SOMETIMES (You have sometimes seen or heard or used the word, but not often.)

or

4. OFTEN (You have often seen or heard or used the word, but not very often.)

or

5. VERY OFTEN (You have seen or heard or used the word nearly every day of your life.)

Do not be bothered if you are unable to give a definition of some of the words. Simply rate each one as to the number of times you have come in contact with it regardless of its meaning.

There may be some words which you have used or heard more often than you have seen them. Or there may be other words which you have seen more often than you have used or heard them. In such cases, always give the word the highest rating of the three.

For example, you probably use or hear the word SUPERVISOR often, but you may never have seen it in print. In this case, you would rate SUPERVISOR as "often" as shown on the line below"

SUPERVISOR:

Never	Rarely	Sometimes	X Often	Very Often

Please turn to the sample items.

APPENDIX 5

SAMPLE ITEMS

BREAKFAST:

Never Rarely Sometimes Often Very Often

ZITHER:

Never Rarely Sometimes Often Very Often

ENGLAND:

Never Rarely Sometimes Often Very Often

ZYZYGY:

Never Rarely Sometimes Often Very Often

When the examiner gives you the "Go" signal you will turn your page and begin rating the list of words at your own speed. This is not a "speed" test, and you will be given adequate time to finish. The important thing is for you to be as accurate as possible.

Be as honest in your ratings as you can. A number of words in this test are rare, so you are not expected to have come in contact with all of them. Just make the best estimate that you can.

DO NOT BEGIN UNTIL THE EXAMINER GIVES YOU THE SIGNAL.

ATTAR:

Never Rarely Sometimes Often Very Often

PERSON:

Never Rarely Sometimes Often Very Often

SURTAX:

Never Rarely Sometimes Often Very Often

NONSENSE:

Never Rarely Sometimes Often Very Often

APPENDIX 6

ORDER FOR THE ADMINISTRATION OF THE PSYCHOLOGICAL TESTS AND THE NUMBER OF SUBJECTS IN EACH GROUP

APPENDIX 6

Order for the Administration for the Psychological Tests and the Number of Subjects in Each Group (N=104)

Group No.	Order of Presentation 1	2	3	4	5	No. of Subjects
1	m	I	SD	f	A-C	22
2	A-C	m	I	SD	f	18
3	f	A-C	m	I	SD	23
4	SD	f	A-C	m	I	17
5	I	SD	f	A-C	m	24

m : Nobel's "m"
I : Rated Imagery
SD : Semantic Differential Scales
f : Rated Familiarity
A-C: Rated Concreteness

APPENDIX 7

THE RAW DATA FOR THE LINGUISTIC (INDEPENDENT) MEASURES OF THE STUDY

The Raw Data[1] for the Linguistic (Independent) Measures of the Study

Variables	Column Numbers
Subsample number	1
Word number	2-3
Subject number	4-6
Nobel's m	7-9
Pavio's I	10-12
Denotative meaning (m + I)	13-15
Connotative meaning (SD)	16-18
*m + I + SD	19-21
Familiarity (f)	22-24
Concreteness (A-C)	25-27

[1]The identification code corresponds directly to the computer printout of the data matrix, and all columns (and variables) are identified from left to right.

*Variable not analyzed in the present study.

APPENDIX 8

THE SCL_{max}, SCL_{min} AND SCR_{max} SCORES FOR THE RANGE CORRECTION PROCEDURES FOR THE TONIC AND PHASIC SKIN CONDUCTANCE MEASURES IN HABITUATION EXPERIMENTS I AND II

The SCL_{max}, SCL_{min} and SCR_{max} Scores (Micromhos/cm^2 skin surface) for the Range Correction Procedures for the Tonic and Phasic Skin Conductance Measures in Habituation Experiments I (Subjects 1-48) and II (Subjects 49-96)

Scoring Code No.	SCL_{max}	SCL_{min}	SCR_{max}
1	21.930	18.360	4.590
5	16.830	5.610	6.375
23	23.460	18.870	5.100
20	11.220	4.080	7.650
30	28.050	19.890	6.120
34	25.500	15.300	6.630
13	18.360	11.730	10.200
16	15.300	10.710	2.550
26	21.675	14.280	10.200
9	23.205	14.790	11.220
38	10.710	8.160	5.100
42	19.890	12.750	6.630
2	25.500	14.790	11.730
6	22.950	13.260	12.750
24	12.750	4.335	10.200
21	25.550	16.320	10.200
35	13.260	5.865	9.690
43	16.830	13.260	7.650
14	26.520	13.770	15.300
31	17.850	10.200	7.650
39	24.900	18.360	8.670
10	17.085	11.730	7.650
17	20.400	11.220	5.100
27	18.870	10.710	10.200
3	29.580	20.400	8.670
7	12.750	5.100	8.670
25	24.735	18.870	10.200
36	12.240	4.080	7.650
44	24.480	20.400	7.140
48	10.710	9.180	2.550

APPENDIX 8

Scoring Code No.	SCL_{max}	SCL_{min}	SCR_{max}
15	18.870	13.515	7.395
32	11.475	5.610	7.650
40	29.325	21.675	6.630
11	5.100	1.785	2.040
18	22.440	12.240	10.200
28	17.850	11.475	4.080
4	10.200	6.120	3.315
8	6.630	5.355	2.550
22	15.530	3.570	7.905
37	9.690	4.335	3.315
45	10.710	8.670	2.040
47	7.140	2.805	2.550
12	10.200	6.120	6.120
33	7.140	3.825	2.040
41	17.085	11.730	7.650
19	22.185	16.320	10.710
29	19.380	10.710	10.200
46	20.910	16.575	6.630
51	12.750	8.160	4.080
57	10.710	7.140	4.590
65	15.810	12.495	5.100
77	9.690	7.395	2.040
90	18.360	14.280	3.570
92	19.380	13.260	5.100
73	16.575	11.220	2.040
82	16.065	10.710	5.100
87	13.260	8.925	2.040
53	14.790	8.925	3.060
61	20.400	12.495	5.100
69	19.380	13.005	6.120
52	24.480	16.320	6.120
58	17.085	11.985	5.610
66	11.475	2.295	4.080

Scoring Code No.	SCL_{max}	SCL_{min}	SCR_{max}
78	9.180	3.570	4.590
93	23.460	11.730	15.300
96	16.065	7.140	15.300
74	17.850	10.455	7.650
83	10.200	2.805	9.180
88	15.555	10.200	5.865
54	14.025	9.180	5.610
62	9.435	5.355	6.120
70	31.620	20.910	10.200
49	10.455	5.610	2.550
67	10.200	4.335	3.570
75	9.180	3.570	10.200
59	12.240	4.590	1.020
79	16.320	12.240	6.120
94	10.710	5.355	3.570
55	19.380	15.045	10.200
71	21.930	12.750	15.300
91	18.615	15.555	7.650
63	33.150	20.910	25.500
81	9.435	4.080	1.530
84	10.200	4.080	7.140
50	10.200	5.610	3.570
76	24.480	13.515	15.300
86	19.380	14.280	5.100
60	16.065	9.690	10.200
68	12.240	6.120	8.160
80	12.750	7.905	5.100
56	31.110	20.400	13.770
64	16.830	9.180	7.650
72	15.300	10.200	10.200
85	12.750	7.395	7.650
89	17.340	9.690	9.180
95	15.300	8.925	10.710

APPENDIX 9

THE SUBJECT NUMBER (REAL) USED TO ASSIGN SUBJECTS RANDOMLY TO ONE OF THE FOUR CONDITIONS, AND THE SCORING CODE NUMBERS USED FOR THE SCORING OF THE POLYGRAPH RECORDS IN EXPERIMENT I (SUBJECTS 1-48) AND EXPERIMENT II (SUBJECTS 49-96)

APPENDIX 9

The Subject Number (Real) Used to Assign Subjects Randomly to One of the Four Conditions, and the Scoring Code Numbers Used for the Scoring of the Polygraph Records in Experiment I (Subjects 1-48) and Experiment II (Subjects 49-96)

Subject No.	Scoring Code No.	Subject No.	Scoring Code No.	Subject No.	Scoring Code No.
1	1	34	40	78	93
12	5	36	11	86	96
18	23	44	18	52	74
27	20	48	28	62	83
39	30	7	4	69	88
37	34	13	8	73	54
6	13	17	22	79	52
16	16	24	37	88	70
20	26	39	45	51	49
28	9	46	47	57	67
32	38	10	12	81	75
41	42	15	33	83	59
2	2	23	41	90	79
8	6	26	19	93	94
19	24	43	29	53	55
22	21	47	46	59	71
30	35	49	51	82	91
48	43	60	57	84	63
4	14	66	65	92	81
14	31	75	77	96	84
21	39	77	90	55	50
25	10	85	92	61	76
31	17	54	73	65	86
40	27	64	82	72	60
3	3	68	87	87	68
9	7	76	53	94	80
33	25	80	61	58	56
35	36	89	69	63	64
42	44	50	52	71	72
45	48	56	58	74	85
5	15	67	66	91	89
11	32	70	78	95	95

APPENDIX 10

THE RAW DATA FOR THE PHYSIOLOGICAL (DEPENDENT) VARIABLES IN HABITUATION EXPERIMENTS I AND II

APPENDIX 10

The Raw Data[1] for the Physiological (Dependent) Variables in Habituation Experiments I and II

Variables	Column No.
Experiment Number (1, 2)	1
Denotative Meaning (1=H, 2=L, 3=Nil)	2
Connotative Meaning (1=H, 2=L, 3=Nil)	3
Word Concreteness (1=H, 2=L, 3=Nil)	4
Trial Number	5-6
*NA	7
Scoring Code Number	8-10
Word Number	11-13
LAT_1	14-15
$*NA_1$	16-17
LAT_2	18-20
SCL_2	21-26
SCR	27-32
SCR-TISI	33-38
SCL-RAN	39-43
SCR-RAN	44-48
SCR-TISI-RAN	49-53
$Spont_1$	54-56
$Spont_2$	57-59
Extraversion (A+B)	60-62
Neuroticism (A+B)	63-65
Extraversion (A)	66-68
Neuroticism (A)	69-71
Extraversion (B)	72-74
Neuroticism (B)	75-77

[1]The identification code corresponds directly to the computer printout of the data matrix, and all columns (and variables) are identified from left to right. (All SC variables expressed in micromhos/cm^2 skin surface, rounded off at 3 sig. decimals.)

*Variables not analyzed in the present study.

1123184	7	5	1	1	1	7650	1020	1020	333	118	118								
1123194	7	5	1	1	1	9435	1020	1020	567	118	118								
1123204	7	5	1	1	1	7140	1020	1020	267	118	118								
1123215	7	5	1	1	1	8415	255	255	433	29	29								
1123225	7	5	5		42	7140	0	0	267	0	0								
1123235	7	5	1	1	1	5120	1530	1530	133	177	177								
1123246	7	5	5		40	8160	0	0	400	0	0								
1123255	7	5	2	2	2	6885	1275	1275	233	147	147								
1123266	7	5	1	1	1	6630	2295	2295	200	265	265								
1123276	7	5	3	3	3	10710	1020	1020	733	118	118								
1123286	7	5	3	3	3	7650	255	255	333	29	29								
1123296	7	5	3	3	3	7650	2295	2295	333	265	265								
1123306	7	5	1	1	1	7650	3060	3060	333	353	353								
1123 11	25	5	1	1	1	22695	5355	5355	652	525	525	8	31	20	15	7	5	13	10
1123 21	25	5	3	3	3	20910	3060	3060	348	300	300								
1123 31	25	5	3	3	3	20145	3570	3570	217	350	350								
1123 41	25	5	2	2	2	19635	4080	4080	130	400	400								
1123 51	25	5	3	3	3	20910	3570	3570	348	350	350								
1123 62	25	5	2	2	2	20910	2040	2040	348	200	200								
1123 72	25	5	2	2	2	20655	2570	2570	304	350	350								
1123 82	25	5	5		42	23205	0	0	773	0	0								
1123 92	25	5	1	1	1	21675	7650	7650	478	750	750								
1123102	25	5	2	2	2	21420	5865	5865	435	575	575								
1123113	25	5	2	2	2	22185	6630	6630	565	650	650								
1123123	25	5	2	2	2	22695	1530	1530	652	150	150								
1123133	25	5	3	3	3	23205	2805	2805	739	275	275								
1123143	25	5	3	3	3	21930	1530	1530	522	150	150								
1123153	25	5	3	3	3	20400	2550	2550	261	250	250								
1123164	25	5	5		17	22185	2550	2550	565	250	250								
1123174	25	5	3	3	3	23460	5100	5100	783	500	500								
1123184	25	5	2	2	2	22695	5610	5610	652	550	550								
1123194	25	5	3	3	3	22185	1020	1020	565	100	100								
1123204	25	5	3	3	3	21420	510	510	435	50	50								
1123215	25	5	3	3	3	21400	2550	2550	261	250	250								
1123225	25	5	1	1	1	20910	1530	1530	348	150	150								
1123235	25	5	1	1	1	21165	765	765	391	75	75								
1123245	25	5	3	3	3	20910	2550	2550	348	250	250								
1123255	25	5	1	1	1	20400	3825	3825	261	375	375								
1123266	25	5	2	2	2	19890	5100	5100	174	500	500								
1123276	25	5	5		36	24735	0	0	1000	0	0								
1123286	25	5	5		27	21675	0	2550	478	0	250								
1123296	25	5	5		42	20910	0	0	348	0	0								
1123306	25	5	5		25	18970	0	3060	0	0	300								
1123 11	36	5	3	3	3	4845	1530	1530	94	200	200	1	2	29	28	13	15	16	13
1123 21	36	5	5		28	6630	0	0	317	0	0								
1123 31	36	5	5		40	6375	0	0	281	0	0								
1123 41	36	5	5		34	5610	0	0	188	0	0								
1123 51	36	5	5		26	5355	0	0	156	0	0								
1123 62	36	5	5		36	5100	0	0	125	0	0								
1123 72	36	5	5		30	4590	0	0	63	0	0								
1123 82	36	5	5		42	4590	0	0	63	0	0								
1123 92	36	5	5		28	4335	0	0	31	0	0								
1123102	36	5	5		40	4335	0	0	31	0	0								
1123113	36	5	5		34	4080	0	0	0	0	0								
1123123	36	5	5		26	4080	0	0	0	0	0								
1123133	36	5	1	1	1	5610	1530	1530	188	200	200								
1123143	36	5	5		30	12240	0	0	1000	0	0								
1123153	36	5	1	1	1	10965	510	510	844	67	67								
1123164	36	5	5		28	10200	0	0	750	0	0								

[illegible]	[illegible]	8	[illegible]		26	[illegible]	0	0	538	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		34	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	510	[illegible]	0	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]		5		4	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	231	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	4375	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	0	0	77	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	77	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	[illegible]	0	0	750	
[illegible]	[illegible]	[illegible]	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]			[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	8	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]		5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	76	[illegible]	733	[illegible] 17 13 7 [illegible] [illegible]
[illegible]	41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	267	[illegible]	
[illegible]	41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]040	[illegible]040	[illegible]	[illegible]	[illegible]	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	8	5		24	[illegible]	0	[illegible]	[illegible]	0	67	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	0	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	0	0	0	
[illegible]	41	8	4	4	4	[illegible]	[illegible]	[illegible]	[illegible]	400	[illegible]	
[illegible]	41	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	41	[illegible]	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	5		[illegible]	[illegible]		0	[illegible]	0	0	
[illegible]	41	[illegible]	5		[illegible]	[illegible]	0	[illegible]	0	0	400	
[illegible]	41	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
1223174	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	8	[illegible]		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	1000	0	0	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	510	[illegible]	0	67	
[illegible]	41	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	41	8	5		[illegible]	[illegible]	0	0	[illegible]	0	0	
[illegible]	41	8	5		34	[illegible]	0	0	[illegible]	0	0	
[illegible]	[illegible]	8	2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	133	
[illegible]	41	[illegible]	[illegible]		[illegible]	[illegible]	0	0	48	0	0	
[illegible]	41	[illegible]	5		15	[illegible]	0	510	[illegible]	0	[illegible]	
[illegible]	41	8	[illegible]		42	[illegible]	0	0	[illegible]	0	0	
[illegible]	4	8	[illegible]		[illegible]	11770	0	0	0	0	0	
[illegible]	[illegible]	[illegible]	[illegible]	2	[illegible]	17340	7140	7140	174	667	[illegible]	17 50 [illegible] [illegible] [illegible] 10 13 14
[illegible]	[illegible]	8	[illegible]	[illegible]	[illegible]	[illegible]	4590	4590	[illegible]	429	[illegible]	
[illegible]	[illegible]	8	1	1	1	[illegible]	[illegible]	[illegible]	174	[illegible]	143	
[illegible]	[illegible]	[illegible]	[illegible]	1	1	17595	1020	1020	217	[illegible]	[illegible]	
[illegible]	10	[illegible]	[illegible]	2	[illegible]	[illegible]	[illegible]	[illegible]	0	429	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	2	2	18870	[illegible]	[illegible]	435	191	[illegible]	
[illegible]	19	[illegible]	[illegible]	1	1	[illegible]	2040	2040	1000	[illegible]	191	

APPENDIX 11

CRITICAL VALUES FOR THE FOUR MULTIVARIATE TEST CRITERIA WILKS (Λ), ROY (θs), LAWLEY-HOTELLING ($U^{(s)}$), AND PILLAI ($V^{(s)}$), FOR THE HYPOTHESES (H_A, H_B, H_{AB}) IN THE PRESENT HABITUATION EXPERIMENTS

Critical Values for the Four Multivariate Test Criteria Wilks (Λ), Roy (θs), Lawley-Hotelling ($U^{(s)}$), and Pillai ($V^{(s)}$), for the Hypotheses (H_A, H_B, H_{AB}) in the Present Habituation Experiments

Hypotheses	H_A	H_B	H_{AB}
Multivariate Criteria			
Wilks Λ <	.840	.840	.840
Roy θs >	.160	.160	.160
Lawley-Hotelling $U^{(s)}$ >	.187	.187	.187
Pillai $V^{(s)}$ >	.160	.160	.160

APPENDIX 12

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE MEANINGFULNESS (m) SCORES BETWEEN SUBSAMPLE I AND SUBSAMPLE II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

APPENDIX 12

A Comparison of the Means and Standard Deviations for the Meaningfulness (m) Scores between Subsample I and Subsample II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52) Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	1.71	1.73	2.41	2.12
2	amour	7.23	6.79	3.80	3.16
3	anger	7.69	7.42	2.54	2.60
4	array	4.60	3.98	2.05	1.98
5	attar	.81	.77	.79	.76
6	baby	12.19	11.73	2.79	2.81
7	blister	9.77	9.13	1.94	2.47
8	bodice	6.58	6.85	3.46	2.78
9	bosom	7.29	6.87	3.09	2.76
10	carom	1.25	.85	1.91	.85
11	concept	4.21	3.81	1.85	1.37
12	cotton	10.13	10.13	2.83	2.63
13	cradle	8.96	7.98	2.84	2.31
14	danger	8.46	8.34	2.51	2.61
15	davit	1.29	.94	1.61	.75
16	deceit	4.69	3.96	1.84	1.87
17	devil	9.77	8.71	2.22	2.04
18	divorce	9.21	9.27	2.50	2.62
19	dummy	5.98	6.27	1.88	2.10
20	essence	3.02	2.88	1.13	1.34
21	event	4.83	4.48	1.64	1.32
22	fabric	9.56	9.48	2.55	2.38
23	foible	1.21	1.21	.96	1.00
24	folly	3.10	3.02	1.94	1.61
25	gadfly	2.75	2.54	2.08	2.03
26	gamin	1.63	1.25	1.99	1.53
27	garret	3.87	2.85	3.14	2.48
28	iron	9.98	9.15	2.99	2.75
29	maelstrom	1.60	1.58	1.99	2.03
30	malice	3.37	3.40	2.04	1.49
31	market	9.96	9.67	2.50	3.07
32	matrix	4.13	3.98	1.51	1.71
33	matter	5.92	5.81	2.50	2.60
34	mercy	6.81	6.65	2.95	2.40
35	metal	9.73	9.23	2.94	2.85

APPENDIX 12

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	4.10	3.62	2.11	1.94
37	number	8.52	7.90	2.68	3.20
38	object	7.02	6.61	2.68	1.98
39	office	10.52	10.23	2.71	2.25
40	outcome	5.85	5.17	2.65	1.90
41	panic	8.67	7.46	2.69	2.61
42	paper	11.87	10.73	2.84	2.58
43	passion	7.92	7.08	2.92	2.56
44	pencil	10.58	9.98	3.09	2.63
45	percept	4.65	4.27	2.53	2.74
46	person	7.81	7.83	3.01	2.89
47	prison	11.27	10.65	2.75	2.77
48	quota	4.83	4.98	2.05	2.05
49	river	12.35	11.40	2.97	2.78
50	saloon	10.23	10.12	2.80	2.77
51	savant	2.15	2.21	2.16	1.88
52	sequence	4.87	4.85	1.24	1.11
53	sunburn	10.79	9.81	2.78	2.43
54	surface	7.12	6.77	2.28	2.06
55	surtax	4.13	4.10	1.66	1.73
56	table	10.79	10.23	2.85	2.93
57	temper	7.65	7.04	2.24	2.12
58	trouble	6.17	6.13	2.26	2.27
59	virtue	4.15	3.79	1.50	1.27
60	water	13.04	12.83	2.75	2.69

APPENDIX 13

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE IMAGERY (I) SCORES BETWEEN SUBSAMPLE I AND SUBSAMPLE II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

APPENDIX 13

A Comparison of the Means and Standard Deviations for the Imagery (I) Scores between Subsample I and Subsample II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52 Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	1.96	2.10	1.47	1.59
2	amour	4.73	4.10	2.05	2.25
3	anger	5.40	5.29	2.02	1.77
4	array	4.60	4.12	2.05	2.07
5	attar	2.19	1.65	1.84	1.01
6	baby	6.98	6.85	.14	.67
7	blister	6.81	6.77	.53	.58
8	bodice	6.00	6.00	1.64	1.46
9	bosom	6.65	6.02	.74	1.63
10	carom	1.54	1.71	1.16	1.35
11	concept	2.79	2.37	1.85	1.55
12	cotton	6.77	6.77	.58	.61
13	cradle	6.94	6.85	.24	.61
14	danger	5.15	5.06	2.04	1.75
15	davit	1.71	1.56	1.45	1.14
16	deceit	3.87	3.44	2.14	2.08
17	devil	6.40	5.98	1.45	1.66
18	divorce	5.60	5.02	1.74	2.02
19	dummy	6.21	5.40	1.26	1.88
20	essence	3.94	3.31	2.13	2.13
21	event	4.92	4.50	1.78	1.91
22	fabric	6.79	6.58	.41	.80
23	foible	2.42	2.08	1.61	1.37
24	folly	3.46	3.17	2.05	1.65
25	gadfly	3.25	2.96	2.37	2.25
26	gamin	1.77	2.31	1.45	1.98
27	garret	4.08	3.65	2.42	2.30
28	iron	6.75	6.52	.97	.94
29	maelstrom	2.52	2.25	2.02	1.94
30	malice	3.85	3.37	2.13	1.80
31	market	6.75	6.54	.59	.78
32	matrix	4.60	3.63	2.04	2.03
33	matter	4.35	3.92	2.07	2.06
34	mercy	4.19	3.29	2.21	1.70
35	metal	6.31	6.19	1.25	1.05

APPENDIX 13

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	4.02	3.25	2.27	1.92
37	number	6.27	6.06	1.40	1.39
38	object	5.58	5.54	2.00	1.93
39	office	6.69	6.38	.94	.97
40	outcome	3.27	2.83	2.26	1.94
41	panic	5.48	5.31	1.75	1.58
42	paper	6.81	6.88	.86	.47
43	passion	5.40	5.44	1.84	1.59
44	pencil	6.90	6.79	.45	.80
45	percept	2.63	2.38	1.72	1.61
46	person	6.77	6.31	.70	1.34
47	prison	6.92	6.75	.44	.90
48	quota	4.06	3.31	2.20	1.87
49	river	6.85	6.85	.54	.41
50	saloon	6.69	6.40	.73	1.19
51	savant	2.65	2.40	1.97	1.96
52	sequence	4.71	4.60	2.29	1.99
53	sunburn	6.92	6.77	.27	.55
54	surface	5.69	5.81	1.69	1.46
55	surtax	3.69	2.60	1.99	1.71
56	table	6.90	6.83	.50	.47
57	temper	5.50	5.06	1.89	1.75
58	trouble	4.63	3.92	1.72	1.94
59	virtue	3.65	2.92	2.02	2.02
60	water	6.96	6.81	.19	.56

APPENDIX 14

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE DENOTATIVE LINGUISTIC MEANING SCORES (m+I) BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

APPENDIX 14

A Comparison of the Means and Standard Deviations for the Denotative Linguistic Meaning Scores (m+I) between Subsamples I and II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52 Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	3.67	3.83	3.27	3.25
2	amour	11.96	10.73	4.79	4.33
3	anger	13.10	12.71	3.47	3.12
4	array	8.65	8.10	3.09	3.26
5	attar	3.00	2.40	2.11	1.36
6	baby	19.17	18.57	2.78	3.06
7	blister	16.58	15.90	1.95	2.56
8	bodice	12.58	12.84	4.39	3.39
9	bosom	13.94	12.69	3.11	3.66
10	carom	2.77	2.56	2.75	1.73
11	concept	7.00	6.17	2.73	1.89
12	cotton	16.90	16.90	3.00	2.65
13	cradle	15.90	14.82	2.84	2.44
14	danger	13.62	13.44	3.73	3.15
15	davit	3.00	2.50	2.63	1.46
16	deceit	8.56	7.40	3.06	2.64
17	devil	16.17	14.69	2.71	2.53
18	divorce	14.81	14.29	3.02	3.30
19	dummy	12.19	11.67	2.34	2.80
20	essence	6.96	6.19	2.59	2.60
21	event	9.75	8.98	2.63	2.38
22	fabric	16.35	16.06	2.62	2.48
23	foible	3.62	3.29	2.07	1.89
24	folly	6.56	6.19	3.14	2.51
25	gadfly	5.98	5.50	3.72	3.63
26	gamin	3.40	3.56	2.92	3.15
27	garret	7.94	6.50	4.89	4.09
28	iron	16.73	15.67	3.14	2.97
29	maelstrom	4.12	3.83	3.55	3.57
30	malice	7.21	6.77	3.29	2.36
31	market	16.71	16.21	2.48	3.22
32	matrix	8.73	7.62	2.96	2.67
33	matter	10.27	9.73	3.38	3.67
34	mercy	11.00	9.94	3.98	2.82
35	metal	16.04	15.42	3.40	3.16

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	8.12	6.87	3.01	3.04
37	number	14.79	13.96	2.92	3.49
38	object	12.60	12.15	3.57	2.89
39	office	17.21	16.62	2.78	2.55
40	outcome	9.12	8.00	3.60	2.66
41	panic	14.15	12.77	3.39	2.89
42	paper	18.67	17.62	2.93	2.66
43	passion	13.33	12.53	3.98	2.85
44	pencil	17.48	16.96	3.04	3.42
45	percept	7.29	6.65	3.51	3.11
46	person	14.58	14.13	3.21	3.00
47	prison	18.19	17.40	2.83	2.94
48	quota	8.88	8.33	3.05	2.54
49	river	19.00	18.25	3.06	2.69
50	saloon	16.92	16.54	3.03	3.06
51	savant	4.81	4.62	3.40	3.28
52	sequence	9.58	9.44	2.78	2.11
53	sunburn	17.71	16.58	2.78	2.39
54	surface	12.81	12.58	2.72	2.37
55	surtax	7.83	6.69	3.03	2.62
56	table	17.69	17.06	2.83	3.07
57	temper	13.15	12.10	2.99	2.72
58	trouble	10.81	10.06	3.01	3.00
59	virtue	7.81	6.71	2.54	2.24
60	water	20.00	19.63	2.77	2.81

APPENDIX 15

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE CONNOTATIVE LINGUISTIC MEANING (SD) SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

A Comparison of the Means and Standard Deviations for the Connotative Linguistic Meaning (SD) Scores between Subsamples I and II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52 Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	6.27	7.00	5.98	6.23
2	amour	23.56	21.75	5.72	7.42
3	anger	15.52	14.13	6.42	5.60
4	array	11.21	11.19	7.02	7.84
5	attar	6.62	6.71	7.06	6.70
6	baby	21.73	22.25	6.02	5.24
7	blister	16.12	15.79	6.05	5.98
8	bodice	9.15	10.02	6.76	5.66
9	bosom	14.27	13.12	7.01	7.20
10	carom	5.62	4.31	6.35	5.35
11	concept	11.46	11.19	7.48	7.71
12	cotton	14.75	14.17	4.32	5.54
13	cradle	17.88	18.17	6.07	6.64
14	danger	15.35	14.69	5.83	6.16
15	davit	5.88	6.29	5.49	5.95
16	deceit	23.55	20.90	5.27	7.22
17	devil	22.13	20.63	6.15	5.86
18	divorce	15.02	15.75	6.51	6.39
19	dummy	9.46	8.90	4.70	5.27
20	essence	12.08	12.08	7.13	7.98
21	event	10.27	13.83	7.68	8.03
22	fabric	13.37	13.46	6.08	5.56
23	foible	6.21	6.87	4.74	4.82
24	folly	11.62	10.37	6.37	5.77
25	gadfly	9.00	7.87	6.81	5.95
26	gamin	6.17	6.19	5.44	6.52
27	garret	8.06	7.37	5.16	5.90
28	iron	9.90	9.17	4.56	4.24
29	maelstrom	7.81	8.19	7.24	6.70
30	malice	20.54	19.15	7.30	6.29
31	market	14.75	14.31	6.60	5.86
32	matrix	8.60	7.40	6.18	5.79
33	matter	7.48	8.02	6.75	6.82
34	mercy	18.71	17.83	7.13	7.50
35	metal	10.25	10.25	4.37	4.98

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	9.71	7.58	5.89	4.06
37	number	9.92	8.65	6.51	5.24
38	object	6.15	7.73	5.82	7.93
39	office	12.15	12.21	5.38	6.41
40	outcome	9.44	11.29	7.55	7.87
41	panic	14.56	13.25	5.81	5.11
42	paper	10.23	10.04	4.54	4.37
43	passion	19.83	17.06	7.49	7.86
44	pencil	9.02	8.12	3.76	4.36
45	percept	8.73	10.02	5.45	6.97
46	person	15.62	17.44	10.12	9.75
47	prison	19.75	17.08	6.63	5.37
48	quota	8.29	7.21	4.59	4.09
49	river	17.44	16.25	5.45	6.09
50	saloon	10.31	9.31	4.96	4.86
51	savant	9.04	8.13	6.44	6.64
52	sequence	8.65	8.38	5.63	4.62
53	sunburn	12.38	13.69	6.68	5.48
54	surface	8.08	8.85	6.27	5.76
55	surtax	9.21	8.98	4.92	5.71
56	table	10.37	10.83	5.11	5.54
57	temper	15.54	13.35	6.58	6.62
58	trouble	16.98	16.02	5.94	6.26
59	virtue	19.46	19.40	8.00	7.14
60	water	18.33	16.08	6.09	6.40

APPENDIX 16

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE FAMILIARITY SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

A Comparison of the Means and Standard Deviations for the Familiarity Scores Between Subsamples I and II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52 Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	1.67	1.52	.76	.73
2	amour	3.23	3.19	1.04	.97
3	anger	4.62	4.31	.57	.64
4	array	3.04	2.69	1.05	1.02
5	attar	1.42	1.25	.82	.48
6	baby	4.79	4.73	.41	.45
7	blister	4.12	4.02	.73	.70
8	bodice	3.42	3.63	1.05	.95
9	bosom	3.73	3.48	.82	.98
10	carom	1.23	1.08	.58	.27
11	concept	3.94	3.94	.75	.70
12	cotton	4.54	4.42	.61	.64
13	cradle	3.90	3.87	.72	.77
14	danger	4.42	4.29	.61	.64
15	davit	1.31	1.21	.54	.41
16	deceit	3.53	3.53	.73	.83
17	devil	4.06	4.08	.85	.74
18	divorce	4.19	4.13	.72	.69
19	dummy	4.33	4.06	.65	.80
20	essence	3.52	3.27	.75	.77
21	event	4.17	4.06	.75	.73
22	fabric	4.54	4.50	.64	.58
23	foible	1.69	1.83	1.04	.96
24	folly	3.06	2.81	.92	.91
25	gadfly	1.88	1.48	.90	.70
26	gamin	1.40	1.29	.63	.61
27	garret	2.13	1.85	.93	.85
28	iron	4.48	4.27	.58	.74
29	maelstrom	1.63	1.44	.71	.57
30	malice	3.37	3.13	.74	.89
31	market	4.19	4.10	.79	.72
32	matrix	3.04	3.23	.95	.90
33	matter	4.37	4.17	.74	.81
34	mercy	3.83	3.71	.76	.70
35	metal	4.31	4.21	.76	.75

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	4.33	3.81	.65	.84
37	number	4.85	4.87	.41	.40
38	object	4.60	4.56	.60	.64
39	office	4.52	4.31	.61	.67
40	outcome	4.10	4.04	.77	.74
41	panic	4.14	4.00	.77	.69
42	paper	4.94	4.96	.24	.19
43	passion	4.00	3.81	.69	.74
44	pencil	4.83	4.90	.38	.30
45	percept	3.04	2.88	.95	.98
46	person	4.96	4.79	.19	.46
47	prison	4.10	4.04	.72	.71
48	quota	3.37	3.15	.89	.75
49	river	4.65	4.63	.56	.49
50	saloon	3.52	3.17	.80	.81
51	savant	1.79	1.63	1.00	.97
52	sequence	3.69	3.73	.70	.74
53	sunburn	4.42	4.19	.57	.56
54	surface	4.15	4.02	.75	.73
55	surtax	2.83	2.48	.81	1.15
56	table	4.94	4.90	.24	.30
57	temper	4.50	4.23	.61	.67
58	trouble	4.67	4.33	.51	.68
59	virtue	3.71	3.46	.80	.73
60	water	4.96	4.96	.19	.19

APPENDIX 17

A COMPARISON OF THE MEANS AND STANDARD DEVIATIONS FOR THE CONCRETENESS (A-C) SCORES BETWEEN SUBSAMPLES I AND II FOR THE LIST OF 60 DISSYLLABLE WORD (NOUN) STIMULI

A Comparison of the Means and Standard Deviations for the Concreteness (A-C) Scores between Subsamples I and II for the List of 60 Dissyllable Word (Noun) Stimuli (n=52 Each Sample)

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
1	adage	2.23	2.42	1.53	1.73
2	amour	3.54	2.85	2.12	1.89
3	anger	3.40	3.27	2.26	1.84
4	array	3.90	3.37	1.97	1.78
5	attar	2.60	2.58	1.89	1.63
6	baby	6.75	6.87	.97	.44
7	blister	6.73	6.85	.97	.46
8	bodice	6.12	6.02	1.53	1.31
9	bosom	6.23	6.04	1.37	1.43
10	carom	2.56	2.54	1.67	1.72
11	concept	1.67	1.54	1.37	.90
12	cotton	6.87	6.75	.44	.62
13	cradle	6.60	6.85	1.16	.41
14	danger	3.38	2.87	2.18	1.67
15	davit	2.62	2.58	1.86	1.72
16	deceit	2.56	2.27	1.70	1.29
17	devil	3.50	3.15	2.31	2.26
18	divorce	3.88	3.56	1.95	2.12
19	dummy	5.02	4.73	2.09	2.09
20	essence	3.27	3.10	2.18	2.28
21	event	3.60	3.52	1.94	1.80
22	fabric	6.71	6.81	.94	.44
23	foible	2.35	2.46	1.52	1.51
24	folly	2.58	2.65	1.67	1.36
25	gadfly	3.87	3.83	2.49	2.37
26	gamin	2.92	3.00	1.98	1.89
27	garret	3.96	3.62	2.33	2.21
28	iron	6.52	6.71	1.35	.70
29	maelstrom	2.87	2.92	1.97	2.06
30	malice	2.46	2.40	1.64	1.64
31	market	6.15	6.27	1.42	.99
32	matrix	4.21	4.46	2.15	1.97
33	matter	4.50	4.40	2.32	2.05
34	mercy	2.15	2.15	1.54	1.24
35	metal	6.58	6.65	1.16	.84

Word No.	Word	$\bar{X}_1$	$\bar{X}_2$	SD_1	SD_2
36	nonsense	2.60	2.15	1.85	1.32
37	number	5.04	4.77	2.15	2.36
38	object	5.96	5.88	1.74	1.69
39	office	6.23	6.56	1.49	.85
40	outcome	2.63	2.65	1.79	1.66
41	panic	3.54	3.35	2.14	1.92
42	paper	6.85	6.98	.85	.14
43	passion	3.46	2.96	2.28	1.71
44	pencil	6.87	6.98	.84	.14
45	percept	2.12	1.88	1.26	1.38
46	person	6.52	6.35	1.24	1.43
47	prison	6.29	6.54	1.40	1.13
48	quota	3.46	3.73	1.98	2.05
49	river	6.83	6.75	.86	.71
50	saloon	6.19	6.29	1.36	1.24
51	savant	2.17	2.73	1.40	1.70
52	sequence	3.48	3.50	2.13	2.05
53	sunburn	6.67	6.69	.86	.61
54	surface	6.08	6.02	1.37	1.46
55	surtax	3.88	3.38	2.22	1.91
56	table	6.88	6.85	.83	.85
57	temper	3.15	2.87	2.12	1.52
58	trouble	3.27	2.88	1.83	1.49
59	virtue	2.17	1.60	1.76	.82
60	water	6.96	6.90	.28	.36

APPENDIX 18

LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING MEANINGFULNESS (MEAN) SCORES (m) FOR SUBSAMPLES I AND II COMBINED

APPENDIX 18

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Meaningfulness (Mean) Scores (m) for Subsamples I and II Combined (N=104)

Word No.	Rank	Word	$\bar{X}$	SD
60	60	water	12.93	2.71
6	59	baby	11.96	2.80
49	58	river	11.88	2.90
42	57	paper	11.30	2.76
47	56	prison	10.96	2.77
56	55	table	10.51	2.89
39	54	office	10.38	2.49
53	53	sunburn	10.30	2.65
44	52	pencil	10.28	2.87
50	51	saloon	10.18	2.77
12	50	cotton	10.13	2.72
31	49	market	9.82	2.79
28	48	iron	9.57	2.89
22	47	fabric	9.52	2.45
35	46	metal	9.48	2.89
7	45	blister	9.45	2.23
17	44	devil	9.24	2.19
18	43	divorce	9.24	2.54
13	42	cradle	8.47	2.62
14	41	danger	8.42	2.55
37	40	number	8.21	2.95
41	39	panic	8.07	2.70
46	38	person	7.82	2.94
3	37	anger	7.56	2.56
43	36	passion	7.50	2.76
57	35	temper	7.35	2.19
9	34	bosom	7.08	2.92
2	33	amour	7.01	3.49
54	32	surface	6.94	2.17
38	31	object	6.82	2.35

Word No.	Rank	Word	$\bar{X}$	SD
34	30	mercy	6.73	2.68
8	29	bodice	6.71	3.12
58	28	trouble	6.15	2.25
19	27	dummy	6.13	1.99
33	26	matter	5.87	2.54
40	25	outcome	5.51	2.32
48	24	quota	4.90	2.04
52	23	sequence	4.86	1.17
21	22	event	4.65	1.49
45	21	percept	4.46	2.63
16	20	deceit	4.33	1.88
55	19	surtax	4.12	1.69
32	18	matrix	4.06	1.61
4	17	array	4.02	1.97
11	16	concept	4.01	1.63
59	15	virtue	3.97	1.40
36	14	nonsense	3.86	2.03
30	13	malice	3.38	1.78
27	12	garret	3.36	2.86
24	11	folly	3.06	1.78
20	10	essence	2.95	1.23
25	9	gadfly	2.64	2.05
51	8	savant	2.18	2.02
1	7	adage	1.72	2.26
29	6	maelstrom	1.59	2.00
26	5	gamin	1.44	1.78
23	4	foible	1.21	.97
15	3	davit	1.12	1.26
10	2	carom	1.05	1.48
5	1	attar	.79	.77

APPENDIX 19

LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING IMAGERY (MEAN) SCORES (I) FOR SUBSAMPLES I AND II COMBINED

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Imagery (Mean) Scores (I) for Subsamples I and II Combined (N=104)

Word No.	Rank	Word	$\bar{X}$	SD
6	60	baby	6.91	.48
13	59	cradle	6.89	.46
60	58	water	6.88	.43
56	57	table	6.87	.48
42	56	paper	6.85	.69
44	55	pencil	6.85	.65
49	54	river	6.85	.48
53	53	sunburn	6.85	.44
47	52	prison	6.84	.71
7	51	blister	6.79	.55
12	50	cotton	6.77	.59
22	49	fabric	6.68	.64
31	48	market	6.64	.70
28	47	iron	6.63	.96
50	46	saloon	6.55	.99
39	45	office	6.54	.97
46	44	person	6.54	1.09
9	43	bosom	6.34	1.30
35	42	metal	6.25	1.15
17	41	devil	6.19	1.56
37	40	number	6.16	1.39
8	39	bodice	6.00	1.55
19	38	dummy	5.81	1.64
54	37	surface	5.75	1.57
38	36	object	5.56	1.96
43	35	passion	5.42	1.71
41	34	panic	5.39	1.66
3	33	anger	5.35	1.89
18	32	divorce	5.31	1.90
57	31	temper	5.28	1.83

APPENDIX 19

Word No.	Rank	Word	$\bar{X}$	SD
14	30	danger	5.11	1.89
21	29	event	4.71	1.85
52	28	sequence	4.65	2.14
2	27	amour	4.41	2.17
4	26	array	4.36	2.07
58	25	trouble	4.28	1.86
33	24	matter	4.13	2.06
32	23	matrix	4.12	2.08
27	22	garret	3.87	2.36
34	21	mercy	3.74	2.01
48	20	quota	3.68	2.07
16	19	deceit	3.65	2.11
36	18	nonsense	3.64	2.13
20	17	essence	3.63	2.14
30	16	malice	3.61	1.98
24	15	folly	3.32	1.86
59	14	virtue	3.29	2.04
55	13	surtax	3.14	1.94
25	12	gadfly	3.11	2.30
40	11	outcome	3.05	2.11
11	10	concept	2.58	1.76
51	9	savant	2.53	1.96
45	8	percept	2.51	1.66
29	7	maelstrom	2.38	1.98
23	6	foible	2.25	1.50
26	5	gamin	2.04	1.75
1	4	adage	2.03	1.52
5	3	attar	1.92	1.50
15	2	davit	1.64	1.30
10	1	carom	1.63	1.26

APPENDIX 20

LIST OF 60 DISSYLLABLE WORD STIMULI ARRANGED IN RANK ORDER OF DECREASING FAMILIARITY (MEAN) SCORES (f) FOR SUBSAMPLES I AND II COMBINED

List of 60 Dissyllable Word Stimuli Arranged in Rank Order of Decreasing Familiarity (Mean) Scores (f) for Subsamples I and II Combined (N=104)

Word No.	Rank	Word	$\bar{X}$	SD
60	60	water	4.96	.19
42	59	paper	4.95	.21
56	58	table	4.92	.27
46	57	person	4.88	.36
44	56	pencil	4.87	.34
37	55	number	4.86	.40
6	54	baby	4.76	.43
49	53	river	4.64	.52
38	52	object	4.58	.62
22	51	fabric	4.52	.61
58	50	trouble	4.50	.62
12	49	cotton	4.48	.62
3	48	anger	4.46	.62
39	47	office	4.41	.65
28	46	iron	4.38	.67
57	45	temper	4.37	.65
14	44	danger	4.36	.62
53	43	sunburn	4.31	.58
33	42	matter	4.27	.78
35	41	metal	4.26	.75
19	40	dummy	4.19	.74
18	39	divorce	4.16	.70
31	38	market	4.14	.76
21	37	event	4.11	.74
54	36	surface	4.09	.74
7	35	blister	4.07	.71
17	34	devil	4.07	.79
36	33	nonsense	4.07	.79
40	32	outcome	4.07	.75
41	31	panic	4.07	.73

Word No.	Rank	Word	$\bar{X}$	SD
47	30	prison	4.07	.71
11	29	concept	3.94	.72
43	28	passion	3.90	.72
13	27	cradle	3.88	.74
34	26	mercy	3.77	.73
52	25	sequence	3.71	.72
9	24	bosom	3.61	.91
59	23	virtue	3.59	.77
8	22	bodice	3.53	1.00
16	21	deceit	3.52	.78
20	20	essence	3.39	.77
50	19	saloon	3.35	.82
48	18	quota	3.26	.82
30	17	malice	3.25	.82
2	16	amour	3.21	1.00
32	15	matrix	3.13	.92
45	14	percept	2.96	.96
24	13	folly	2.93	.92
4	12	array	2.87	1.04
55	11	surtax	2.65	1.00
27	10	garret	1.99	.90
23	9	foible	1.76	1.00
51	8	savant	1.71	.98
25	7	gadfly	1.68	.83
1	6	adage	1.60	.74
29	5	maelstrom	1.54	.65
26	4	gamin	1.35	.62
5	3	attar	1.34	.68
15	2	davit	1.26	.48
10	1	carom	1.15	.46

APPENDIX 21

THE EYSENCK PERSONALITY INVENTORY (FORMS A AND B)

EYSENCK PERSONALITY INVENTORY

FORM A

By H. J. Eysenck
and Sybil B. G. Eysenck

Name_____ Age_____ Sex_____

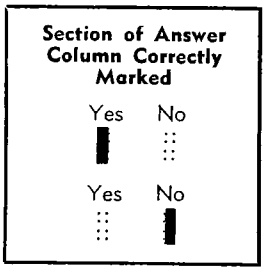
Grade or Occupation _____ Date_____

School or Firm_____ Marital Status_____

INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."



Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

PUBLISHED BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
BOX 7234, SAN DIEGO, CALIFORNIA 92107

COPYRIGHT © 1963 BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
ALL RIGHTS RESERVED
REPRODUCTION OF THIS FORM BY ANY MEANS STRICTLY PROHIBITED
PRINTED IN U S A

E N L

1. Do you often long for excitement? Yes No
2. Do you often need understanding friends to cheer you up? Yes No
3. Are you usually carefree? Yes No
4. Do you find it very hard to take no for an answer? Yes No
5. Do you stop and think things over before doing anything? Yes No
6. If you say you will do something do you always keep your promise, no matter how inconvenient it might be to do so? Yes No
7. Does your mood often go up and down? Yes No
8. Do you generally do and say things quickly without stopping to think? Yes No
9. Do you ever feel "just miserable" for no good reason? Yes No
10. Would you do almost anything for a dare? Yes No
11. Do you suddenly feel shy when you want to talk to an attractive stranger? Yes No
12. Once in a while do you lose your temper and get angry? Yes No
13. Do you often do things on the spur of the moment? Yes No
14. Do you often worry about things you should not have done or said? Yes No
15. Generally do you prefer reading to meeting people? Yes No
16. Are your feelings rather easily hurt? Yes No
17. Do you like going out a lot? Yes No
18. Do you occasionally have thoughts and ideas that you would not like other people to know about? Yes No
19. Are you sometimes bubbling over with energy and sometimes very sluggish? Yes No
20. Do you prefer to have few but special friends? Yes No
21. Do you daydream a lot? Yes No
22. When people shout at you, do you shout back? Yes No
23. Are you often troubled about feelings of guilt? Yes No
24. Are all your habits good and desirable ones? Yes No
25. Can you usually let yourself go and enjoy yourself a lot at a gay party? Yes No
26. Would you call yourself tense or "highly-strung"? Yes No
27. Do other people think of you as being very lively? Yes No
28. After you have done something important, do you often come away feeling you could have done better? Yes No
29. Are you mostly quiet when you are with other people? Yes No
30. Do you sometimes gossip? Yes No
31. Do ideas run through your head so that you cannot sleep? Yes No
32. If there is something you want to know about, would you rather look it up in a book than talk to someone about it? Yes No
33. Do you get palpitations or thumping in your heart? Yes No
34. Do you like the kind of work that you need to pay close attention to? Yes No
35. Do you get attacks of shaking or trembling? Yes No
36. Would you always declare everything at the customs, even if you knew that you could never be found out? Yes No
37. Do you hate being with a crowd who play jokes on one another? Yes No
38. Are you an irritable person? Yes No
39. Do you like doing things in which you have to act quickly? Yes No
40. Do you worry about awful things that might happen? Yes No
41. Are you slow and unhurried in the way you move? Yes No
42. Have you ever been late for an appointment or work? Yes No
43. Do you have many nightmares? Yes No
44. Do you like talking to people so much that you would never miss a chance of talking to a stranger? Yes No
45. Are you troubled by aches and pains? Yes No
46. Would you be very unhappy if you could not see lots of people most of the time? Yes No
47. Would you call yourself a nervous person? Yes No
48. Of all the people you know are there some whom you definitely do not like? Yes No
49. Would you say you were fairly self-confident? Yes No
50. Are you easily hurt when people find fault with you or your work? Yes No
51. Do you find it hard to really enjoy yourself at a lively party? Yes No
52. Are you troubled with feelings of inferiority? Yes No
53. Can you easily get some life into a rather dull party? Yes No
54. Do you sometimes talk about things you know nothing about? Yes No
55. Do you worry about your health? Yes No
56. Do you like playing pranks on others? Yes No
57. Do you suffer from sleeplessness? Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

EYSENCK PERSONALITY INVENTORY

FORM B

By H. J. Eysenck
and Sybil B. G. Eysenck

Name_____ Age_____ Sex_____

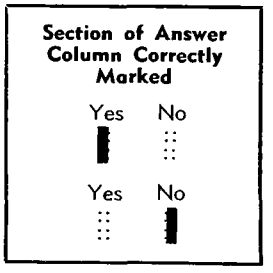
Grade or Occupation_____ Date_____

School or Firm_____ Marital Status_____

INSTRUCTIONS

Here are some questions regarding the way you behave, feel and act. After each question is a space for answering "Yes," or "No."

Try and decide whether "Yes," or "No" represents your usual way of acting or feeling. Then blacken in the space under the column headed "Yes" or "No."



Work quickly, and don't spend too much time over any question; we want your first reaction, not a long drawn-out thought process. The whole questionnaire shouldn't take more than a few minutes. Be sure not to omit any questions. Now turn the page over and go ahead. Work quickly, and remember to answer every question. There are no right or wrong answers, and this isn't a test of intelligence or ability, but simply a measure of the way you behave.

PUBLISHED BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
BOX 7234, SAN DIEGO, CALIFORNIA 92107

COPYRIGHT © 1963 BY EDUCATIONAL AND INDUSTRIAL TESTING SERVICE
ALL RIGHTS RESERVED
REPRODUCTION OF THIS FORM BY ANY MEANS STRICTLY PROHIBITED
PRINTED IN U S A

E N L

1. Do you like plenty of excitement and bustle around you? Yes No
2. Have you often got a restless feeling that you want something but do not know what? Yes No
3. Do you nearly always have a "ready answer" when people talk to you? Yes No
4. Do you sometimes feel happy, sometimes sad, without any real reason? Yes No
5. Do you usually stay in the background at parties and "get-togethers"? Yes No
6. As a child did you always do as you were told immediately and without grumbling? Yes No
7. Do you sometimes sulk? Yes No
8. When you are drawn into a quarrel, do you prefer to "have it out" to being silent hoping things will blow over? Yes No
9. Are you moody? Yes No
10. Do you like mixing with people? Yes No
11. Have you often lost sleep over your worries? Yes No
12. Do you sometimes get cross? Yes No
13. Would you call yourself happy-go-lucky? Yes No
14. Do you often make up your mind too late? Yes No
15. Do you like working alone? Yes No
16. Have you often felt listless and tired for no good reason? Yes No
17. Are you rather lively? Yes No
18. Do you sometimes laugh at a dirty joke? Yes No
19. Do you often feel "fed-up"? Yes No
20. Do you feel uncomfortable in anything but everyday clothes? Yes No
21. Does your mind often wander when you are trying to attend closely to something? Yes No
22. Can you put your thoughts into words quickly? Yes No
23. Are you often "lost in thought"? Yes No
24. Are you completely free from prejudices of any kind? Yes No
25. Do you like practical jokes? Yes No
26. Do you often think of your past? Yes No
27. Do you very much like good food? Yes No
28. When you get annoyed do you need someone friendly to talk to about it? Yes No
29. Do you mind selling things or asking people for money for some good cause? Yes No
30. Do you sometimes boast a little? Yes No
31. Are you touchy about some things? Yes No
32. Would you rather be at home on your own than go to a boring party? Yes No
33. Do you sometimes get so restless that you cannot sit long in a chair? Yes No
34. Do you like planning things carefully, well ahead of time? Yes No
35. Do you have dizzy spells? Yes No
36. Do you always answer a personal letter as soon as you can after you have read it? Yes No
37. Can you usually do things better by figuring them out alone than by talking to others about it? Yes No
38. Do you ever get short of breath without having done heavy work? Yes No
39. Are you an easy-going person, not generally bothered about having everything "just-so"? Yes No
40. Do you suffer from "nerves"? Yes No
41. Would you rather plan things than do things? Yes No
42. Do you sometimes put off until tomorrow what you ought to do today? Yes No
43. Do you get nervous in places like elevators, trains or tunnels? Yes No
44. When you make new friends, is it usually you who makes the first move, or does the inviting? Yes No
45. Do you get very bad headaches? Yes No
46. Do you generally feel that things will sort themselves out and come right in the end somehow? Yes No
47. Do you find it hard to fall asleep at bedtime? Yes No
48. Have you sometimes told lies in your life? Yes No
49. Do you sometimes say the first thing that comes into your head? Yes No
50. Do you worry too long after an embarrassing experience? Yes No
51. Do you usually keep "yourself to yourself" except with very close friends? Yes No
52. Do you often get into a jam because you do things without thinking? Yes No
53. Do you like cracking jokes and telling funny stories to your friends? Yes No
54. Would you rather win, than lose a game? Yes No
55. Do you often feel self-conscious when you are with superiors? Yes No
56. When the odds are against you, do you still usually think it worth taking a chance? Yes No
57. Do you often get "butterflies in your stomach" before an important occasion? Yes No

PLEASE CHECK TO SEE THAT YOU HAVE ANSWERED ALL THE QUESTIONS.