A NORMATIVE STUDY OF NEUROPSYCHOLOGICAL PERFORMANCES OF ADULT MALE POPULATION OF TURKEY

by

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ABSTRACT

A NORMATIVE STUDY OF NEUROPSYCHOLOGICAL PERFORMANCE OF ADULT MALE POPULATION OF TURKEY

Cognitive and motor skills of people are needed in designing ergonomic products and human-work and human-technology systems. These skills, which may vary across the populations of the world, are measured by neuropsychological tests. Some developed countries have already generated normative data of their populations. In Turkey, although there are several related studies, a comprehensive normative data does not exist. For the purpose, the main aims of this study were: (i) Establishing a normative database of neuropsychological performances for the adult male population of Turkey in four main areas (attention, concentration and speed, memory and learning, intellectual function and motor function); and (ii) investigating the effects of age, education level, marital status and smoking on the performances. Six different neuropsychological tests (Digit Span, Corsi Span, Stroop-Color, Raven, Reaction Time and Purdue Pegboard) are applied to 252 adult male participants aged from 18 to 93 with family origins from different regions of Turkey. Subjects are divided into six age groups (18-30, 31-40, 41-50, 51-60, 61-70, 71+), four education groups (0-5, 6-12, 13-16, 17+), three income levels (low, medium, high), two marital status groups (married/single) and two smoker groups (smoker/non-smoker). As a result, a normative database is established. The results show that memory, learning, attention and decision-making abilities decrease gradually after the age of 50. It has been observed that motor function performance decrease with age. Education has a positive effect on all the performances. Marital status and smoking habits have no effect on the performances. When compared to the other nationalities, the neuropsychological performance of male population of Turkey, in general, is similar to Australian and Italian and lower than Chinese, Korean and the US samples. The established database may serve a reference guide for ergonomic designs as well as clinical applications.

ÖZET

TÜRKİYE YETİŞKİN ERKEK NÜFUSUNUN NEROPSİKOLOJİK PERFORMANSININ NORMATİF ÇALIŞMASI

Günümüzde interaktif ürünlerin ve sistemlerin tasarımında toplumun birlikte bilişsel ve motor kapasitesi de göz önünde bulundurulmaktadır. İnsanların bilişsel performanslarının ölçümünde nöropsikolojik testlerden yararlanılmaktadır. Nöropsikolojik performanslar da ülkelerarası farklılıklar gösterebilmektedir. Bu nedenle, dünyanın birçok gelişmiş ülkesinde toplumun bilişsel kapasite ölçümlerinden oluşan veri tabanları mevcuttur. Ülkemizde birkaç bilişsel çalışma olmakla birlikte, tasarımlarda ihtiyaç duyulan verileri karşılamak için kapsam ve istatistiksel özellikler açışından kullanışlı veri tabanı oluşturmak mümkün değildir. Bu kapsamda, bu çalışmanın ana amaçları; (i) Türkiye yetişkin erkek nüfusunun neropsikolojik testlerdeki performansının 4 temel alanı (dikkat, konsantrasyon ve hız, hafızave öğrenme, motor fonksiyonları, zekâ fonksiyonları) kapsayacak şekilde ölçülerek veritabanının oluşturulması; (ii) yaş, eğitim, medeni durum, sigara alışkanlığı ve gelir seviyesinin nöropsikolojik performans üzerindeki etkilerini araştırmak ve (iii) sonuçları daha önce yapılan çalışmalarla karşılaştırmak. Bu amaçla 18-93 yaş arası 252 örnekleme 6 farklı nöropsikolojik test uygulanarak (Digit Span, Corsi Span, Stroop-Color, Raven, Purdue Pegboard, Reaction Time) farklı alanlardaki performans verileri toplanmıştır. Örneklem 6 yaş grubuna (18-30, 31-40, 41-50, 51-60, 61-70, 71+), 4 eğitim grubuna (0-5, 5-12, 12-16, 16+), 3 gelir seviyesine (düşük, orta, yüksek), evli/bekar olarak 2 medeni hal durumu ve sigara içen/içmeyen olarak 2 gruba bölünmüştür. Bu çalışmanın sonucunda hafıza, öğrenme ve karar verme gibi yeteneklerin 50 yaşından sonra dereceli olarak azaldığı görülmüştür. Reaksiyon süresi gibi motor fonksiyonu performanslarının yaş ile birlikte hemen azaldığı gözlemlenmiştir. Sonuçlar testlerin çoğunda eğitim seviyesi arttıkça performansın da arttığını göstermiştir. Sigara alışkanlığı ve medeni durumun sonuçlar üzerinde etkisi gözlemlenmemiştir. Diğer ülkelerin sonuçları ile karşılaştırıldığında ise, Türkiye erkek nüfusunun performansı, İtalyan ve Avustralyalılara benzerken; Çinliler, Koreler ve Amerikanlardan küçük olduğu görülmüştür.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS iii
ABSTRACT iv
ÖZET v
LIST OF FIGURES x
LIST OF TABLES xx
LIST OF SYMBOLS xxv
LIST OF ACRONYMS/ABBREBIATIONS xxvii
1. INTRODUCTION 1
2. LITERATURE REVIEW 3
2.1. Overview 3
2.2. Test Types 14
2.2.1. The Digit Span Test 14
2.2.2. The Corsi Span Test 21
2.2.3. The Stroop Color and Word Test 25
2.2.4. Reaction Time Test 45
2.2.5. Purdue Pegboard Test 50
2.2.6. Raven Standard Progressive Matrices 57
2.3. Critics of findings 63
2.3.1. Digit Span Test 63
2.3.2. Corsi Span Test 64
2.3.3. Reaction Time Tesrt 64
2.3.4. Raven Standard Progressive Matrices 65
2.3.5. Purdue Pegboard Test 65
2.3.6. Stroop Color Word Test 66
3. RATIONALE AND OBJETIVE OF THE STUDY 68
3.1. Rationale of the Study 68

3.2. Objective of the Study 68

4. METHODOLOGY 69

4.1. Subjects 71

4.2. Tests, Equipment, Tools 73

4.2.1. Digit Span Test 74

4.2.2. Corsi Span Test 77

4.2.3. Stroop Color and Word Test 79

4.2.4. Reaction Time 82

4.2.5. Purdue Pegboard Test 84

4.2.6. The Raven Standard Progressive Test 88

4.3. Experimental Design and Statistical Analysis 90

4.3.1. Experimental Variables 90

4.4. Experimental Model 93

4.5. Pilot Study 98

4.6. Sample Size Determination 99

4.7. Repeatability Study 101

4.8. Statistical Analysis 103

4.8.1. Descriptive Statistics 104

4.8.2. Inferential Statistics 104

5. RESULTS 105

5.1. Overview 105

5.2. Descriptive Statistics 105

5.2.1. Descriptive Statistics of Responses 105

5.2.2. Box Plot Diagrams of Test Results 107

5.2.3. Independent Variable Groups 113

5.2.4. Descriptive Statistics of Independent Variable Groups 114

5.2.5. Box Plots of Responses w.r.t. Independent Variable Groups 122

5.3. Inferential Statistics 165

5.3.1. Checking the Assumptions for Parametric Tests 165

5.3.2. Correlation Analysis 169

5.3.4. Factor Effects 174

5.3.5. ANOVA Assumptions 174

5.3.6. ANOVA Results 175

5.3.7. Post-hoc Analysis (Pairwise Comparisions) 180

5.3.8. T-test for Reaction Time and Purdue Pegboard Tests 193

5.4. Regression 194

5.4.1. Regression Assumptions 194

5.4.2. The Developed Models 195

6. DISCUSSION 201

6.1. Discussion on the Results 201

6.1.1. Age Effect 201

6.1.2. Education Effect 202

6.1.3. Income Level Effect 202

6.1.4. Smoking Habit Effect 202

6.1.5. Marital Status Effect 202

6.1.6. Dominant/Non Dominant Hand Effect 203

6.1.7. Correlation among the Response Variables 203

6.2. Comparisons with Other Studies 204

6.2.1. Digit Span Test 204

6.2.2. Corsi Span Test 205

6.2.3. Raven Test 206

6.2.4. Stroop Color Word Test 206

6.2.5. Reaction Time Test 207

6.2.6. Purdue Pegboard Test 207

7. CONCLUSIONS 216

7.1. Contributions and Recommendation to Practitioners 216

7.2. Limitations of Current Study 217

REFERENCES 218

APPENDIX A: FORMS 230

A.1. Brief Medical History Form 230

A.2. Personal Consent Form 234
A.3. Personal Data Form... 237
A.4. Record Form 239
A.5. Digit Span Kayıt Formu.. 240
A.6. Corsi Span Kayıt Formu 241
A.7. Stroop Color Word Test Kayıt Formu 242
A.8. Raven Kayıt Formu.. 243
A.9. Purdue Pegboard Kayıt Formu... 244
A.10. Reaction Time Kayıt Formu 245
A.11. Test Prosedürleri - Türkçe... 246

APPENDIX B: QUESTIONS FOR RAVEN TEST... 251

APPENDIX C: RESIDUAL PLOTS 266

APPENDIX D: TUKEY GROUPING TABLES 275

APPENDIX E: SCATTER PLOTS of RESPONSE VARIABLES 280

LIST OF FIGURES

Figure 4.1. Flow chart showing the steps of the study.. 69

Figure 4.2. Distribution of family origin regions of the subjects.. 71

Figure 4.3. A participant conducting Purdue Pegboard test 74

Figure 4.4. Corsi Block Tapping Apparatus (Milner, 1971).. 77

Figure 4.5. The cards that are used in the experiment (Karakaş, 2011). 80

Figure 4.6. Reaction time test is applied to a participant... 83

Figure 4.7. Screens of computer-based reaction time test (Shadmehr and Amiri, 2012)......... 84

Figure 4.8. Purdue Pegboard Test Model 32020 testing board.. 85

Figure 4.9. Pins, washers and collars 85

Figure 5.1. Box plot of Digit Span Forward test results 107

Figure 5.2. Box plot of Digit Span Backward test results 107

Figure 5.3. Box plot of Corsi Span Forward test results.. 108

Figure 5.4. Box plot of Corsi Span Backward test results 108

Figure 5.5. Box plot of Reaction Time Dominant Hand test results...................................... 108

Figure 5.6. Box plot of Reaction Time Non-Dominant Hand test results 109

Figure 5.7. Box plot of Raven test results 109

Figure 5.8. Box plot of Purdue Pegboard Dominant Hand test results 109

Figure 5.9. Box plot of Purdue Pegbooard Non-Dominant Hand test results 110

Figure 5.10. Box plot of Purdue Pegbooard Both Hand test results 110

Figure 5.11. Box plot of Purdue Pegbooard Total test results 110

Figure 5.12. Box plot of Purdue Pegbooard Assembly test results 111

Figure 5.13. Box plot of Stroop Color Word Part 1 test results 111

Figure 5.14. Box plot of Stroop Color Word Part 2 test results 111

Figure 5.15. Box plot of Stroop Color Word Part 3 test results 112

Figure 5.16. Box plot of Stroop Color Word Part 4 test results 112

Figure 5.17. Box plot of Stroop Color Word Part 5 test results 112

Figure 5.18. Box plot of Digit Forward Test according to age group (in years) 122

Figure 5.19. Box plot of Digit Backward Test according to age groups 123

Figure 5.20. Box plot of Corsi Forward Test according to age group 123

Figure 5.21. Box plot of Corsi Backward Test according to age groups 124

Figure 5.22. Box plot of Reaction Time (Dominant Hand) according to age groups 124

Figure 5.23. Box plot of Reaction Time (Non-Dominant Hand) according to age group...... 125

Figure 5.24. Box plot of Raven Test according to age group.. 125

Figure 5.25. Box plot of Purdue Pegboard (Dominant Hand) according to age group 126

Figure 5.26. Box plot of Purdue Pegboard (Non-Dominant Hand) according to age group.. 126

Figure 5.27. Box plot of Purdue Pegboard (Both Hand) according to age group.................. 127

Figure 5.28. Box plot of Purdue Pegboard (Total) according to age group........................... 127

Figure 5.29. Box plot of Purdue Pegboard (Assembly) according to age group 128

Figure 5.30. Box plot of Stroop Color Word Test Part I according to age group.................. 128

Figure 5.31. Box plot of Stroop Color Word Test Part II according to age group 129

Figure 5.32. Box plot of Stroop Color Word Test Part III according to age group................ 129

Figure 5.33. Box plot of Stroop Color Word Test Part IV according to age group................ 130

Figure 5.34. Box plot of Stroop Color Word Test Part V according to age group 130

Figure 5.35. Box plot of Digit Forward Test according to education groups (in years)......... 131

Figure 5.36. Box plot of Digit Backward Test according to education groups 132

Figure 5.37. Box plot of Corsi Forward Test according to education groups 132

Figure 5.38. Box plot of Corsi Backward Test according to education groups...................... 132

Figure 5.39. Box plot of Reaction Time (Dominant Hand) according to education groups... 133

Figure 5.40. Box plot of Reaction Time (Non Dominant Hand) according to education groups.. 133

Figure 5.41. Box plot of Raven Test Results according to education groups......................... 134

Figure 5.42. Box plot of Purdue Pegboard (Dominant Hand) according to education groups134

Figure 5.43. Box plot of Purdue Pegboard (Non-Dominant Hand) according to education groups.. 135

Figure 5.44. Box plot of Purdue Pegboard (Both Hand) according to education groups....... 135

Figure 5.45. Box plot of Purdue Pegboard (Total) according to education groups................ 136

Figure 5.46. Box plot of Purdue Pegboard (Assembly) according to education groups 136

Figure 5.47. Box plot of Stroop Color Word Test Part I according to education groups....... 137

Figure 5.48. Box plot of Stroop Color Word Test Part II according to education groups...... 137

Figure 5.49. Box plot of Stroop Color Word Test Part III according to education groups 138

Figure 5.50. Box plot of Stroop Color Word Test Part IV according to education groups.... 138

Figure 5.51. Box plot of Stroop Color Word Test Part V according to education groups 139

Figure 5.52. Box plot of Digit Forward Test according to income levels 139

Figure 5.53. Box plot of Digit Backward Test according to income levels........................... 140

Figure 5.54. Box plot of Corsi Forward Test according to income levels 140

Figure 5.55. Box plot of Corsi Backward Test according to income levels 141

Figure 5.56. Box plot of Reaction Time (Dominant Hand) according to income levels 141

Figure 5.57. Box plot of Reaction Time (Non-Dominant Hand) according to income levels 142

Figure 5.58. Box plot of Raven Test according to income levels 142

Figure 5.59. Box plot of Purdue Pegboard (Dominant Hand) according to income levels 143

Figure 5.60. Box plot of Purdue Pegboard (Non Dominant Hand) according to income levels 143

Figure 5.61. Box plot of Purdue Pegboard (Both Hand) according to income levels 143

Figure 5.62. Box plot of Purdue Pegboard (Total) according to income levels 144

Figure 5.63. Box plot of Purdue Pegboard (Assembly) according to income levels 144

Figure 5.64. Box plot of Stroop Color Word Test Part I according to income levels 145

Figure 5.65. Box plot of Stroop Color Word Test Part II according to income levels 145

Figure 5.66. Box plot of Stroop Color Word Test Part III according to income levels.......... 146

Figure 5.67. Box plot of Stroop Color Word Test Part IV according to income levels 146

Figure 5.68. Box plot of Stroop Color Word Test Part V according to income levels........... 147

Figure 5.69. Box plot of Digit Forward Test according to marital status 147

Figure 5.70. Box plot of Digit Backward Test according to marital status 148

Figure 5.71. Box plot of Corsi Forward Test according to marital status 148

Figure 5.72. Box plot of Corsi Backward Test according to marital status............................ 149

Figure 5.73. Box plot of Reaction Time (Dominant Hand) according to marital status......... 149

Figure 5.74. Box plot of Reaction Time (Non Dominant Hand) according to marital status. 150

Figure 5.75. Box plot of Raven Test according to marital status 150

Figure 5.76. Box plot of Purdue Pegboard (Dominant Hand) according to marital status..... 151

Figure 5.77. Box plot of Purdue Pegboard (Non Dominant Hand) according to marital status 151

Figure 5.78. Box plot of Purdue Pegboard (Both Hand) according to marital status 152

Figure 5.79. Box plot of Purdue Pegboard (Total) according to marital status 152

Figure 5.80. Box plot of Purdue Pegboard (Assembly) according to marital status 153

Figure 5.81. Box plot of Stroop Color Word Test Part I according to marital status 153

Figure 5.82. Box plot of Stroop Color Word Test Part II according to marital status........... 154

Figure 5.83. Box plot of Stroop Color Word Test Part III according to marital status 154

Figure 5.84. Box plot of Stroop Color Word Test Part IV according to marital status 155

Figure 5.85. Box plot of Stroop Color Word Test Part V according to marital status 155

Figure 5.86. Box plot of Digit Forward Test according to smoking habit............................. 156

Figure 5.87. Box plot of Digit Backward Test according to smoking habit........................... 156

Figure 5.88. Box plot of Corsi Forward Test according to smoking habit 157

Figure 5.89. Box plot of Corsi Backward Test according to smoking habit 157

Figure 5.90. Box plot of Reaction Time (Dominant Hand) according to smoking habit 158

Figure 5.91. Box plot of Reaction Time (Non-Dominant Hand) according to smoking habit158

Figure 5.92. Box plot of Raven Test according to smoking habit 159

Figure 5.93. Box plot of Purdue Pegboard (Dominant Hand) according to smoking habit ... 159

Figure 5.94. Box plot of Purdue Pegboard (Non Dominant Hand) according to smoking habit.. 160

Figure 5.95. Box plot of Purdue Pegboard (Both Hand) according to smoking habit........... 160

Figure 5.96. Box plot of Purdue Pegboard (Total) according to smoking habit..................... 161

Figure 5.97. Box plot of Purdue Pegboard (Assembly) according to smoking habit 161

Figure 5.98. Box plot of Stroop Color Word Test Part I according to smoking habit........... 162

Figure 5.99. Box plot of Stroop Color Word Test Part II according to smoking habit 162

Figure 5.100. Box plot of Stroop Color Word Test Part III according to smoking habit....... 163

Figure 5.101. Box plot of Stroop Color Word Test Part IV according to smoking habit....... 163

Figure 5.102. Box plot of Stroop Color Word Test Part V according to smoking habit........ 164

Figure B.1. Questions of Raven Test 266

Figure C.1. Residual plots for Digit Forward Test Results.. 266

Figure C.2. Residual plots for Digit Backward Test Results 266

Figure C.3. Residual plots for Corsi Forward Test Results 267

Figure C.4. Residual plots for Corsi Backward Test Results 267

Figure C.5. Residual plots for Reaction Time Dominant Hand Results 268

Figure C.6. Residual plots for Reaction Time Non Dominant Hand Results 268

Figure C.7. Residual plots for Raven Test Results 269

Figure C.8. Residual plots for Purdue Pegboard Dominant Hand Results 269

Figure C.9. Residual plots for Purdue Pegboard Non Dominant Hand Results 270

Figure C.10. Residual plots for Purdue Pegboard Both Hand Results 270

Figure C.11. Residual plots for Purdue Pegboard Total 271

Figure C.12. Residual plots for Purdue Pegboard Assembly Results.................................... 271

Figure C.13. Residual plots for Stroop Color Word Test Part I Results................................ 272

Figure C.14. Residual plots for Stroop Color Word Test Part II Results 272

Figure C.15. Residual plots for Stroop Color Word Test Part III Results 273

Figure C.16. Residual plots for Stroop Color Word Test Part IV Results 273

Figure C.17. Residual plots for Stroop Color Word Test Part V Results 274

Figure E.1. Scatterplot of Digit Span Forward vs Age 280

Figure E.2. Scatterplot of Digit Span Forward vs Education 280

Figure E.3. Scatterplot of Digit Span Backward vs Age 281

Figure E.4. Scatterplot of Digit Span Backward vs Education 281

Figure E.5. Scatterplot of Corsi Span Forward vs Age 282

Figure E.6. Scatterplot of Corsi Span Forward vs Education 282

Figure E.7. Scatterplot of Corsi Span Backward vs Age 283

Figure E.8. Scatterplot of Corsi Span Backward vs Education 283

Figure E.9. Scatterplot of Raven Test vs Age 284

Figure E.10. Scatterplot of Raven Test vs Education 284

Figure E.11. Scatterplot of Purdue Pegboard Dominant Hand vs Age 285

Figure E.12. Scatterplot of Purdue Pegboard Non-Dominant Hand vs Age 285

Figure E.13. Scatterplot of Purdue Pegboard Both Hand vs Age 286

Figure E.14. Scatterplot of Purdue Pegboard Total Result vs Age.. 286

Figure E.15. Scatterplot of Purdue Pegboard Assembly Result vs Age 287

Figure E.16. Scatterplot of Purdue Pegboard Assembly Result vs Education........................ 287

Figure E.17. Scatterplot of Stroop Color Word Part I vs Age 288

Figure E.18. Scatterplot of Stroop Color Word Part I vs Education...................................... 288

Figure E.19. Scatterplot of Stroop Color Word Part II vs Age.. 289

Figure E.20. Scatterplot of Stroop Color Word Part II vs Education 289

Figure E.21. Scatterplot of Stroop Color Word Part III vs Age 290

Figure E.22. Scatterplot of Stroop Color Word Part III vs Education................................... 290

Figure E.23. Scatterplot of Stroop Color Word Part IV vs Age 291

Figure E.24. Scatterplot of Stroop Color Word Part IV vs Education................................... 291

Figure E.25. Scatterplot of Stroop Color Word Part V vs Age.. 292

Figure E.26. Scatterplot of Stroop Color Word Part V vs Education 292

Figure E.27. Scatterplot of Reaction Time Dominant Hand vs Age 293

Figure E.28. Scatterplot of Reaction Time Non-Dominant Hand vs Age 293

LIST OF TABLES

Table 2.1. Literature review table 6

Table 2.2. Digit Span Test studies in the literature 15

Table 2.3. Corsi Span Test studies in the literature 23

Table 2.4. Stroop Color Word Test studies in the literature 27

Table 2.5. Reaction Time Test studies in the literature 46

Table 2.6. Purdue Pegboard Test studies in the literature 51

Table 4.1 Distribution of the subjects' family origins 71

Table 4.2. Subject information 72

Table 4.3. Forward and backward versions of Digit Span Test (Hebb, 1961) 76

Table 4.4. Sequence of Corsi Span Test (Milner, 1971) 78

Table 4.5. Parts of Stroop Color Word Test (Karakaş, 2011) 79

Table 4.6. Classification factors and their levels 90

Table 4.7. Test, response and independent variables 91

Table 4.8. Descriptive statistics of pilot study 98

Table 4.9. Minimum sample size of experiments 100

Table 4.10. Results of repeatability study 101

Table 4.11. F test results of all test results 102

Table 4.12. Paired t test results of all tests 103

Table 5.1 Descriptive statistics of test results 105

Table 5.2 Percentile values of response variables 106

Table 5.3. Details of independent variables 113

Table 5.4. Descriptive statistics for Age Factor 114

Table 5.5. Descriptive statistics for Education Factor 116

Table 5.6. Descriptive statistics for Income Factor 117

Table 5.7. Descriptive statistics for Marital Status Factor 119

Table 5.8. Descriptive statistics for Smoking Habbit Factor 120

Table 5.9. Distribution of Response Variables 165

Table 5.10. Levene Test Results 167

Table 5.11. Correlation Matrix 170

Table 5.12. Point Biseral Correlation Matrix 171

Table 5.13. Pearson Correlation between test results 173

Table 5.14. ANOVA results for Digit Span Forward Test 175

Table 5.15. ANOVA results for Digit Span Backward Test... 175

Table 5.16. ANOVA results for Corsi Span Forward Test.. 175

Table 5.17. ANOVA results for Corsi Span Backward Test 176

Table 5.18. ANOVA results for Raven Test.. 176

Table 5.19. ANOVA results for Stroop Color Word Test Part I 176

Table 5.20. ANOVA test for Stroop Color Word Test Part II 177

Table 5.21. ANOVA results for Stroop Color Word Test Part III... 177

Table 5.22. ANOVA results for Stroop Color Word Test Part IV 177

Table 5.23. ANOVA results for Stroop Color Word Test Part V 178

Table 5.24. ANOVA results for Purdue Pegboard Dominant Hand...................................... 178

Table 5.25. ANOVA results for Purdue Pegboard Non Dominant Hand 178

Table 5.26. ANOVA results for Purdue Pegboard Both Hand 178

Table 5.27. ANOVA test results for Purdue Pegboard Total Result 178

Table 5.28. ANOVA test results for Purdue Pegboard Assembly Result.............................. 179

Table 5.29. ANOVA test results for Reaction Time Dominant Hand 179

Table 5.30. ANOVA test results for Reaction Time Non Dominant Hand 179

Table 5.31. Tukey's test results for age group differences 181

Table 5.32. Tukey's Test results for education group differences... 189

Table 5.33. Tukey's Test results for income group differences 191

Table 5.34. F test results 193

Table 5.35. Paired t test results 193

Table 6.1. Comparisons between Population of Turkey and other nationalities for Digit Span Test.. 209

Table 6.2. Comparisons between Population of Turkey and other nationalities for Corsi Span Test.. 211

Table 6.3. Comparisons between Population of Turkey and other nationalities for Raven Test... 212

Table 6.4. Comparisons between Population of Turkey and other nationalities for Stroop Color Word Test 212

Table 6.5. Comparisons between Population of Turkey and other nationalities for Reaction Time Test 214

Table 6.6. Comparisons between Population of Turkey and other nationalities for Purdue Pegboard Test.. 214

Table D.1. Tukey Test grouping results according to Age factor.. 275

Table D.2. Tukey Test grouping results according to Education factor 278

Table D.3. Tukey Test grouping results according to Income factor 279

LIST OF SYMBOLS

H_0	Null hypothesis
H_1	Alternative hypothesis
i	Age factor levels
j	Education factor levels
k	Income factor levels
l	Marital status factor levels
m	Smoking habit factor levels
Mp	Mean for categorical group 1 (i.e., those coded as 1s)
Mq	Mean for categorical group 2 (i.e., those coded as 0s)
N	Sample size
o	Subjects
p	Proportion of subjects that in group 1 (i.e., those coded as 1s)
q	Proportion of subjects that in group 2 (i.e., those coded as 0s)
R^2_{adj}	Adjusted coefficient of determination
r_{pbi}	Point-biserial correlation coefficient
s	Standard deviation of sample
$tobs$	t observation value
$tcrit$	t critical value
X_n	Independent predictors for regression analysis
Y	Response variable

α	The percentage of relative accuracy desired
α_i	The effect of i^{th} level of age
βj	The effect of the j^{th} level of education
β_v	Parameters of regression analysis

ε	Random error component (0, σ^2)
μ	Overall mean
σ^2	Variance of sample
γl	The effect of the l^{th} level of marital status

LIST OF ACRONYMS/ABBREBIATIONS

Adj.	Adjusted
ANOVA	Analysis of Variance
DH	Dominant Hand
Max	Maximum
Min	Minimum
NDH	Non-Dominant Hand
SCWT	Stroop Color Word Test
Std Er	Standard Error

1. INTRODUCTION

Physical and cognitive capabilities of people are taken into account when developing products within the framework of universal design standards. Knowhow about abilities and weaknesses of potential users is necessary for development of websites and human computer interface systems (Chan *et al.*, 2009).

Normative data on cognitive and physical abilities of people is essential for designing product, user interface systems and functionality. Most common ways to gather and assess normative cognitive data are neuropsychological assessments (Arancivaa *et al.*, 2012).

Most studies to provide normative cognitive data on neuropsychological performances are performed on Chinese, Spanish, Korean, USA, Dutch, Australian, Italian and Portuguese populations. These studies also investigated the effects of age, gender, and education on the performances. For the case of Turkey, there are several studies that contain neuropsychological performances. One study uses only Trail Making Test to assess executive functions, attention, planning and organization. A sample size of 238 female participants at the age of 50 were the participants of this test. Age, gender and education effect on test results were examined (Cangoz *et al.*, 2009). Another study of Trail Making Test and The Stroop Color-Word Test is applied to 64 participants (34 female and 30 male) selected from Bogazici University with at least 55 TOEFL score (Dugbartey *et al.*, 2000). Because of the fact that previous studies have not provided comprehensive normative data for the population of Turkey, this study includes six widely used neuropsychological tests to assess four cognitive abilities and five factor effects on test performance with 252 male participants older than 18 years old. Unlike the existing other studies, the sample have been chosen so that different age groups, different geographical regions and different education groups are included to represent the population of Turkey.

As the reviewed studies show, race or country has an effect on cognitive abilities. For example; normative data of US population, Chinese, Spanish and Japanese people are different from each other. So, we can say that data provided for other nationalities might not be valid for the population of Turkey.

In general, there are four main cognitive areas to investigate for a comprehensive study (Monaco *et al.*, 2012). These areas are:

(i) Attention, concentration and speed
(ii) Memory and learning
(iii) Intellectual function
(iv) Motor functions

These areas will be investigated in this study because they are the cognitive abilities of the most frequent concern to professionals (Monaco *et al.*, 2012). The most widely used neuropsychological tests related to the mentioned areas will be used for developing the norms.

In this study, normative data of cognitive abilities will be developed and also age, education level, income, marital status, handedness and smoking effect on the responses will be investigated.

2. LITERATURE REVIEW

2.1. Overview

For many years, researchers have tried different methods to understand and predict human behavior. Human behavior is formed by three elements which are emotionality, cognition and executive functions. Among the three, cognition is the most important element of human behavior since it is about how information is being processed by human. Cognitive functions can be assessed by using various neuropsychological tests (Lezak *et al.*, 2004). Comprehensive neuropsychological tests mostly examine individual's cognitive abilities such as attention, memory, ability to learn, speed, motor functions, emotional status and intelligence (Males, 2009).

Attention seen as the most important part of cognitive abilities can be defined as selection for action briefly. Selective attention is the process of focusing on a specific goal or object in the environment for a while (Lezak *et al.*, 2004).

Human memory is a complex, brain-wide process that defines to understand, store and recall information. Neuropsychological tests like digit span usually measure short term memory which is also known as working memory. Working memory defines ability of recall and processes information at the same time (Karakaş *et al.*, 2002).

Intellectual function means thinking, judging, correlating, reasoning and conceptualizing capabilities of a person. Problem solving and decision making are also aspects of intellectual function (Mackintosh and Bennett, 2005).

Reaction time measures response time for any kind of stimulus. It is also known as reflexes. The speed of our reactions has a big role in everyday life. Neurons act as sensory processing centers that process and decide response to the stimulus. This ability shows peoples' motor functions. Reaction time test is widely used test in neuropsychology to measure this capability (Dyck *et al.*, 2008).

According to literature review, various neuropsychological tasks have been conducted to participants from different age groups to gather normative data for related population. For example, in USA; Trail Making Test, Digit Span Test and Block Design Test have been applied to adults in order to investigate age effect on motor control and memory. Results of this study will be used to design of computer mouse by taking into account needs of older people (Smith *et al.*, 1999).

Another example from China shows importance of older people's needs while designing products and interfaces. They have benefited from different kinds of neuropsychological tests such as Visual Span Test, Strop-Color Word Test, Token Test, Symbol Digit Modalities Test, Purdue Pegboard Test and Digit Span Test in order to design automated teller machine (ATM). 91 participants older than 65 have joined study and accomplished the tasks (Chan *et al.*, 2009).

Raven Standard Progressive Matrices is applied to participants to analyze correlation of cognitive abilities effect and workload. This test is used to evaluate problem solving ability. According to this study, high scored people on test can work easily under high workload (Gonzalez, 2005). Beside Gonzalez, Carpenter *et al.* (1990) recommends using Raven Standard Progressive Matrices to predict the ability to perform dynamic tasks because of the fact that this matrix is used for measuring people's ability of adjusting changing situations, solving difficult problems and handling a number of objectives in their working memory.

Digit span test measures short term (working) memory is used in a study which examined how individuals, younger and older, interacted with an imperfect automated system. The impact of workload on performance and automation use is also investigated. The main intent of using digit span test is to understand how different segments of the population use automation. According to results, design principles have been determined (McBride *et al.*, 2011).

In a study about stopping decision and effect of presentation order of information, Corsi Block tapping task is used for measuring working memory and showing the effect of working memory on decision making (Yu and Gonzalez, 2013).

The results of Stroop Color-Word test which measures selective attention, control, information processing speed, cognitive flexibility and short administration time are used in a study to modify automatic processes for older adults (Rogers and Fisk, 1991).

In a study by O'Brien *et al.* (2008), normative data of Reaction Time, Reverse Digit Span, Digit Symbol Substitution, and Digit Symbol Substitution Recall tests are used for designing virtual keyboards for users from different age groups. They developed design recommendations for virtual keyboards by using data from cognitive tests.

From all of these studies, it could be said that with new technological developments, using cognitive capabilities of people are essential for ergonomic design of products, human computer interfaces and also new software like decision making tools etc. So, for using cognitive abilities of people in designs, there are many studies that develop normative data all over the world. For the purpose of this study, normative data studies from different countries are reviewed.

A list of studies that provides normative data for different cognitive tests from different countries are presented in Table 2.1. The list also includes detailed information of the studies. The source of the study, subjects' sample size, population and detail information about sample are given. Also, main measurements and instruments that are used for developing normative data are given too. Finally, dependent and independent variables which are used for statistical analysis are given too.

Table 2.1. Literature review table

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
1	Hiesh and Tori (2007)	Chinese	Total: 324	Five Digit Test	• Time+ number of errors	• Age
			Male: 180	Fuld Object Memory	• Number of true recall	• Gender
			Female: 144	Symbol Digit Modalities Test	• Total number of correct responses	• Education
				Trail Making Test	• Time to complete test	
				Color Trails	• Time to complete test	
				Verbal Fluency Test (Animal Naming)	• Number of animals	
				WAISRC Digit Span	• Length of digits	
2	Chan *et al.* (2009)	Chinese	Total: 91	Self-Constructed Memory of Digit Test	• Number of digits recall	• Age
			Male: 53	Digit Span Test	• Length of digits	• Education
			Female: 38	Visual Span Test	• Length of sequence	
				Stroop-Color Word Test	• Error, response time	
				Token Test	• Correct answers	
				Symbol Digit Modalities Test	• Total number of correct responses	
				Purdue Pegboard Test	• Number of pins	
3	Moering *et al.* (2004)	Afro-American	Total: 236 Male: 108 Female: 128	Stroop Color and Word Test (Golden)	• Error • Response time	• Age • Gender • Education

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
4	Elst *et al.* (2006)	Dutch	Total: 1856	Stroop Color-Word Test	• Error • Response time	• Age • Gender • Education
5	Rognonia *et al.* (2013)	Spanish	Total: 179	Stroop Color Word Test (Golden) Tower of London-Drexel University Test Problem Solving	• Error • Response time • Total moves and latency time	• Age • Gender • Education
6	Dugbartey *et al.* (2000)	Turkish	Total: 64 Male: 30 Female: 34	Color Trails Test Trail Making Test Stroop Color Word Test (Golden) Symbol Search Subtest from The Wechsler İntelligence Scale for Children Controlled Oral Word Association Test Symbol Subtest from The Wechsler Adult İntelligence Scale-Revised	• Time to complete test • Time to complete test • Error • Response time • IQ score • number of words produced • IQ score	
7	Karakas *et al.* (1999)	Turkish	Total: 395	Stroop test TBAG Form	• Error • Response time	

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
8	Jorm *et al.* (2004)	Australian	Total: 7485	California Verbal Learning Test Digit Span Backwards Symbol–Digit Modalities Test Spot-The-Word Reaction Time	• Correct answers • Length of digits • Correct responses • Correct answers • Average time	• Gender • Mediated effects
9	Mccury *et al.* (2001)	Japanese American	Total: 201	Wais-R Digit Span Trail Making Test Purdue Pegboard Test Finger Tapping	• Length of digits • Time to complete test • Number of pins • Total number of taps for the six ten-second periods for each hand	• Gender • Language • Age
10	Lee *et al.* (2010)	Chinese	Total: 475 341 adolescents. Male: 164 Girl: 177 134 adults Male: 59 Female: 75	The Digit Span Test (Dst) Symbol Digit Modalities Test (Sdmt), The Stroop Color-Word Test, Trail Making Test (Tmt) The Chinese Rey Auditory Verbal Learning Test (C-Ravlt) Aggie Figure Learning Test (Aflt) The Word Fluency Test (Wft) The Design Fluency Test (Dft)	• Length of digits • Correct responses • Error, Response time • Time to complete test • Correct answers • Correct answers • Number of words produced • Number of design produced	• Gender • Education • Age

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
11	Monaco *et al.* (2012)	Italian	Total: 362 Male: 187 Female: 175	The Digit Span Corsi Span Both Forward and Backward Version	• Length of digits • Maximum number of blocks	• Gender • Education • Age
12	Llina`s-Regla *et al.* (2013)	Spanish	Total: 2151	The Stroop Color and Word Test (Scwt) Golden Version	• Error • Response time	• Age • Education • Gender • Main language
13	Lynn and Irwing (2008)			The Digit Span Test Mental Arithmetic (Wechsler İntelligence Tests for Adults and For Children)	• Number of digits	• Age • Education • Race
14	Ludwig, *et al.* (2010)	French	Total: 228	Stroop Color Test (Comparison of Two Version -A Standard Blocked Paper-And-Pencil Version and A Computerized İtem-By-İtem One.	• Error • Response time	• Gender • Age • Types of test
15	Letie *et al.* (1999)	Brazilian	Total: 92 Male: 39 Female: 53	The Video-Recorded Stroop Color-Word Test	• Error • Response time	• Gender • State-trait anxiety score

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
16	Tomaszewska *et al.* (2008)	Polish	Total: 200 Female: 100 Male: 100	Stroop Color Test Trail Making Test N-Back Test	• Response time	• Education • Age • Gender
17	Bayard *et al.* (2011)	French	Total: 244	The Stroop Color-Word Test-Victoria version (VST)	• Error • Response time	• Age • Education
18	Choi *et al.* (2013)	Korean	Total: 784 Male: 266 Female: 518	Digit Span Test	• Length of digits	• Age • Education • Gender
19	Fine *et al.* (2012)	American (USA)	Total: 680	California Verbal Learning Test-II Short Form Letter fluency task (words that start with the letter ''F'' over a 1-minute interval) Category fluency task (vegetables over a 1-minute interval) Digit Span Test	• Correct answers • Number of words produced • Number of words produced • Length of digits	• Age • Education

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
20	Woods *et al.* (2010)	American (USA)	Total: 31 Male: 16 Female: 15	Digit Span Test Hopkins Verbal Learning Test Benton Visual Retention Test	• Length of digits • Correct items • Correct items	
		New Zealand	Total: 763	Digit Symbol Test National Adult Reading Test	• Correct answers • Correct pronuanciation	
21	Yang *et al.* (2012)	Taiwan	Total: 888	Digit Span Test	• Length of digits	• Age • Gender • Education
22	Wechsler (1997)	American	Total: 2450	Digit Span Test	• Length of digits	• Age • Gender
23	Kessels *et al.* (2008)	Dutch	Total: 246 Male: 112 Female: 134	Corsi block-tapping task Digit Span Test	• Length of sequence • Length of digits	• Age

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
24	Piccardi *et al.* (2008)	Italian	Total: 75 Male: 40 Female: 35	Standard Corsi Span Modified Corsi Span	• Length of sequence • Length of sequence and correct recall	• Gender
25	Pagulayan *et al.* (2007)	American (USA)	Total: 340 Male: 148 Female: 192 Elementary school: 174 Middle school: 72 Undergraduate :94	Corsi block-tapping task The Peabody Picture Vocabulary Test-Revised	• Length of sequence • Correct answers	• Age • Gender
26	Postma *et al.* (2004)	Dutch	Total: 64 Male: 32 Female: 32	Corsi block-tapping task	• Length of sequence	• Gender

Table 2.1. Literature review table (cont.)

NO	SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE	INDEPENDENT VARIABLES
27	Martins *et al.* (2013)	Portuguese	Total: 479 Male: 172 Female: 307	The Stroop test (1935 version) Digit span forward and backward Symbol Search Trail Making Test The Matrix Reasoning Semantic (Foods and Animals) and phonemic (Letter ‘‘P’’) verbal fluency tasks	• Correct responses • Length of digits • Correct answers • Time to complete test • Correct answers • The maximum number of items	• Age • Education

2.2. Test Types

2.2.1. The Digit Span Test

Digit Span test is the most popular test to measure ‘attention’ and ‘short-term memory’ (working memory) ability (Hsieh and Tori, 2007). There are two versions of Digit Span test which are called forward and backward. For both versions, test response is the maximum length of digits recalled by participants (Casanovaa *et al.*, 2009). The result of each version is a single number which indicates the participant’s digit span (recalled maximum digit number).

Table 2.2 shows the Digit Span test results of different populations. Independent variables and response variable as number of digits of tests can also be seen from the table.

There are only a few studies to provide normative data from neuropsychological tests in China. Limited studies show that Chinese people has different abilities compared to Western populations (Hsieh and Tori, 2007). In this research; age, gender and education level have been investigated as factors. Results show that age and education have important effect on cognitive capability (Hsieh and Tori, 2007).

In the USA, Digit Span Test has been applied to large samples from different age groups and different education levels to examine effects of age and education level on test results. It has been observed that age and education have important effect on the results.

Digit Span Test has been conducted to Taiwanese people. Results show that there are differences between American and Taiwan population. Digit Span Test has been applied to 1658 participants from 11 different age groups to provide normative data of Taiwan population. Taiwan subjects have better results than the American (Yang *et al.*, 2012).

Table 2.2. Digit Span Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (number of digits) mean	S.D
Hsieh and Tori (2007)	Chinese	142	forward	age	mean: 35.77 years	7.85	1.21
			backward			4.4	1.44
		71	forward	age	mean:52.65 years	7.55	1.05
			backward			4.06	1.24
		68	forward	age gender	mean:69.27 years male	7.49	1.29
			backward			3.82	1.29
		43	forward	age gender	mean:69.27 years female	7.4	1.03
			backward			3.42	1.45
Chan *et al.* (2009)	Chinese	90	forward	education	total	7.28	1.3
		38			high	7.92	1.12
		52			low	6.81	1.22
Jorm *et al.* (2004)	Australian	2404	backward	age gender	20-25 years male	5.47	2.31
					20-25 years female	5.23	2.26
		2530	backward	age gender	40-44 years male	5.33	2.36
					40-44 years female	5.1	2.23
		2551	backward	age gender	60-64 years male	5	2.26
					60-64 years female	4.75	2.22
Monaco *et al.* (2013)	Italian	50	forward	age	20-30 years	6.47	0.94
			backward			5.07	1.25
		58	forward	age	31-40 years	6.38	1.09
			backward			5.16	1.04
		50	forward	age	41-50 years	6.12	1.15
			backward			4.68	1.04
		50	forward	age	51-60 years	5.8	0.95
			backward			4.66	1.24
		54	forward	age	61-70 years	5.7	0.92
			backward			4.15	0.91
		50	forward	age	71-80 years	5.39	0.86
			backward			3.92	0.98
		50	forward	age	81-90 years	4.92	0.81
			backward			3.6	0.67
		362	forward	age	total	5.84	1.09
			backward			4.47	1.19

Table 2.2. Digit Span Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (number of digits) mean	S.D
Lee *et al.* (2010)	Chinese	28	forward	age education gender	mean :12.33 7 years male	8.89	0.88
			backward			6.14	1.86
		29	forward	age education gender	mean :12.43 7 years female	8.17	1.4
			backward			6.38	1.28
		23	forward	age education gender	mean :12.50 7 years male	9.14	1.48
			backward			5.48	1.81
		21	forward	age education gender	mean :12.71 7 years female	8	1.22
			backward			5.05	1.32
		32	forward	age education gender	mean :14.15 9 years male	9.03	0.97
			backward			6.91	1.78
		27	forward	age education gender	mean :14.17 9 years female	9.15	1.17
			backward			6.44	1.5
		18	forward	age education gender	mean :14.58 9 years male	8.78	0.81
			backward			5.38	1.62
		38	forward	age education gender	mean :14.95 9 years female	8.24	1.2
			backward			5.03	1.55
		36	forward	age education gender	mean :16.03 11 years male	9.44	1.25
			backward			7.53	1.68
		31	forward	age education gender	mean :16.06 11 years female	8.97	0.87
			backward			6.52	1.57
		27	forward	age education gender	mean :16.72 11 years male	8.78	1.55
			backward			6.3	1.66
		31	forward	age education gender	mean :16.38 11 years female	8.58	1.54
			backward			5.45	1.81
		134	forward	age education	total	8.86	1.24
			backward			6.39	1.73
		14	forward	age education	20-46 years <9 years	7.86	1.29
			backward			5.15	1.14
		50	forward	age education	20-46 years 9-13 years	8.92	1.21
			backward			6.2	1.7
		69	forward	age education	20-46 years >13 years	9.12	1.16
			backward			6.93	1.64

Table 2.2. Digit Span Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (number of digits) mean	S.D
Choi *et al.* (2013)	Koreans	9	forward	age education gender	60-74 years 0-3 years male	3.89	2.15
			backward			3.56	0.88
		60	forward	age education gender	60-74 years 4-9 years male	5.52	2.48
			backward			4.47	1.56
		109	forward	age education gender	60-74 years >10 years male	7.58	2.49
			backward			5.42	1.55
		101	forward	age education gender	60-74 years 0-3 years female	3.66	1.73
			backward			2.86	1.43
		167	forward	age education gender	60-74 years 4-9 years female	4.93	2.02
			backward			4.12	1.46
		116	forward	age education gender	60-74 years >10 years female	6.86	2.02
			backward			5.05	1.54
		8	forward	age education gender	75-90 years 0-3 years male	4.13	1.13
			backward			3.13	1.46
		41	forward	age education gender	75-90 years 4-9 years male	5.2	2.1
			backward			4.27	1.38
		39	forward	age education gender	75-90 years >10 years male	6.28	1.96
			backward			5.23	1.75
		53	forward	age education gender	75-90 years 0-3 years female	3.04	1.21
			backward			2.55	1.15
		53	forward	age education gender	75-90 years 4-9 years female	4.58	2.17
			backward			3.94	1.46
		28	forward	age education gender	75-90 years >10 years female	6.25	2.84
			backward			4.94	1.88
Woods *et al.* (2010)	New Zealand	763	forward	age education	mean:46.5 years mean:12.5 years	6.35	1.15
			backward			4.61	1.22
Yang *et al.* (2012)	Taiwan	1658	forward	total		7.63	1.44
			backward	education	6-16 years	5.21	1.8
Woods *et al.* (2010)	USA	31	forward	age education	mean:26 years mean:14.8 years	7.36	0.88
			backward			5.8	1.42

Table 2.2. Digit Span Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (number of digits) mean	S.D
Fine *et al.* (2012)	USA	260	forward	age gender	85-86 years female	7.6	2.1
			backward			6.1	2
		143	forward	age education gender	85-86years <12 years female	7.6	2
			backward			6.1	1.9
		117	forward	age education gender	85-86 years >12 years female	7.6	2.2
			backward			6.1	2.1
		279	forward	age gender	87-89 years female	7.4	1.9
			backward			6	2
		148	forward	age education gender	87-89 years <12 years female	7.3	2
			backward			5.8	2
		131	forward	age education gender	87-89 years >12 years female	7.5	1.9
			backward			6.4	2
		141	forward	age gender	90-95 years female	7.5	2.2
			backward			5.9	2.8
		89	forward	age education gender	90-95 years <12 years female	7.4	2.2
			backward			5.6	1.7
		52	forward	age education gender	90-95 years >12 years female	7.8	2.3
			backward			6.2	2
Kessels *et al.* (2008)	Dutch	37	forward	age	50-59 years	6.1	1.3
			backward			4.8	1.3
		112	forward	age	60-69 years	5.7	1.2
			backward			4.3	1.2
		81	forward	age	70-79 years	5.5	1.1
			backward			4	1.2
		16	forward	age	80 + years	5.6	1.1
			backward			4.3	1.1
Wechsler (1997)	USA	2450	forward	age	16-89 years	6.43	1.36
			backward			4.7	1.43

Table 2.2. Digit Span Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (number of digits) mean	S.D
Martins *et al.* (2013)	Portuguese	12	forward	age education	60-65 years 0-3 years	4	1
			backward			3	1
		77	forward	age education	60-65 years 4 years	5	1
			backward			3	1
		72	forward	age education	60-65 years 5-9 years	6	1
			backward			4	1
		71	forward	age education	60-65 years >9 years	6	1
			backward			4	1
		36	forward	age education	>65 years 0-3 years	4	1
			backward			3	1
		108	forward	age education	>65 years 4 years	5	1
			backward			3	1
		59	forward	age education	>65 years 5-9 years	5	1
			backward			4	1
		44	forward	age education	>65 years >9 years	5	1
			backward			4	1
Lee *et al.* (2010)	Chinese	28	forward	age education gender	mean :12.33 years 7 years male	8.89	0.88
			backward			6.14	1.86
		29	forward	age education gender	mean :12.43 years 7 years female	8.17	1.4
			backward			6.38	1.28
		23	forward	age education gender	mean :12.50 years 7 years male	9.14	1.48
			backward			5.48	1.81
		21	forward	age education gender	mean :12.71 years 7 years female	8	1.22
			backward			5.05	1.32
		32	forward	age education gender	mean :14.15 years 9 years male	9.03	0.97
			backward			6.91	1.78
		27	forward	age education gender	mean :14.17 years 9 years female	9.15	1.17
			backward			6.44	1.5
		18	forward	age education gender	mean :14.58years 9 years male	8.78	0.81
			backward			5.38	1.62
		38	forward	age education gender	mean :14.95years 9 years female	8.24	1.2
			backward			5.03	1.55
		36	forward	age education gender	mean :16.03years 11 years male	9.44	1.25
			backward			7.53	1.68
		31	forward	age education gender	mean :16.06years 11 years female	8.97	0.87
			backward			6.52	1.57
		27	forward	age education gender	mean :16.72years 11 years male	8.78	1.55
			backward			6.3	1.66
		31	forward	age education gender	mean :16.38years 11 years female	8.58	1.54
			backward			5.45	1.81

The aim of limited researches for Korean population is to examine the effect of demographic variables on Digit Span test result (Choi *et al.*, 2013). Choi and others show that Digit Span Forward and Backward test results are affected by gender, age and education level by conducting this test on older people.

Digit Span backward and forward tests have been applied to large sample of Dutch population to examine factors' effects such as gender, age and education level on subject's digit span. According to results, gender effect is not observed. Positive effect of education level and negative effect of age are found (Kessels *et al.*, 2008). Unlike other studies, this study also examines differences between forward and backward versions of Digit Span Test. According to results, it can easily be seen that backward version is more difficult than forward version.

Most of the studies used Digit Span Test especially on older age groups. In Portugal, low educated older age Portuguese subjects have completed Digit Span Test to provide normative data. Trail Making Test, Symbol Search, Stroop-Color Test and Digit Span Tests have been applied on 479 adults at mean age 66.4 years (Martins *et al.*, 2013). Results show that gender has an effect on test results. Women performed better than men (Martins *et al.*, 2013).

A study of Australian population indicated the opposite: Male performances were better than females for the age groups of 20-64 (Jorm *et al.*, 2004). Other factors have also been examined such as health state, education level, non-English speaking background, depression, alcohol users' physical activity level (Jorm *et al.*, 2004). The result of the study shows that if mediating variables were controlled, gender differences would not affect the performance of Digit Span Backward Test.

In Turkey, Karakas *et al.* (2002) have conducted a study with Digit Span Test with 1856 subjects from different age groups. As a result, negative effect of age and positive effect of education on digit span performance observed (Karakaş *et al.*, 2002).

In summary:

- Most of studies in Europe and Asia have been done to examine age, education and gender effect on the Digit Span test results.
- A few of them also compared the versions and results show that backward version is more difficult than forward.
- In general, avaliable studies are conducted on older people.
- Result of gender effect has conflicting results. While women result better than men in Portugal, men performance is better in Australia.
- In Turkey, there is only one study including Digit Span Test. Test is applied to 1183 participants aged between 13-89. Results show that test performance increases from 13 to 19 years. After the age of 20, performance decreases gradually.

2.2.2. The Corsi Span Test

Spatial memory is the ability of storing information regarding spatial features of the environment. Since this type of memory helps us to remember the locations of objects, it is very important for everyday tasks (Postma *et al.*, 2004).

Corsi Span Test, also known as Location Memory Test, is often used to measure verbal and visual-spatial short-term memory and learning ability. Unlike the Digit Span Test, Corsi Span Test also evaluates reproducing ability for a sequence of locations (Monaco *et al.*, 2012). Corsi Span Test has two versions which are called backward and forward. The response variables of both versions are the maximum length of sequence that the participant remembers (Kessels *et al.*, 2008).

There are many studies to provide normative data for Italian, American and Dutch populations. One of these studies looks for how the order of the information given plays a role in the decision of a participant to stop performing a task with the help of the Corsi Span test results (Yu and Gonzalez, 2013).

Table 2.3 shows the Corsi Span test results of different populations. The independent variables and response variables which are maximum length of sequence can be seen below.

362 healthy subjects with ages in the range of 20 to 90 years were included in the study examining Italian population. When forward and backward versions of the test are applied, results indicate that there is a negative correlation between the age and performance in all tasks. On the other hand, education plays an affirmative role in the performance of the subject in Corsi span backward version (Monaco *et al.*, 2012). The study looks also for the differences between Corsi Span Test and Digit Span Test. According to the results, forward span performance of the participants is greater in the Digit Span Test than the Corsi Test. Moreover, their backward span performance is lower in the Digit Test than the Corsi Backward Span Test.

In Dutch population, the researches have applied a standardized backward version to 246 older people whose ages in the range of 50 to 92. It also includes performing tests. Differences between Corsi Span test result and Digit Span test result have been examined (Kessels *et al.*, 2008). According to results, there is no correlation between gender and Corsi Span test results. On the other hand, there is a negative correlation between age and the results of Corsi Backward version. Education has positive impact on Corsi Forward test results.

Another study of Corsi Span Test on Dutch people showed that gender has an effect on test performance. Males have higher score than females (Postma *et al.*, 2004).

In Italy, studies have examined gender effect on Corsi Span Test which measures locations and direction memories. According to the test results, males have better location memory for both forward and backward version of Corsi Span Test (Piccardi *et al.*, 2008).

Table 2.3. Corsi Span Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (length of sequence) MEAN	SD
Monaco *et al.* (2012)	Italian	50	forward	age	20-30 years	6	1.09
			backward			5.24	0.9
		58	forward	age	31-40 years	5.94	1.06
			backward			5.38	1.14
		50	forward	age	41-50 years	5.5	1.02
			backward			4.7	0.91
		50	forward	age	51-60 years	5.56	1.02
			backward			5.04	1.05
		54	forward	age	61-70 years	5.17	0.98
			backward			4.66	0.95
		50	forward	age	71-80 years	5.02	0.75
			backward			4.43	0.84
		50	forward	age	81-90 years	4.42	0.89
			backward			3.5	1
		362	forward	age	total	5.38	1.09
			backward			4.72	1.13
Kessels *et al.* (2008)	Dutch	37	forward	age	50-59 years	5.3	0.7
			backward			5.5	1.1
		112	forward	age	60-69 years	5	0.8
			backward			5.1	1.1
		81	forward	age	70-79 years	5.2	0.8
			backward			4.9	1.1
		16	forward	age	80 + years	4.8	0.8
			backward			4.6	0.9
Piccardi *et al.* (2008)	Italian	40	forward	age education gender	mean:23.1 years 13 years male	5.28	0.88
		35	forward	age education gender	mean:23.26 years 13 years female	4.38	0.82
Pagulayan *et al.* (2007)	USA	26	forward	education age	Grade 1 mean:7 years	5	0.8
		27	forward	education age	Grade 2 mean:8.1 years	5.2	1
		24	forward	education age	Grade 3 mean:9 years	5.5	1
		24	forward	education age	Grade 4 mean:10 years	6	1.1
		26	forward	education age	Grade 5 mean:11 years	6.3	0.9
		47	forward	education age	Grade 6 mean:12.2 years	6.3	0.9
		32	forward	education age	Grade 7 mean:12.9 years	6.4	0.9
		40	forward	education age	Grade 8 mean:13.9 years	6.9	1.1
		91	forward	education age	Grade 13+ mean:21.7 years	7.1	1
Postma *et al.* (2004)	Holland	32	forward	age gender	mean: 21.4 years male	6.22	1.1
		32	backward	age gender	mean: 21.5 years female	5.75	0.98

In summary:

- Most of Corsi Span Test studies are performed in Europe to examine age and gender effect on the test performance.
- A few of them also compared the versions and the results show that backward version is more difficult than forward. Some of them also compared Digit Span and Corsi Span test results as well.
- In general, studies are conducted to different age groups. According to results, there is negative correlation between age and Corsi Span test results.
- There is no Corsi Span Test study in Turkey.

2.2.3. The Stroop Color and Word Test

The Stroop Color and Word Test (SCWT) is a worldwide known neuropsychological test which is used to assess the executive functions such as attention control, information running speed, selective attention and cognitive ability (Llina`s-Regla *et al.*, 2013). The reason behind being worldwide used and preferred test for these purposes is that it can be applied in a short time and assess cognitive ability easily (Regard, 1981).

Many of researches show that healthy subjects can perform well on the Stroop Color Test. On the other hand, poor healthy participants having different diseases such as depression, alcoholism, schizophrenia and Alzheimer's disease cannot achieve well on this test (Lezak *et al.*, 2004).

In time, the variety of Stroop Color Test versions has advanced. The differences between versions are number of cards, columns on the cards, size of stimuli cards, conducted guide, scoring way and the normative data calculation. Some procedures evaluate test results by taking errors into account. On the other hand, some of them let subjects correct their errors and only evaluate time as a response variable (Bayard *et al.*, 2011). Even if there are different versions of the Stroop Test, the main procedure has not changed (Elst *et al.*, 2006). The subject achieves a simple task first. Then completes the second task which is harder than the first. The differences between test scores as completion time is called "The Stroop Interference Effect", which indicates the subject's cognitive flexibility (Davidson *et al.*, 2003).

The Stroop Test gathers data from subject's number of read words, colors, and words–colors for all versions (Llinas-Regla *et al.*, 2013). In the most known version of Stroop Color Test called Golden's version, the Stroop Interference Effect is provided by using total time to say a color which is printed in a word of a different color (Llina`s-Regla *et al.*, 2013). Golden's version has three cards and 50 items on each one (Karakaş *et al.*, 1999). The Victoria version is the well-known version of Stroop Color Test which consists of three cards and has 24 items on each one. Subject says the color of dots, words and color of words for each card (Bayard *et al.*, 2011).

Table 2.4 presents a summary of literature review of Stroop Color Word Test.

Victoria version of Stroop Test was applied to 244 elderly French people at age from 50 to 97 years to investigate factor effects such as age and education on selective attention and processing speed. The Stroop Color Test is commonly applied to measure executive functions and provide normative data for both North America and French speaking populations (Bayard *et al.*, 2011). According to the test results, there is no significant effect of gender on test performance. On the other hand, there is positive correlation between education and test performance (Bayard *et al.*, 2011).

In Spain, Stroop Color-Word Test is used to provide normative data through investigating factor effects such as age, gender, and educational level. 2151 subjects older than 55 have been accomplished the test (Llina`s-Regla *et al.*, 2013). Results indicates that demographic variables such as age, gender, number of education year have an effect on Stroop test results. According to the results, age does not have significant effect on test scores for the subjects older than 55 (Llina`s-Regla *et al.*, 2013).

There is another study to gather normative data for different languages by using different versions of Stroop Color Word Test (Lezak *et al.*, 2004). Subjects were chosen from old people in many of these researches due to the importance of gathering normative data of elderly populations.

On the other hand, there is another study proving that age has a significant effect on Stroop Color Word test results. SCWT is applied to 1856 Dutch speaking subject in ages range of 24 to 81 to examine age, gender and education effect. According to the results, age and education level have positive effect on performance (Elst *et al.*, 2006)

In Turkey, there is just one study using Stroop Color Word Test. The purpose of this research was to develop Turkish version of Stroop Color Word Test at the same time providing standardization of test and scoring way. This new version is called as Stroop Test TBAG version (Karakas *et al.*, 1999).

Table 2.4. Stroop Color Word Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Moering *et al.* (2004)	African Americans	37	Word	age	60–71 years	70.49	13.64
			Color	gender	male	31.46	13.98
			Color-Word	education	<12 years	20.57	6.38
		11	Word	age	60–71 years	73.18	14.55
			Color	gender	male	32.82	9.77
			Color-Word	education	12 years	20.73	4.73
		6	Word	age	60–71 years	81.83	18.8
			Color	gender	male	35.67	11.11
			Color-Word	education	>12 years	25.17	7.28
		30	Word	age	60–71 years	74.93	10.93
			Color	gender	female	34.67	12.34
			Color-Word	education	<12 years	21.87	5.85
		16	Word	age	60–71 years	80.87	12.93
			Color	gender	female	34.5	5.42
			Color-Word	education	12 years	25.44	4.49
		11	Word	age	60–71 years	87.45	8.24
			Color	gender	female	53.91	14.52
			Color-Word	education	>12 years	27.82	4.09
		48	Word	age	72-84 years	54.75	17.27
			Color	gender	male	27.5	10.49
			Color-Word	education	<12 years	19.96	3.89
		4	Word	age	72-84 years	65.75	7.37
			Color	gender	male	29	5.42
			Color-Word	education	12 years	20.75	3.4
		2	Word	age	72-84 years	80.5	7.78
			Color	gender	male	45.5	21.92
			Color-Word	education	>12 years	27	15.56
		56	Word	age	72-84 years	66.36	14.59
			Color	gender	female	28.48	7.95
			Color-Word	education	<12 years	20.57	4.38
		11	Word	age	72-84 years	75.27	10.39
			Color	gender	female	32.64	5.87
			Color-Word	education	12 years	23.91	4.21
		4	Word	age	72-84 years	89.5	10.41
			Color	gender	female	56.25	24.07
			Color-Word	education	>12 years	31.5	10.75
		54	Word	age	60–71 years	72.3	14.57
			Color	gender	male	32.2	12.81
			Color-Word			21.11	6.24
		57	Word	age	60–71 years	79.02	11.94
			Color	gender	female	38.33	13.55
			Color-Word			24.02	5.66
		54	Word	age	72-84 years	56.52	17.31
			Color	gender	male	28.28	10.96
			Color-Word			20.28	4.52
		71	Word	age	72-84 years	69.04	14.94
			Color	gender	female	30.69	11.01
			Color-Word			21.7	5.46
		171	Word	education	<12 years	65.5	16.28
			Color			29.94	11.18
			Color-Word			20.63	5.02
		42	Word	education	12 years	75.95	12.84
			Color			33.05	6.86
			Color-Word			23.36	4.72
		23	Word	education	>12 years	85.74	11.81
			Color			48.83	17.2
			Color-Word			27.7	7.13
		236	Word	total		69.33	16.69
			Color			32.33	12.54
			Color-Word			21.8	5.63

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Chan *et al.* (2009)	Chinese	87	Interference time	education	total	14.91	12.06
		35			high	18.05	12.4
		52			low	12.49	11.32
Lee *et al.* (2010)	Chinese	28	Dot subtask (time)	age education gender	mean :12.33 years 7 years male	13.99	33.45
			Dot subtask (error)			0.36	1.13
			Word subtask (time)			16.06	3.31
			Word subtask (error)			0.29	1.51
			Color-Word subtask (time)			24.98	6.19
			Color-Word subtask (error)			1.07	1.96
		29	Dot subtask (time)	age education gender	mean :12.43 years 7 years female	14.27	2.83
			Dot subtask (error)			0.1	0.56
			Word subtask (time)			14.9	2.8
			Word subtask (error)			0	0
			Color-Word subtask (time)			22.22	5.11
			Color-Word subtask (error)			0.48	0.91
		23	Dot subtask (time)	age education gender	mean :12.50 years 7 years male	18.83	5.66
			Dot subtask (error)			0.48	1.31
			Word subtask (time)			5.27	14.68
			Word subtask (error)			0.21	0.06
			Color-Word subtask (time)			12.76	22.12
			Color-Word subtask (error)			2.16	1.63
		21	Dot subtask (time)	age education gender	mean :12.71 years 7 years female	15.61	3.13
			Dot subtask (error)			0.14	0.48
			Word subtask (time)			18.49	3.87
			Word subtask (error)			0.19	0.6
			Color-Word subtask (time)			26.43	4.94
			Color-Word subtask (error)			1.9	4.86
		32	Dot subtask (time)	age education gender	mean :14.15 years 9 years male	12.7	2.21
			Dot subtask (error)			0.16	0.51
			Word subtask (time)			14.68	2.36
			Word subtask (error)			0.06	0.35
			Color-Word subtask (time)			22.12	5.89
			Color-Word subtask (error)			1.63	4.16
		27	Dot subtask (time)	age education gender	mean :14.17 years 9 years female	12.89	2.1
			Dot subtask (error)			0.22	0.58
			Word subtask (time)			14.58	3.25
			Word subtask (error)			0.04	0.19
			Color-Word subtask (time)			22.12	6.3
			Color-Word subtask (error)			1.7	4.73
		18	Dot subtask (time)	age education gender	mean :14.58 years 9 years male	14.98	3.75
			Dot subtask (error)			0.08	0.36
			Word subtask (time)			17.66	4.41
			Word subtask (error)			0.17	0.51
			Color-Word subtask (time)			27.75	9.72
			Color-Word subtask (error)			0.94	1.89
		38	Dot subtask (time)	age education gender	mean :14.95 years 9 years female	13.97	3.65
			Dot subtask (error)			0.08	0.36
			Word subtask (time)			15.7	3.24
			Word subtask (error)			0.05	0.23
			Color-Word subtask (time)			24.18	4.92
			Color-Word subtask (error)			0.53	0.92
		36	Dot subtask (time)	age education gender	mean :16.03 years 11 years male	12.73	3.47
			Dot subtask (error)			0.08	0.37
			Word subtask (time)			13.43	3.3
			Word subtask (error)			0	0
			Color-Word subtask (time)			19.96	6.31
			Color-Word subtask (error)			1.17	4.33

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Lee *et al.* (2010) cont'd	Chinese	31	Dot subtask (time)	age education gender	mean :16.06 years 11 years female	12.16	2.18
			Dot subtask (error)			0.03	0.18
			Word subtask (time)			12.85	2.53
			Word subtask (error)			0.06	0.25
			Color-Word subtask (time)			20	5.19
			Color-Word subtask (error)			0.52	1.18
		27	Dot subtask (time)	age education gender	mean :16.72 years 11 years male	13.39	2.85
			Dot subtask (error)			0.19	0.48
			Word subtask (time)			14.98	3.15
			Word subtask (error)			0	0
			Color-Word subtask (time)			25.23	6.32
			Color-Word subtask (error)			0.96	1.32
		31	Dot subtask (time)	age education gender	mean :16.38 years 11 years female	12.62	2.21
			Dot subtask (error)			0.1	0.4
			Word subtask (time)			14.39	3.23
			Word subtask (error)			0.03	0.18
			Color-Word subtask (time)			23.66	8.11
			Color-Word subtask (error)			1	2.89
Llina`s-Regla *et al.* (2013)	Spanish	476	Word	age	55-61 years	82.1	17.1
			Word-Color	education	0-8 years	31.6	9.2
		334	Word	age	55-61 years	94.9	15.3
			Word-Color	education	9-15 years	37.9	9.5
		227	Word	age	55-61 years	98.8	14.7
			Word-Color	education	16+ years	40.3	9.1
		513	Word	age	62-64 years	79.5	17.6
			Word-Color	education	0-8 years	30.9	9.3
		300	Word	age	62-64 years	94.4	15.9
			Word-Color	education	9-15 years	37.2	9.4
		202	Word	age	62-64 years	97.5	15.2
			Word-Color	education	16+ years	39.7	8.9
		521	Word	age	65-67 years	77.4	18.3
			Word-Color	education	0-8 years	30.4	9.9
		249	Word	age	65-67 years	92.6	15.9
			Word-Color	education	9-15 years	35.9	9.5
		176	Word	age	65-67 years	97.5	15.2
			Word-Color	education	16+ years	38.2	9.7
		515	Word	age	68-70 years	74	18.6
			Word-Color	education	0-8 years	28.9	10.1
		193	Word	age	68-70 years	89.5	16.1
			Word-Color	education	9-15 years	33.9	9.3
		137	Word	age	68-70 years	96	0
			Word-Color	education	16+ years	36	11.1
		469	Word	age	71-73 years	71.2	18.8
			Word-Color	education	0-8 years	28.3	10.5
		139	Word	age	71-73 years	85.3	16.8
			Word-Color	education	9-15 years	32.2	9.2
		109	Word	age	71-73 years	92.3	15.4
			Word-Color	education	16+ years	33	10.6
		444	Word	age	74-76 years	68.9	19.4
			Word-Color	education	0-8 years	26.7	9.3
		115	Word	age	74-76 years	81	16
			Word-Color	education	9-15 years	29.8	8.8
		91	Word	age	74-76 years	87.4	15.1
			Word-Color	education	16+ years	30.8	11.6
		401	Word	age	77-79 years	66	19.2
			Word-Color	education	0-8 years	25.3	9.1

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Llina`s-Regla *et al.* (2013) cont'd	Spanish	100	Word	age	77-79 years	79.7	17
			Word-Color	education	9-15 years	29.1	8.8
		85	Word	age	77-79 years	83.5	15.4
			Word-Color	education	16+ years	29.6	10.7
		300	Word	age	80-82 years	65.9	19
			Word-Color	education	0-8 years	24.7	9.1
		71	Word	age	80-82 years	77	15
			Word-Color	education	9-15 years	27	8.3
		59	Word	age	80-82 years	83.5	15.4
			Word-Color	education	16+ years	29.2	11
		185	Word	age	82 + years	64.9	18.8
			Word-Color	education	0-8 years	23.1	7.9
		46	Word	age	82 + years	75.5	16.3
			Word-Color	education	9-15 years	25.7	8.7
		31	Word	age	82 + years	81	14.6
			Word-Color	education	16+ years	29.3	12.6
		207	Color	gender age education	male 55-61 years 0-8 years	56.6	12.1
		141	Color	gender age education	male 55-61 years 9-15 years	63.9	11.1
		124	Color	gender age education	male 55-61 years 16+ years	64.6	12
		216	Color	gender age education	male 62-64 years 0-8 years	54.5	12.5
		134	Color	gender age education	male 62-64 years 9-15 years	63.4	11.3
		123	Color	gender age education	male 62-64 years 16+ years	64	11.7
		222	Color	gender age education	male 65-67 years 0-8 years	52.7	13
		108	Color	gender age education	male 65-67 years 9-15 years	62.5	10.8
		111	Color	gender age education	male 65-67 years 16+ years	62.8	12.1
		217	Color	gender age education	male 68-70 years 0-8 years	51.1	13.1
		76	Color	gender age education	male 68-70 years 9-15 years	60.6	11.2

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Llina`s-Regla *et al.* (2013) cont'd	Spanish	94	Color	gender age education	male 68-70 years 16+ years	62.2	12.9
		188	Color	gender age education	male 71-73 years 0-8 years	50.2	12.1
		61	Color	gender age education	male 71-73 years 9-15 years	58.5	12.8
		75	Color	gender age education	male 71-73 years 16+ years	59.2	12.3
		189	Color	gender age education	male 74-76 years 0-8 years	48.6	12.2
		51	Color	gender age education	male 74-76 years 9-15 years	53.4	12.3
		63	Color	gender age education	male 74-76 years 16+ years	54.7	11.7
		183	Color	gender age education	male 77-79 years 0-8 years	47.8	12.2
		46	Color	gender age education	male 77-79 years 9-15 years	53.2	12.2
		58	Color	gender age education	male 77-79 years 16+ years	54.4	11.7
		146	Color	gender age education	male 80-82 years 0-8 years	46.2	12.4
		34	Color	gender age education	male 80-82 years 9-15 years	51.4	10.1
		39	Color	gender age education	male 80-82 years 16+ years	53	11.9
		92	Color	gender age education	male 82+ years 0-8 years	43.4	11.8
		21	Color	gender age education	male 82+ years 9-15 years	50.1	10.4
		23	Color	gender age education	male 82+ years 16+ years	53.1	11.2
		269	Color	gender age education	female 55-61 years 0-8 years	58.9	11.9
		193	Color	gender age education	female 55-61 years 9-15 years	65.4	11
		103	Color	gender age education	female 55-61 years 16+ years	66.4	11.5
		297	Color	gender age education	female 62-64 years 0-8 years	57.5	11.8
		166	Color	gender age education	female 62-64 years 9-15 years	64.7	10.8

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Llina`s-Regla *et al.* (2013) cont'd	Spanish	79	Color	gender age education	female 62-64 years 16+ years	65	11.4
		299	Color	gender age education	female 65-67 years 0-8 years	56.8	11.9
		141	Color	gender age education	female 65-67 years 9-15 years	63.2	10.7
		65	Color	gender age education	female 65-67 years 16+ years	63.6	10.5
		298	Color	gender age education	female 68-70 years 0-8 years	54.8	11.7
		117	Color	gender age education	female 68-70 years 9-15 years	62	11.5
		43	Color	gender age education	female 68-70 years 16+ years	61.9	12.1
		281	Color	gender age education	female 71-73 years 0-8 years	53.1	11.6
		78	Color	gender age education	female 71-73 years 9-15 years	58.6	11.3
		34	Color	gender age education	female 71-73 years 16+ years	61.3	13.5
		255	Color	gender age education	female 74-76 years 0-8 years	51.9	11.3
		64	Color	gender age education	female 74-76 years 9-15 years	55.8	9.9
		28	Color	gender age education	female 74-76 years 16+ years	59.1	11.8
		218	Color	gender age education	female 77-79 years 0-8 years	49.6	10.7
		54	Color	gender age education	female 77-79 years 9-15 years	54.7	10
		27	Color	gender age education	female 77-79 years 16+ years	57.5	11.1
		154	Color	gender age education	female 80-82 years 0-8 years	48	10.9
		37	Color	gender age education	female 80-82 years 9-15 years	53	10.6

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Llina`s-Regla *et al.* (2013) cont'd	Spanish	20	Color	gender age education	female 80-82 years 16+ years	56.9	11.5
		93	Color	gender age education	female 82+ years 0-8 years	47.2	11.4
		25	Color	gender age education	female 82+ years 9-15 years	51.6	11
		8	Color	gender age education	female 82+ years 16+ years	54	10.5
Elst *et al.* (2006)	Dutch	21	Stroop I	age education	24-26 years low education	43.23	6.03
		22	Stroop I	age education	29-31 years low education	43.61	6.78
		33	Stroop I	age education	34-36 years low education	44.47	6.71
		37	Stroop I	age education	39-41 years low education	45.94	9.97
		49	Stroop I	age education	44-46 years low education	43.3	7.19
		52	Stroop I	age education	49-51 years low education	44.82	6.66
		81	Stroop I	age education	54-56 years low education	45.43	7.14
		73	Stroop I	age education	59-61 years low education	48.61	8.91
		83	Stroop I	age education	64-66 years low education	47.64	7.8
		80	Stroop I	age education	69-71 years low education	47.16	7.14
		80	Stroop I	age education	74-76 years low education	51.52	8.91
		38	Stroop I	age education	79-81 years low education	51.46	7.54
		77	Stroop I	age education	24-26 years average education	39.49	4.76
		79	Stroop I	age education	29-31 years average education	41.22	6.2
		77	Stroop I	age education	34-36 years average education	38.59	5.28

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	72	Stroop I	age education	39-41 years average education	40.78	5.55
		73	Stroop I	age education	44-46 years average education	41.29	6.94
		71	Stroop I	age education	49-51 years average education	42.68	6.98
		49	Stroop I	age education	54-56 years average education	42.76	6.46
		65	Stroop I	age education	59-61 years average education	42.13	6.85
		50	Stroop I	age education	64-66 years average education	44.51	7.55
		57	Stroop I	age education	69-71 years average education	44.95	7.07
		53	Stroop I	age education	74-76 years average education	47.91	7.4
		9	Stroop I	age education	79-81 years average education	45.78	5.16
		61	Stroop I	age education	24-26 years high education	38.61	6.44
		53	Stroop I	age education	29-31 years high education	39.56	6.25
		47	Stroop I	age education	34-36 years high education	38.96	5.57
		46	Stroop I	age education	39-41 years high education	38.16	4.77
		40	Stroop I	age education	44-46 years high education	39.48	7.09
		37	Stroop I	age education	49-51 years high education	40.47	6.9
		27	Stroop I	age education	54-56 years high education	38.59	5.47
		19	Stroop I	age education	59-61 years high education	43.5	5.88
		20	Stroop I	age education	64-66 years high education	42.92	7.64
		18	Stroop I	age education	69-71 years high education	44.04	7.67
		24	Stroop I	age education	74-76 years high education	44	4.67
		12	Stroop I	age education	79-81 years high education	47.98	8.02
		8	Stroop II	gender age education	male 24-26 years low education	61.37	5.24
		9	Stroop II	gender age education	male 29-31 years low education	56.9	7.35

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	22	Stroop II	gender age education	male 34-36 years low education	57.38	10.05
		21	Stroop II	gender age education	male 39-41 years low education	59.48	8.46
		23	Stroop II	gender age education	male 44-46 years low education	58.91	8.45
		17	Stroop II	gender age education	male 49-51 years low education	57.33	9.41
		33	Stroop II	gender age education	male 54-56 years low education	59.97	12.07
		31	Stroop II	gender age education	male 59-61 years low education	62.05	11.24
		32	Stroop II	gender age education	male 64-66 years low education	63.65	9.69
		35	Stroop II	gender age education	male 69-71 years low education	63.77	10.66
		32	Stroop II	gender age education	male 74-76 years low education	69.81	14.17
		20	Stroop II	gender age education	male 79-81 years low education	71.97	12.8
		37	Stroop II	gender age education	male 24-26 years average education	55.36	7.46
		41	Stroop II	gender age education	male 29-31 years average education	54.16	8.11
		25	Stroop II	gender age education	male 34-36 years average education	50.96	6.49
		24	Stroop II	gender age education	male 39-41 years average education	51.35	8.97
		32	Stroop II	gender age education	male 44-46 years average education	54.34	10.35
		43	Stroop II	gender age education	male 49-51 years average education	54.94	9.43
		27	Stroop II	gender age education	male 54-56 years average education	58.59	7.92
		38	Stroop II	gender age education	male 59-61 years average education	57.61	8.51

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	29	Stroop II	gender age education	male 64-66 years average education	62.74	14.06
		34	Stroop II	gender age education	male 69-71 years average education	61.83	10.36
		27	Stroop II	gender age education	male 74-76 years average education	65.83	10.82
		4	Stroop II	gender age education	male 79-81 years average education	63.85	7.73
		33	Stroop II	gender age education	male 24-26 years high education	50.36	7.43
		29	Stroop II	gender age education	male 29-31 years high education	51.55	7.03
		31	Stroop II	gender age education	male 34-36 years high education	50.49	7.92
		32	Stroop II	gender age education	male 39-41 years high education	51.73	7.45
		23	Stroop II	gender age education	male 44-46 years high education	51.37	8.23
		19	Stroop II	gender age education	male 49-51 years high education	53.77	8.45
		21	Stroop II	gender age education	male 54-56 years high education	52.1	7.94
		12	Stroop II	gender age education	male 59-61 years high education	56.77	5.67
		15	Stroop II	gender age education	male 64-66 years high education	56.61	9.72
		12	Stroop II	gender age education	male 69-71 years high education	60.07	8.63
		18	Stroop II	gender age education	male 74-76 years high education	59.36	8.7
		6	Stroop II	gender age education	male 79-81 years high education	60.14	5.74
		13	Stroop II	gender age education	female 24-26 years low education	58.7	8.47
		13	Stroop II	gender age education	female 29-31 years low education	54.45	7.74
		11	Stroop II	gender age education	female 34-36 years low education	57.67	10.06
		16	Stroop II	gender age education	female 39-41 years low education	57.2	13.84

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	26	Stroop II	gender age education	female 44-46 years low education	51.7	7.58
		35	Stroop II	gender age education	female 49-51 years low education	56.14	9.19
		48	Stroop II	gender age education	female 54-56 years low education	57.74	8.57
		42	Stroop II	gender age education	female 59-61 years low education	62.5	8.82
		51	Stroop II	gender age education	female 64-66 years low education	61.36	10.11
		45	Stroop II	gender age education	female 69-71 years low education	60.8	8.13
		48	Stroop II	gender age education	female 74-76 years low education	67.9	11.3
		18	Stroop II	gender age education	female 79-81 years low education	71.38	11.82
		40	Stroop II	gender age education	female 24-26 years average education	49.68	8.27
		38	Stroop II	gender age education	female 29-31 years average education	51.17	6.31
		52	Stroop II	gender age education	female 34-36 years average education	48.84	6.84
		48	Stroop II	gender age education	female 39-41 years average education	52.13	8.3
		41	Stroop II	gender age education	female 44-46 years average education	51.53	7.84
		28	Stroop II	gender age education	female 49-51 years average education	52.39	7.23
		22	Stroop II	gender age education	female 54-56 years average education	56.34	7.1
		27	Stroop II	gender age education	female 59-61 years average education	53.89	7.52

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	21	Stroop II	gender age education	female 64-66 years average education	57.08	8.44
		23	Stroop II	gender age education	female 69-71 years average education	56.72	10.01
		26	Stroop II	gender age education	female 74-76 years average education	63.8	8.43
		5	Stroop II	gender age education	female 79-81 years average education	65.71	11.06
		28	Stroop II	gender age education	female 24-26 years high education	49.66	8.72
		24	Stroop II	gender age education	female 29-31 years high education	49.41	9.47
		16	Stroop II	gender age education	female 34-36 years high education	50.86	4.52
		14	Stroop II	gender age education	female 39-41 years high education	44.91	5.62
		17	Stroop II	gender age education	female 44-46 years high education	49.88	6.51
		18	Stroop II	gender age education	female 49-51 years high education	55.69	14.29
		6	Stroop II	gender age education	female 54-56 years high education	48.62	11.04
		7	Stroop II	gender age education	female 59-61 years high education	56.55	7.71
		5	Stroop II	gender age education	female 64-66 years high education	58.41	10.75
		6	Stroop II	gender age education	female 69-71 years high education	54.58	11.8
		6	Stroop II	gender age education	female 74-76 years high education	56.34	9.02
		6	Stroop II	gender age education	female 79-81 years high education	61.96	7.63

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	8	Interference	gender age education	male 24-26 years low education	47.14	8.34
		9	Interference	gender age education	male 29-31 years low education	36.29	8.53
		22	Interference	gender age education	male 34-36 years low education	38.75	12.86
		21	Interference	gender age education	male 39-41 years low education	43.03	16.59
		23	Interference	gender age education	male 44-46 years low education	53.65	18.59
		17	Interference	gender age education	male 49-51 years low education	54.9	19.37
		33	Interference	gender age education	male 54-56 years low education	55.87	28.49
		31	Interference	gender age education	male 59-61 years low education	49.55	17.17
		32	Interference	gender age education	male 64-66 years low education	60.7	25.11
		35	Interference	gender age education	male 69-71 years low education	65.33	28.49
		32	Interference	gender age education	male 74-76 years low education	76.36	22.91
		20	Interference	gender age education	male 79-81 years low education	88.95	29.22
		37	Interference	gender age education	male 24-26 years average education	36.16	11.19
		41	Interference	gender age education	male 29-31 years average education	36.17	10.95
		25	Interference	gender age education	male 34-36 years average education	33.06	9.56
		24	Interference	gender age education	male 39-41 years average education	37.36	10.55

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	32	Interference	gender age education	male 44-46 years average education	38.85	14.94
		43	Interference	gender age education	male 49-51 years average education	39.35	15.94
		27	Interference	gender age education	male 54-56 years average education	45.02	14.58
		38	Interference	gender age education	male 59-61 years average education	43.12	13.5
		29	Interference	gender age education	male 64-66 years average education	46.88	14.03
		34	Interference	gender age education	male 69-71 years average education	52.73	18.94
		27	Interference	gender age education	male 74-76 years average education	60.92	20.06
		4	Interference	gender age education	male 79-81 years average education	74.44	24.52
		33	Interference	gender age education	male 24-26 years high education	29.52	7.52
		29	Interference	gender age education	male 29-31 years high education	36.47	10.097
		31	Interference	gender age education	male 34-36 years high education	33.33	11.56
		32	Interference	gender age education	male 39-41 years high education	37.68	15.3
		23	Interference	gender age education	male 44-46 years high education	38.01	13
		19	Interference	gender age education	male 49-51 years high education	34.04	11.58
		21	Interference	gender age education	male 54-56 years high education	38.77	13.77
		12	Interference	gender age education	male 59-61 years high education	44.35	17.72

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	15	Interference	gender age education	male 64-66 years high education	49.86	13.55
		12	Interference	gender age education	male 69-71 years high education	49.95	12.73
		18	Interference	gender age education	male 74-76 years high education	57.9	19.6
		6	Interference	gender age education	male 79-81 years high education	61.24	17.55
		13	Interference	gender age education	female 24-26 years low education	41.33	15.42
		13	Interference	gender age education	female 29-31 years low education	40.42	14.8
		11	Interference	gender age education	female 34-36 years low education	37.97	10.05
		16	Interference	gender age education	female 39-41 years low education	38.55	16.35
		26	Interference	gender age education	female 44-46 years low education	36.3	10.94
		35	Interference	gender age education	female 49-51 years low education	41.52	10.29
		48	Interference	gender age education	female 54-56 years low education	49.09	14.79
		42	Interference	gender age education	female 59-61 years low education	56.51	18.42
		51	Interference	gender age education	female 64-66 years low education	55.73	18.72
		45	Interference	gender age education	female 69-71 years low education	58.59	18.34
		48	Interference	gender age education	female 74-76 years low education	72.47	26.45
		18	Interference	gender age education	female 79-81 years low education	89.06	29.11

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	40	Interference	gender age education	female 24-26 years average education	30.13	7.43
		38	Interference	gender age education	female 29-31 years average education	31.04	10.42
		52	Interference	gender age education	female 34-36 years average education	33.72	10.64
		48	Interference	gender age education	female 39-41 years average education	33.76	10.95
		41	Interference	gender age education	female 44-46 years average education	37.48	10.73
		28	Interference	gender age education	female 49-51 years average education	35.56	14.34
		22	Interference	gender age education	female 54-56 years average education	46.16	12.22
		27	Interference	gender age education	female 59-61 years average education	41.1	11.19
		21	Interference	gender age education	female 64-66 years average education	47.07	23.1
		23	Interference	gender age education	female 69-71 years average education	55.91	20.89
		26	Interference	gender age education	female 74-76 years average education	58.54	16.41
		5	Interference	gender age education	female 79-81 years average education	70.81	14.78
		28	Interference	gender age education	female 24-26 years high education	31.34	9.82
		24	Interference	gender age education	female 29-31 years high education	29.81	12.95
		16	Interference	gender age education	female 34-36 years high education	35.15	10.29
		14	Interference	gender age education	female 39-41 years high education	28.64	8.56

Table 2.4. Stroop Color Word Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds) MEAN	SD
Elst *et al.* (2006) cont'd	Dutch	17	Interference	gender age education	female 44-46 years high education	29.84	9.6
		18	Interference	gender age education	female 49-51 years high education	38.85	11.53
		6	Interference	gender age education	female 54-56 years high education	35.03	11.81
		7	Interference	gender age education	female 59-61 years high education	37.94	7.35
		5	Interference	gender age education	female 64-66 years high education	40.88	7.85
		6	Interference	gender age education	female 69-71 years high education	47.16	7.68
		6	Interference	gender age education	female 74-76 years high education	58.03	25.88
		6	Interference	gender age education	female 79-81 years high education	69.91	27.93
Karakaş *et al.* (1999)	Turkish	395	Part I	age education	20-54 years 5-8 years	12.13	6.29
			Part II			13.61	7.41
			Part III			17.46	9.6
			Part IV			28.07	13.85
			Part V			40.57	24.24
			Part I	age education	55-74 years 5-8 years	13.51	5.49
			Part II			16.47	6.76
			Part III			24.45	13.36
			Part IV			38.39	18.52
			Part V			47.93	20.82
			Part I	age education	20-54 years 9+ years	8.81	1.76
			Part II			9.43	2.52
			Part III			12.32	2.71
			Part IV			16.95	6.7
			Part V			26.38	12.29
			Part I	age education	55-74 years 9+ years	10.09	3.71
			Part II			11.63	5.41
			Part III			15.93	4.06
			Part IV			24.87	10.94
			Part V			35.96	16.23
Bayard *et al.* (2011)	French	40	Dot	total		17.7	7.57
			Word			23.3	8.37
			Interference			43.9	23.06

In summary:

- Most of the studies including Stroop Color Word Test are performed in Europe to examine age, education and gender effect on the test performance.
- In general, studies are conducted on old people to gather normative data of elderly population. According to the results, there is positive correlation between age and test performance. This means elder people need more time to complete Stroop Color Word Test.
- In Turkey, there is only one study including Stroop Color Word Test of which aim is to develop Turkish version of the test. With this study, scoring method for Turkish standardisation is established and the importance of task five is observed since there is distracted factor in that part. Factor analysis showed that the test scores of each part represents interference and attention.

2.2.4. Reaction Time Test

Reaction is a purposeful voluntary response to stimulus. Reaction time is a period between application of stimulus and motor response which gives information how fast and quickly person responses after stimulus (Ritesh and Tejas, 2012). The measurement of reaction time is used to assess the processing speed of Central Nervous System and the co-ordination between the sensory and motor systems (Ritesh and Tejas, 2012).

Since the nineteenth century, reaction time has been used in the study of psychology in order to measure performance of motor function. Reaction Time Test measures hand reaction speed which is seen by some as a fundamental factor in the age-related decline in various cognitive and motor functions (Nissan *et al.*, 2013).

Today there are two types of reaction time which are simple reaction and choice reaction. In simple reaction time, there is only one stimulus. Response variable is time average of five trials for simple reaction. On the other hand, there are multiple stimuli and multiple responses. Response variables are time average and correct answers (Nissan *et al.*, 2013).

In Table 2.5, the results of Simple and Choice Reaction Time tests for different populations are listed. The independent variables, sample information, sample size and result variables are given as well.

In a normative study for the population of Scotland, both simple and choice reaction time tests with number and light boxes have been applied to 150 people from different age groups. Three age groups have been determined to examine effect of age on the test performance (Nissan *et al.*, 2013). The results show that age has significant effect on the reaction time tests apart from light task choice reaction time. From the results, it can easily be seen that younger people is faster and less variable.

Table 2.5. Reaction Time Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (ms) mean	S.D
Nissan *et al.* (2013)	Scottish	50	Simple Reaction Time (LS)	age	18-25 years	230.8	42.3
			Choice Reaction Time (LC)			334.7	52.9
			Simple Reaction Time (NS)			230.2	40.8
			Choice Reaction Time (NC)			459.4	80.8
		50	LS		45-60 years	276.2	58.1
			LC			432.9	75.4
			NS			269.1	54
			NC			581.2	115.5
		50	LS		61-80 years	270.7	55.4
			LC			470.1	93.1
			NS			267.7	54.2
			NC			626.8	128.2
Van Dyck *et al.* (2008)	American (USA)	36	simple reaction time	age education	68-88 years 9-20 years	217.3	34
Cinaz *et al.* (2012)	German	20	simple reaction time - wearable reaction time test (one handed)	age	mean: 24.3 years	321.4	25.7
			simple reaction time - wearable reaction time test (two handed)			274	27.6
			simple reaction time- computer based reaction time test (one handed)			355.2	20.7
			simple reaction time- computer based reaction time test (two handed)			343.5	23.5

Table 2.5. Reaction Time Test studies in the literature (cont.)

SOURCE	**POPULATION**	**SAMPLE SIZE**	**TEST TYPE**	**INDEPENDENT VARIABLES**		**RESULTS (ms)**	
						mean	**S.D**
Ritesh and Tejas (2012)	Indıan	50	Simple reaction time	gender	male	165.9	26.8
			Choice reaction time			308.6	74.9
Padilla-Medina *et al.* (2013)	Mexican	28	Simple reaction time	age	mean:11.57 years sd: 2.71	662	20.7
			Choice reaction time			329.3	242.3
			Simple reaction time		mean: 11.64 years sd:2.82	535.2	6.86
			Choice reaction time			242.3	562.1
Gentier *et al.* (2013)	Belgian	19	Simple reaction time	age	6-12 years	460.69	49.87
			Choice reaction time			560.48	66.56
Jakobsen *et al.* (2010)	Danish	130	Simple reaction time	gender	50 males. 80 females	242	31
			Choice reaction time	age	19-68 years	481	56
		70	Simple reaction time	gender	32 males. 38 females	301	55
			Choice reaction time	age	19-68 years	620	89
Anstey *et al.* (2007)	Australian	432	Simple reaction time	gender	209 female. 223 male	250	50
			Choice reaction time	age	mean: 62.13 years	320	40
		57	Simple reaction time	gender	19 female. 38 male	290	90
			Choice reaction time	age	mean: 62.53 years	340	70
Howley *et al.* (2012)	Irish	26	Simple reaction time	gender	14 male. 12 female	222.7	6.05
				age	mean:11.85 years		
		31	Simple reaction time	gender	15 male. 16 female	235.9	16.50
				age	mean: 11.26 years		

In Germany, simple and choice reaction time tests are applied to 20 subjects to obtain normative data. Both computerized version and wearable version of the tests have been applied to the subjects (Cinaz *et al.*, 2012). The reason behind using wearable version is that it can be operated throughout everyday life unlike computer based test. The independent variables are the number of hands used in the test and test type. Significantly faster reaction times are observed for both wearable version. The fastest reaction time has been obtained from the wearable design under two-handed condition.

In India, there is a comparative study of simple and choice reaction time on 50 male students. The results indicate that for young Indian male subjects' simple reaction time is shorter than choice reaction time (Ritesh and Tejas, 2012).

According to a study results from Mexico, diabetes patients' reaction time is longer than non-diabetes participants (Padilla-Medina *et al.*, 2013). Both simple and choice reaction time tests have been applied to 14 healthy and 14 diabetes patients with mean-aged 11. Both diabetes and non-diabetes subjects have shorter reaction time but high standard deviation for choice reaction time.

Another study from Belgium examined weight status effect on controlling functions and movement execution to determine whether or not childhood obesity is relevant to impaired perceptual-motor function (Gentier *et al.*, 2013). Simple and choice reaction time tests have been applied to 19 obese children (9 girl, 10 boy) and 19 healthy children (9 girl, 10 boy). It is observed that healthy weighted children achieved shorter reaction time for the both simple and choice reaction time test. From the results, it can be said that obesity has negative effect on reaction time which means motor functions. For both groups, choice reaction time is longer than simple reaction time.

There are many studies examine effect of health problems on motor functions. One of them is from Denmark investigating the effect of malnutrition which is a common problem in hospitalized patients and causes decreased cognitive function and impaired quality of life (Jakobsen *et al.*, 2011). 130 healthy subjects and 70 patients have been assessed for simple and choice reaction time tests and cognitive function. Results indicate that simple reaction time is shorter than choice reaction time for both healthy and patient subjects. Simple reaction time and choice reaction time test are associated with cognitive function in healthy subjects and patients.

Another study from Australia analyzes the effect of health problems on motor function. Study hypothesizes that both faster mean reaction time and less intra-individual variability would be associated with larger corpus callosum size in older adults, and that these associations would be stronger in adults with mild cognitive disorders (Anstey *et al.*, 2007). Results show that associations between the reaction time measures and corpus callosum size were much larger in the sample with mild cognitive disorders. In addition, that, reaction time for healthy subjects is shorter than mild cognitive disorders paints. For both subject groups, simple reaction time is shorter than choice reaction time.

Deletion Syndrome is an ordinary micro deletion disorder related to mild to moderate mental disability and specific neurocognitive deficits, especially in visual-motor and attentional abilities (Howley *et al.*, 2012). In a study for Ireland children population, relationship between reaction time and this disorder has been investigated. Simple reaction time has been applied to 26 healthy subjects and 31 patients. Results show that subjects with genetic disorder has longer reaction time.

In summary:

- Most of the studies in Europe, Asia and USA have been performed to examine age and health condition effect on the Reaction Time. Most of them used two versions of the test to measure simple and choice reaction times.
- In general, studies are conducted to different age groups. According to the results, there is positive correlation between age and Reaction Time test results. That is, younger people are faster.
- The studies which examine health effect on test performance show that health problems have negative effect on motor functions.
- Although, there are a few studies including Reaction Time Test in Turkey, none of them is comphrensive to indicate normative data of the population of Turkey. Most of them conducted Reaction Time test to children. One study contains 36 male Turkish wrestlers to compare reaction time abilities of greco-roman and freestyle national team wrestlers (Koç and Aydos, 2018). Results show that there is no significant effect of wrestling style on reaction time performance.

2.2.5. Purdue Pegboard Test

Purdue Pegboard Test is a neuropsychological test measuring two different abilities which are gross movements of fingers, hands and arms and fine motor extremity (Tiffin and Asher, 1948). First version of Purdue Pegboard test has been developed by Joseph Tiffin in 1948. Purdue Pegboard test is used for selection of employees, physical therapy, occupational therapy and injury rehabilitation (Tiffin and Asher, 1948).

There are five scores of the test which are dominant hand, non-dominant hand, both hands, sum of dominant, non-dominant and both hands and assembly. Subjects should do the test in progressive order (Tiffin and Asher, 1948). Response variables are number of pins for the all parts of the test (Tiffin and Asher, 1948).

In Table 2.6, a summary literature review of Purdue Pegboard Test is provided.

In the US, Purdue Pegboard Test is applied to present normative data of the elder Japanese American. Effects of age, gender, and primary spoken language are also investigated (Mccurry *et al.*, 2001). Results of this study have been compared to the previous studies. They have indicated that there are limited studies for older adults due to difficulties of conducting tests to adults. That’s why they chose older adults as a target sample. Sample has been determined as age 65 or older who were at least %50 Japanese heritage. 453 subjects have attended the research. After clinical assessments, 384 non-demented subjects aged 70 years or older have participated in research. Neuropsychological testing has assessed effect of age and dementia on memory, attention, motor function and speed. The results indicate that age and education have significant effect on motor function ability and speed. In addition to age and education, gender effect can be considered when evaluating score of Japanese Americans. Female subjects are better than male. There is a negative correlation between age and results.

Table 2.6. Purdue Pegboard Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS mean	S.D
Hamm and Curtis (1980)	American (USA)	340	Right Hand	age gender	age <35 years males	13.59	1.25
			Left Hand			13.18	3.84
			Both Hand			21.62	3.86
			Assembly			27.86	11.12
			Right Hand	age gender	age <35 years females	15.18	2.41
			Left Hand			14.49	2.13
			Both Hand			24.48	3.66
			Assembly			36.19	6.99
			Right Hand	age gender	age >=35 years males	12.96	1.81
			Left Hand			11.09	3.02
			Both Hand			20.46	3.4
			Assembly			28.31	3.97
			Right Hand	age gender	age >=35 years females	14.08	2.22
			Left Hand			15.14	4.19
			Both Hand			22.66	3.2
			Assembly			31.76	4.84
Tiffin and Asher (1948)	American (USA)	7814	Right Hand	work type gender	College Men	16.43	1.8
			Left Hand			15.91	1.77
			Both Hand			26.66	1.5
			Assembly			37.52	5.71
			Right Hand	work type gender	College Women	17.76	1.98
			Left Hand			16.48	1.66
			Both Hand			27.86	1.55
			Assembly			39.08	5.44
			Right Hand	work type gender	Veterans Men	16.75	1.92
			Left Hand			15.98	1.99
			Both Hand			26.54	1.69
			Assembly			36.72	5.84
			Right Hand	work type gender	Industrial Applicants Men	15.87	2.09
			Left Hand			15.16	1.98
			Both Hand			25.16	1.79
			Assembly			33.07	6.25
			Right Hand	work type gender	Industrial Applicants Women	17.7	1.83
			Left Hand			15.98	1.99
			Both Hand			28.3	1.55
			Assembly			36.68	6.76

Table 2.6. Purdue Pegboard Test studies in the literature (cont.)

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS mean	S.D
Garner and Broman (1979)	American (USA)	663 (male)	Right Hand	age	5.0-5.5 years	9.33	1.81
			Left Hand			8.4	1.33
			Both Hand			12.46	2.34
			Assembly			14.1	3.29
			Right Hand		5.6-5.11 years	9.93	1.51
			Left Hand			8.83	1.95
			Both Hand			12.94	3.08
			Assembly			15.57	3.56
			Right Hand		6.0-6.5 years	9.77	1.57
			Left Hand			9.13	1.83
			Both Hand			14.6	3.06
			Assembly			15.93	2.94
			Right Hand		6.5-6.11 years	11.57	1.45
			Left Hand			10.17	2.17
			Both Hand			16.46	3.54
			Assembly			19.2	3.84
			Right Hand		7.0-7.5 years	11.67	1.67
			Left Hand			11	1.7
			Both Hand			17.54	2.82
			Assembly			19.23	4.95
			Right Hand		7.6-7.11 years	12.07	1.95
			Left Hand			11.23	1.68
			Both Hand			19.14	3.18
			Assembly			20.4	4.1
			Right Hand		8.0-8.5 years	12.7	1.6
			Left Hand			12.17	1.51
			Both Hand			19.66	3.02
			Assembly			23.2	3.8
			Right Hand		8.6-8.11 years	13.9	2.19
			Left Hand			12.57	1.85
			Both Hand			21.8	3.46
			Assembly			24.47	5.35
			Right Hand		9.0-9.5 years	13.33	1.6
			Left Hand			12.43	1.59
			Both Hand			21	2.96
			Assembly			24.57	3.75
			Right Hand		9.6-9.11 years	13.87	1.91
			Left Hand			12.87	2.05
			Both Hand			22.66	3.3
			Assembly			27.37	4.55

Table 2.6. Purdue Pegboard Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS	
						mean	S.D
Garner and Broman (1979) (cont.)	American (USA)	663 (male)	Right Hand	age	10.0-10.5 years	14.03	1.88
			Left Hand			12.87	1.72
			Both Hand			21.86	3.68
			Assembly			26.37	6.15
			Right Hand		10.6-10.11 years	14.73	1.51
			Left Hand			13.9	1.84
			Both Hand			23.54	3.3
			Assembly			28.17	5.38
			Right Hand		11.0-11.5 years	14.93	1.86
			Left Hand			14	1.98
			Both Hand			22.6	3.36
			Assembly			29.53	6.19
			Right Hand		11.6-11.11 years	14.83	1.6
			Left Hand			13.93	1.6
			Both Hand			24.54	2.82
			Assembly			31.33	5.19
			Right Hand		12.0-12.5 years	14.83	1.78
			Left Hand			13.67	2.02
			Both Hand			23.34	3.04
			Assembly			31.13	5.78
			Right Hand		12.6-12.11 years	15.37	2.81
			Left Hand			14	2.38
			Both Hand			23.74	3.74
			Assembly			30.13	6.08
			Right Hand		13.0-13.5 years	15.15	1.92
			Left Hand			13.9	2
			Both Hand			23.7	3.16
			Assembly			33.73	5
			Right Hand		13.6-13.11 years	14.87	1.72
			Left Hand			14.1	1.47
			Both Hand			23.06	3.6
			Assembly			34.57	5.88
			Right Hand		14.0-14.5 years	15.67	1.47
			Left Hand			14.4	1.57
			Both Hand			24.06	3.34
			Assembly			33.97	6.58
			Right Hand		14.6-14.11 years	14.7	1.49
			Left Hand			14.33	1.65
			Both Hand			24.4	3.22
			Assembly			31.37	7.24

Table 2.6. Purdue Pegboard Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS mean	S.D
Garner and Broman (1979) (cont.)	American (USA)	663 (male)	Right Hand	age	15.0-15.5 years	15.57	1.59
			Left Hand			14.87	1.5
			Both Hand			25.14	2.96
			Assembly			32.2	6.21
			Right Hand		15.6-15.11 years	15.09	1.5
			Left Hand			14.3	1.61
			Both Hand			25.03	2.6
			Assembly			33.04	6.24
		671 (female)	Right Hand		5.0-5.5 years	10	1.53
			Left Hand			8.5	1.36
			Both Hand			13.94	2.5
			Assembly			14.7	2.55
			Right Hand		5.6-5.11 years	9.3	1.73
			Left Hand			9.13	1.59
			Both Hand			13.54	2.56
			Assembly			14.37	4.02
			Right Hand		6.0-6.5 years	11.43	1.33
			Left Hand			10.23	1.52
			Both Hand			17.06	2.92
			Assembly			18.03	3.54
			Right Hand		6.5-6.11 years	11.87	1.68
			Left Hand			10.47	1.38
			Both Hand			17.34	3.58
			Assembly			20.63	4.27
			Right Hand		7.0-7.5 years	12.03	1.65
			Left Hand			10.47	2.08
			Both Hand			17.66	3.6
			Assembly			19.77	4.49
			Right Hand		7.6-7.11 years	12.47	1.53
			Left Hand			11.5	1.8
			Both Hand			19	3.4
			Assembly			20.2	4.61
			Right Hand		8.0-8.5 years	13.07	1.78
			Left Hand			12.03	1.4
			Both Hand			20.2	3.62
			Assembly			21.93	4.31
			Right Hand		8.6-8.11 years	13.77	1.63
			Left Hand			12.3	1.26
			Both Hand			20.86	3.18
			Assembly			24.5	5.83

Table 2.6. Purdue Pegboard Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS	
						mean	S.D
Garner and Broman (1979) (cont.)	American (USA)	671 (female)	Right Hand	age	9.0-9.5 years	13.37	1.79
			Left Hand			11.83	2.12
			Both Hand			19.66	3.24
			Assembly			24.97	6.81
			Right Hand		9.6-9.11 years	14.4	1.52
			Left Hand			13.03	1.67
			Both Hand			23.2	3.3
			Assembly			29.07	6.01
			Right Hand		10.0-10.5 years	15.13	1.48
			Left Hand			13.2	1.35
			Both Hand			22.66	2.84
			Assembly			27.9	5.1
			Right Hand		10.6-10.11 years	15.47	1.59
			Left Hand			13.63	1.33
			Both Hand			24.54	2.92
			Assembly			31.7	6.02
			Right Hand		11.0-11.5 years	14.9	1.79
			Left Hand			14	2
			Both Hand			23.34	3.26
			Assembly			32.77	5.5
			Right Hand		11.6-11.11 years	15.7	1.84
			Left Hand			13.83	1.88
			Both Hand			24	3.64
			Assembly			33.47	7.24
			Right Hand		12.0-12.5 years	15.57	1.65
			Left Hand			14.2	1.73
			Both Hand			24	2.46
			Assembly			34.57	5.2
			Right Hand		12.6-12.11 years	15.4	1.96
			Left Hand			14.07	1.66
			Both Hand			24.06	3.3
			Assembly			34.7	7.52
			Right Hand		13.0-13.5 years	15.55	1.69
			Left Hand			14.15	1.64
			Both Hand			24.06	2.88
			Assembly			34.85	5.57
			Right Hand		13.6-13.11 years	15.38	1.58
			Left Hand			14.09	1.44
			Both Hand			24.26	2.62
			Assembly			37.4	5.34

Table 2.6. Purdue Pegboard Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS	
						mean	S.D
Garner and Broman (1979) (cont.)	American (USA)	671 (female)	Right Hand	age	14.0-14.5 years	16.33	1.73
			Left Hand			14.93	1.78
			Both Hand			25.26	3.22
			Assembly			36.43	6.76
			Right Hand		14.6-14.11 years	16.03	1.77
			Left Hand			14.83	1.66
			Both Hand			24.8	3.88
			Assembly			34.17	6.62
			Right Hand		15.0-15.5 years	16.68	1.49
			Left Hand			14.89	1.4
			Both Hand			25.78	3.28
			Assembly			36.89	7.75
			Right Hand		15.6-15.11 years	16.42	1.84
			Left Hand			15.29	2.04
			Both Hand			25.54	2.9
			Assembly			37.35	8.24
Mccurry *et al.* (2001)	Japanese - America	384	Right Hand	age	70-79 years	13.7	2
			Left Hand			12.7	2.3
			Right Hand		80+ years	12.5	2.3
			Left Hand			11.3	1.9

The first version of Purdue Pegboard Test was developed by Tiffin in 1948 (Tiffin and Asher, 1948). Tiffin and Asher's study contains normative data for population of the US as well. According to them., the Purdue Pegboard Test was widely used for employee selection in industrial jobs such as packing, assembly and operation etc. to assess finger dexterity. In this study, sample has been divided into five groups as college men, college women, veterans (men), industrial applicants (men) and industrial applicants (women). Sample size was 7814. The results show that there is no significant difference between the mean scores of college men and the mean scores of veterans. There is no significant difference between industrial women and college women. It can easily be seen from the results that women are better than men. So, gender has an effect on the motor function and finger dexterity.

Purdue Pegboard test is used to provide normative data of 1334 school children (663 girls, 671 boys) aged between 5 and 15 in the US (Gardner and Broman, 1979). The results indicate that girls are better than boys. They indicated that gender has an effect on gross movements of fingers, hands and arms and fine motor extremity.

A research in the US has covered 340 male and female candidates aged from 16 to 58 for vocational rehabilitation (Hamm and Curtis, 1980). Age and gender effect on results have been investigated. According to the scores, female participants are better than male participants. Participants younger than 35 years old are better than older. They stated that there is a negative relationship between age and score. In addition, gender has an effect on results.

In summary:

- Most of the studies with Purdue Pegboard Test are performed in US to examine age, education and gender effect on the test performance.
- In general, studies are conducted with different age groups. However, there are limited studies for older adults since it is hard to apply the test. According to the results, there is negative correlation between age and Purdue Pegboard test results.
- The studies also examine gender effect on the test performance that shows female participants are better than males.
- There is no Purdue Pegboard Test study in Turkey.

2.2.6. Raven Standard Progressive Matrices

Raven’s Progressive Matrices Test is known as the best, most popular and widely used intelligence test of all time (Raven *et al.*, 2005). It measures fluid intelligence like reasoning and problem-solving abilities. There are number of reasons for this. The Raven Matrices Test is easy to conduct both as an individual and group test. The test can be applied to a wide age range as well. Another advantage of this test is being non-verbal; therefore, can be conducted in diverse language and cultures and in different settings as schools, organizations etc. (Raven, 2000).

Raven's Matrices is used widely for design and decision making. Raven's matrices test examines the possible effects of human cognitive capacity and its relationship to time constraints (Raven, 2000).

The Standard Progressive Matrices includes 5 sets of 12 matrices, sequentially increasing in difficulty (Raven *et al.*, 2005). This test includes 60 questions and it is scored after 40 minutes. In Table 2.7, the results of Raven Progressive Matrices for different populations are listed. The independent variables, sample information, sample size and result variables are given as well. The short version of Raven Test includes fewer questions.

In England, a study performed to obtain normative data of 17/18 aged girls and boys (Mackintosh and Bennett, 2005). The study mentioned that a study of South African university students found a small but statistically significant male advantage in Raven Progressive Matrices score which is 90.9 correct percentages for boys and 89.2 correct percentages for girls. The aim of this study was to investigate gender effect on score for population of England (Mackintosh and Bennett, 2005). The short version of Raven Progressive Matrices containing 36 questions were applied to 34 male and 95 female English sixth-form students, aged 16–17. The results for English students indicate that males perform better than female participants same as South African university students.

In a study in Romania, The Raven's Standard Progressive Matrices has been conducted on 2755 people aged 6 to 80 years (1,240 were aged between 6 and 17 and 1,535 aged between 18 and 80) to provide normative data for the population of Romania. (Dobrean *et al.*, 2005). The sample has been chosen from all demographic regions of the country to present a valid data for all stratums. The study indicated that norms for Romanian are below from other countries but the retest which assessed one month later for reliability is similar to other countries.

Table 2.7. Raven Test studies in the literature

SOURCE	POPULATION	SAMPLE SIZE	INDEPENDENT VARIABLES		RESPONSE VARIABLE (number of correct answers) mean	S.D
Bass (2000)	African	379	age	Mean: 6.5 years	12	1.41
				Mean: 7 years	13	1.44
				Mean: 7.5 years	13.3	2.5
				Mean: 8 years	14.6	3.15
				Mean: 8.5 years	17.4	6.55
				Mean: 9 years	14.7	3.1
				Mean: 9.5 years	15.1	5.41
				Mean: 10 years	16.8	5.52
				Mean: 10.5 years	19.8	5.13
				Mean: 11 years	20	5.84
				Mean: 11.5 years	22.1	5.73
				Mean: 12 years	20.9	5.27
				Mean: 12.5 years	22.1	7.47
				Mean: 13 years	23.8	7.09
				Mean: 13.5 years	22.1	7.47
				Mean: 14 years	23.7	5.26
				Mean: 14.6 years	22.7	5.28
				Mean: 15 years	24	5.98
				Mean: 15.5 years	23.9	5.47
				Mean: 16 years	23.8	6.87
				Mean: 16.5 years	23.8	5.75
				Mean: 17 years	21.4	6.39
				Mean: 17.5 years	25	9.9
Raven (2000)	USA	2924	age	Mean: 12.5 years	42	
				Mean: 12.5 years	41	
				Mean: 12.5 years	42	
				Mean: 12.5 years	37	
				Mean: 12.5 years	36	
				Mean: 13 years	43	
				Mean: 13 years	42	
				Mean: 13 years	43	
				Mean: 13 years	38	
				Mean: 13 years	36	
				Mean: 13.5 years	44	
				Mean: 13.5 years	43	
				Mean: 13.5 years	43	
				Mean: 13.5 years	39	
				Mean: 13.5 years	37	
				Mean: 14 years	45	
				Mean: 14 years	44	
				Mean: 14 years	43	
				Mean: 14 years	40	
				Mean: 14 years	38	
				Mean: 14.5 years	46	
				Mean: 14.5 years	47	
				Mean: 14.5 years	44	

Table 2.7. Raven Standard Progressive Matrices Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	INDEPENDENT VARIABLES		RESPONSE VARIABLE (number of correct answers) mean	S.D
Raven (2000) (cont.)	USA	2924	age	Mean: 14.5 years	41	
				Mean: 14.5 years	39	
				Mean: 15 years	47	
				Mean: 15 years	48	
				Mean: 15 years	45	
				Mean: 15 years	42	
				Mean: 15 years	40	
				Mean: 15.5 years	47	
				Mean: 15.5 years	48	
				Mean: 15.5 years	46	
				Mean: 15.5 years	43	
				Mean: 15.5 years	41	
				Mean: 16 years	-	
				Mean: 16 years	48	
				Mean: 16 years	47	
				Mean: 16 years	44	
				Mean: 16 years	43	
				Mean: 16.5 years	-	
				Mean: 16.5 years	49	
				Mean: 16.5 years	48	
				Mean: 16.5 years	45	
				Mean: 16.5 years	44	
Dobrean *et al.* (2005)	Romanian	2755	age	Mean: 6.5 years	15	
				Mean: 7 years	16	
				Mean: 7.5 years	18	
				Mean: 8 years	20	
				Mean: 8.5 years	22	
				Mean: 9 years	23	
				Mean: 9.5 years	24	
				Mean: 10 years	24	
				Mean: 10.5 years	25	
				Mean: 11 years	25	
				Mean: 11.5 years	26	
				Mean: 12 years	27	
				Mean: 12.5 years	28	
				Mean: 13 years	29	
				Mean: 13.5 years	30	
				Mean: 14 years	31	
				Mean: 14.5 years	31	
				Mean: 15 years	32	
				Mean: 15.5 years	32	
				Mean: 16 years	33	
				Mean: 16.5 years	33	
				Mean: 17 years	34	
				Mean: 17.5 years	34	
				Mean: 18 years	35	
				Mean: 18.5 years	36	
				Mean: 20 years	37	
				Mean: 25 years	36	
				Mean: 30 years	34	
				Mean: 35 years	32	
				Mean: 40 years	31	
				Mean: 45 years	30	
				Mean: 50 years	28	
				Mean: 55 years	27	
				Mean: 60 years	25	
				Mean: 65 years	24	
				Mean: 70 years	22	
				Mean: 73+ years	19	

Table 2.7. Raven Standard Progressive Matrices Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	INDEPENDENT VARIABLES		RESPONSE VARIABLE (number of correct answers) mean	S.D
Norms for Fort Bend (1999)	American (USA)	244	age	Mean: 6.5 years	18	
				Mean: 8 years	25	
				Mean: 12 years	33	
				Mean: 15 years	37	
				Mean: 17 years	39	
Norms for Poland (2000)	Polish	977	age	Mean: 15 years	39	
				Mean: 17 years	41	
				Mean: 18 years	42	
				Mean: 25 years	39	
Mackintosh and Bennett (2005)	English	97	gender age	Male 17- 18 years	25.21	5.97
			gender age	Female 17- 18 years	22.94	4.31
Bass (2000)	African	380	age	6-12 yeras	14.3	3.59
				7-13 years	18.2	5.57
				8-17 years	18.4	5.62
				9-16 years	20.7	4.9
				10-20 years	22.8	5.38
				11-17 years	25.9	5.87
Raven (2000)	English	3464	age	Mean: 6.5 years	16	
				Mean: 7 years	19	
				Mean: 7.5 years	22	
				Mean: 8 years	25	
				Mean: 8.5 years	31	
				Mean: 9 years	33	
				Mean: 9.5 years	36	
				Mean: 10 years	38	
				Mean: 10.5 years	39	
				Mean: 11 years	40	
				Mean: 11.5 years	41	
				Mean: 12 years	41	
				Mean: 12.5 years	42	
				Mean: 13 years	43	
				Mean: 13.5 years	44	
				Mean: 14 years	45	
				Mean: 14.5 years	46	
				Mean: 15 years	47	
				Mean: 15.5 years	47	

The Raven's Colored Progressive Matrices non-verbal intelligence test designed for children aged from 5.5 to 18 is widely used in South Africa (Bass, 2000). The aim of this research was to provide normative data for African primary school children. 182 female and 197 male of Xhosa speaking children in grades two to seven have done the test. It can easily be seen from the results that age has significant effect on the score. The study showed that males are performing significantly better than female subjects and there is no important effect of education on the score.

The study of John Raven in 2000 has summarized norms of different cultural, ethnic, and socioeconomic groups (Raven, 2000). According to John Raven, the test assesses two different abilities which are educative ability and reproductive ability. This study has presented normative data for British children aged from 6.5 to 15.5. Also, this study has showed normative data of children for ethnic groups in US aged between 12.5 and 16.5.

There is also a normative data study for population of Poland with 977 participants aged between 15 and 55 (Dobrean *et al.*, 2005). The results have been compared to other norms from Fort Bend (USA) with 244 participants. The results showed that Poland's norms are better than Fort Bend's norms.

There is also another study to examine mental ability of 608 adults aged between 17 to 65 years from four communities (Novi Pazar Christians, Novi Pazar Muslims, Tutin Muslims, Belgrade Christians) in Serbia. Results showed that there is not significant difference between communities or males and females (Rushton and Cvorovic, 2009).

In Turkey, Raven Progressive Matrices has been conducted on Turkish children (Sahin and Duzen, 1994). In this study, sample has been chosen from 15 different primary schools in Ankara. Sample size was 2458 (1170 girls, 1288 boys) aged between 6.5 to 15. Data has been collected between the dates 1992 and 1993. The norms obtained from study have been compared to 1979 British norms. It was seen from the mean scores with the same age, British norms are higher than Turkish norms. Age could be seen as main factor but education level of parents, rural background, and income have been examined as well. Multiple regression techniques were used to assess relative importance of each independent variable. The results showed that despite the fact that the differences between life in rural and urban areas have a significant effect on test scores, it is not as powerful as mother's education level's effect. Significant gender effect is not observed.

In summary:

- Most of the studies including Raven Test are performed in Europe, US and South Africa to examine gender and age effect on the test performance which is used to measure problem solving and intellectual functions.
- In general, studies are conducted on different age groups especially to children between the ranges of 6-16. Results are compared to another populations' norms as well.
- The studies also examine gender effect on the test performance, which show male subjects are better than female.
- There are a study includes Raven test in Turkey and it applied this test to children. The results showed that British norms are higher than Turkish norms.

2.3. Critics of findings

2.3.1. Digit Span Test

In Turkey, there is a study with Digit Span Test to investigate age and education effect on test performance by applying test to 1856 participants from different ages (Karakaş *et al.*, 2002). Due to large sample size, it is an important study to provide normative data for the population of Turkey. On the other hand, this study includes only one neuropsychological test which is Digit Span that can only assess short-term memory ability.

There are other studies from countries like China, Japan and Hong Kong to provide normative data. The aim of these studies is to provide normative data for Digit Span Test by examining factor effects such as age, education and gender. The common lack of these studies is to include only Digit Span Test.

In general, the studies include Digit Span Test show that age and education factors have significant effect on test performance. While age and test performance negatively correlated, education and performance have positive relationship. On the other hand, gender effect is changed from nation to nation. For example, gender effect is not observed for the population of Dutch (Kessels, et al., 2008) . On the other hand, women in Portuguese, men in Australia have better performance.

2.3.2. Corsi Span Test

Study to provide normative data for Corsi Span Test is limited. In Europe, there are some studies to assess location memory by applying Corsi Span Test due to its easy and short administration method (Kessels *et al.*, 2008). In these studies, effects of age, gender and education level on Corsi Span test performance are examined. On the other hand, normative data is limited for other populations. There is not a study with Corsi Span Test in Turkey.

All studies involving Corsi Span in literature agree that there is negative relationship between age and performance. On the other hand, while the two studies on the Dutch population showed no gender effect, it was observed that the performance of men is better in Italy.

2.3.3. Reaction Time Tesrt

Gender effect has not been assessed for reaction time in previous studies. There are normative studies for population of Scotland, Germany, India, Mexico, Belgium, Australia and Ireland which especially investigate age effect on reaction time. In addition to normative studies, there are many studies which compare healthy people and unhealthy records such as diabetes/non-diabetes, obese/healthy weight. Most of them have certain limitations. The sample size is relatively small and does not cover all population just small part of it. Education effect on score is not examined. When we look for normative data in literature for population of Turkey, any comprehensive study presenting norms are not found for Turkish people.

In general, previous studies for reaction time have focused on age effect and all of them agreed on negative effect of age on test performance that means younger people are faster. In addition to age effect, most of studies in literature examine health problems' effect on test performance. Results of the studies show that health problems have negative effect on motor functions.

2.3.4. Raven Standard Progressive Matrices

There are normative studies for the Raven Progressive Matrices examining age, gender, and culture and education effect on score in different countries. Sample size is big enough to assess gender effect as well and sample covers different age groups. Since genetic has an effect on intelligence, education level of parents could be seen as independent variables. Most of these researches present norms for only Raven Progressive Matrices, so correlation between Raven and other neuropsychological tests were not assessed. There are limited studies for population of Turkey. Sample covers only schoolchildren such as aged from 6 to 15 or with attention deficit hyperactivity disorder aged between 6 and 10 to assess relationship between mathematic skills and intelligence. There is no extensive study which submits normative data for all age groups of Turkish people.

Gender effect has been observed in most of the studies including Raven Test in literature. For example, the studies for the population of England and South America students show that male students are better. Results also show that test performance may change according to nationality. According to previous studies, British children have better performance than Turkish, American have better performance than the population of Serbia.

2.3.5. Purdue Pegboard Test

Unlike Europe, there are more studies to provide norms of Purdue Pegboard Test for American population. There are limited studies in Turkey. One of them is conducted to assess the correlation between manual skill of the Turkish nursing students and their class ranks. There is no comprehensive study presenting normative data which covers all stratum of Turkish population.

The studies in literature agree that there is gender effect on the Purdue Pegboard performance that female participants are better than men. In addition to gender effect, there is significant negative effect of age on test performance.

2.3.6. Stroop Color Word Test

In the literature, there are studies including Stroop Color and Word Test to provide normative data for Spanish, French, Dutch, American, Chinese population. Stroop Color and Word Test is widely used to assess selective attention, information processing speed and cognitive flexibility (Lee *et al.*, 2002). Some of the studies only contain Stroop Color and Word Test to assess selective attention, information processing speed and cognitive flexibility, but some of them contain more than one neuropsychological test to assess general overview of cognitive abilities of participants.

In Turkey, there is a standardization study to develop a version of Stroop Test for Turkish people (Karakaş *et al.*, 1999). This study only focuses on Stroop Color and Word Test, so correlation between Stroop performance and another neuropsychological test performance were not examined.

According to result of Stroop Color Test studies, age and education are the important factors on test performance. Positive effect of education on test performance have been observed in all studied in literature. Age effect is seen as older people has longer completion time.

In summary, main findings can be found below:

- In most of the studies, only one or two tests have been applied to gather normative data for one or two cognitive abilities. There is not any comprehensive study that measures cognitive ability by using six different tests.
- In most of the studies, results do not cover all population since sample size is not big enough or not respresentative of the considered population.
- Age, education and gender are the most investigated factors in the literature.

International studies;

- In the reviewed literature, normative data has been formed for some of the populations of Europe, USA and Asia. However, there are limited studies for Purdue Pegboard Test in Europe. Most of the studies in literature are done to provide norms of USA.

Turkish studies;

- In the literature, there is not any comprehensive study in Turkey that examines attention, short term memory, intellectual function, speed and motor functions in parallel.

For the population of Turkey, there is not any comprehensive study which assesses cognitive and motor capability with respect to memory, attention, intellectual function, speed and motor functions.

3. RATIONALE AND OBJETIVE OF THE STUDY

3.1. Rationale of the Study

The data of cognitive and physical abilities of people are necessary in order to design products and user-technology interactions. A number of developed countries have already established such normative data for their populations. Considering the differences among populations, it is a need to develop similar norms for the population of Turkey. Currently, there are a few studies available; however, they are not enough to establish a normative data of population of Turkey.

In this study, six different tests have been conducted to investigate the cognitive capability of male population of Turkey in four different areas. Therefore, this study would be an important reference for other studies and designs in the future.

3.2. Objective of the Study

Based on the rationale, the present study aims the following:

i. Estimating the cognitive and motor capabilities of adult male population of Turkey in four main areas, by using six neuropsychological tests. These four main areas are; Attention, concentration and speed; memory and learning; intellectual function; motor function.

ii. Investigating the effects of age, education, income, marital status and smoking on test results.

iii. Comparing the results of the male population of Turkey with the results of other countries.

iv. Investigating the correlations amoung the considered neuropsychological tests results

4. METHODOLOGY

This chapter covers the applied methods to fulfill specified objectives. The steps are shown in Figure 4.1.

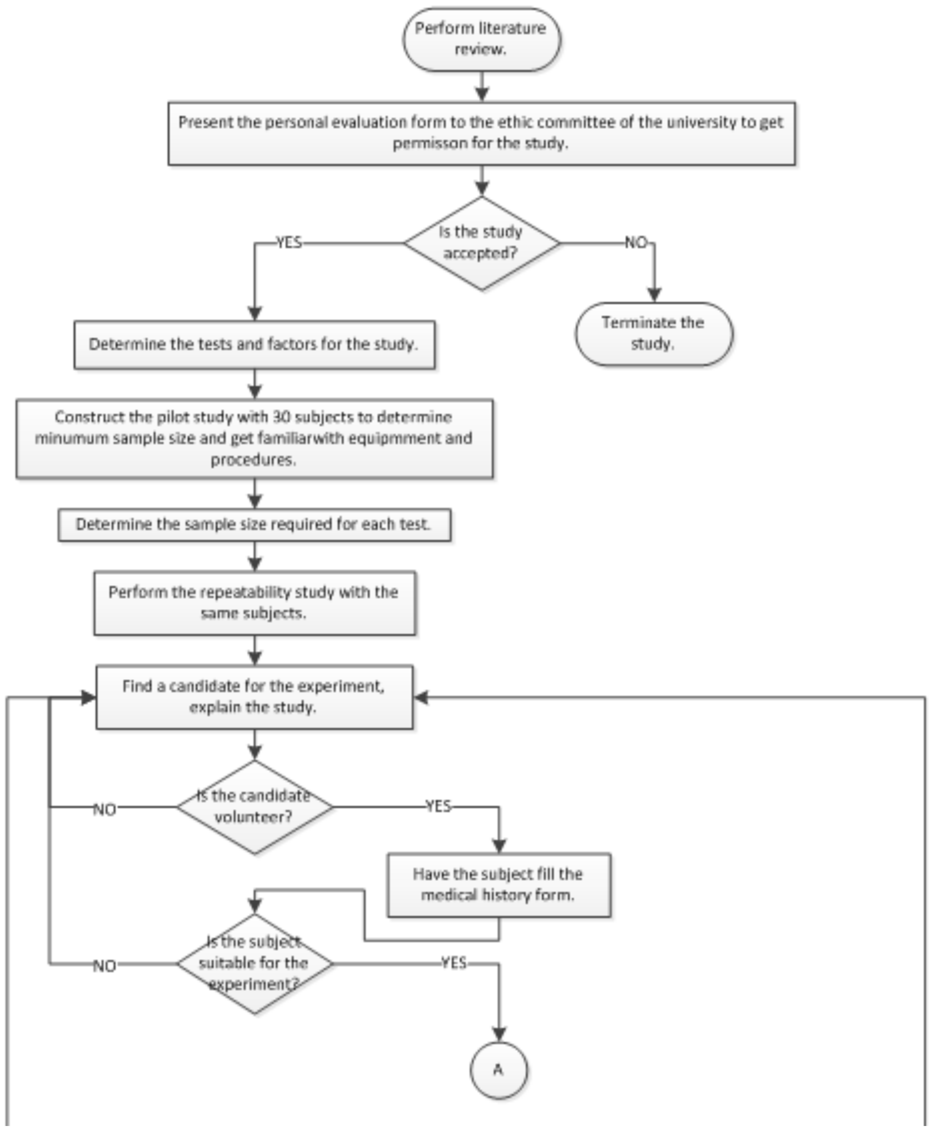


Figure 4.1. Flow chart showing the steps of the study

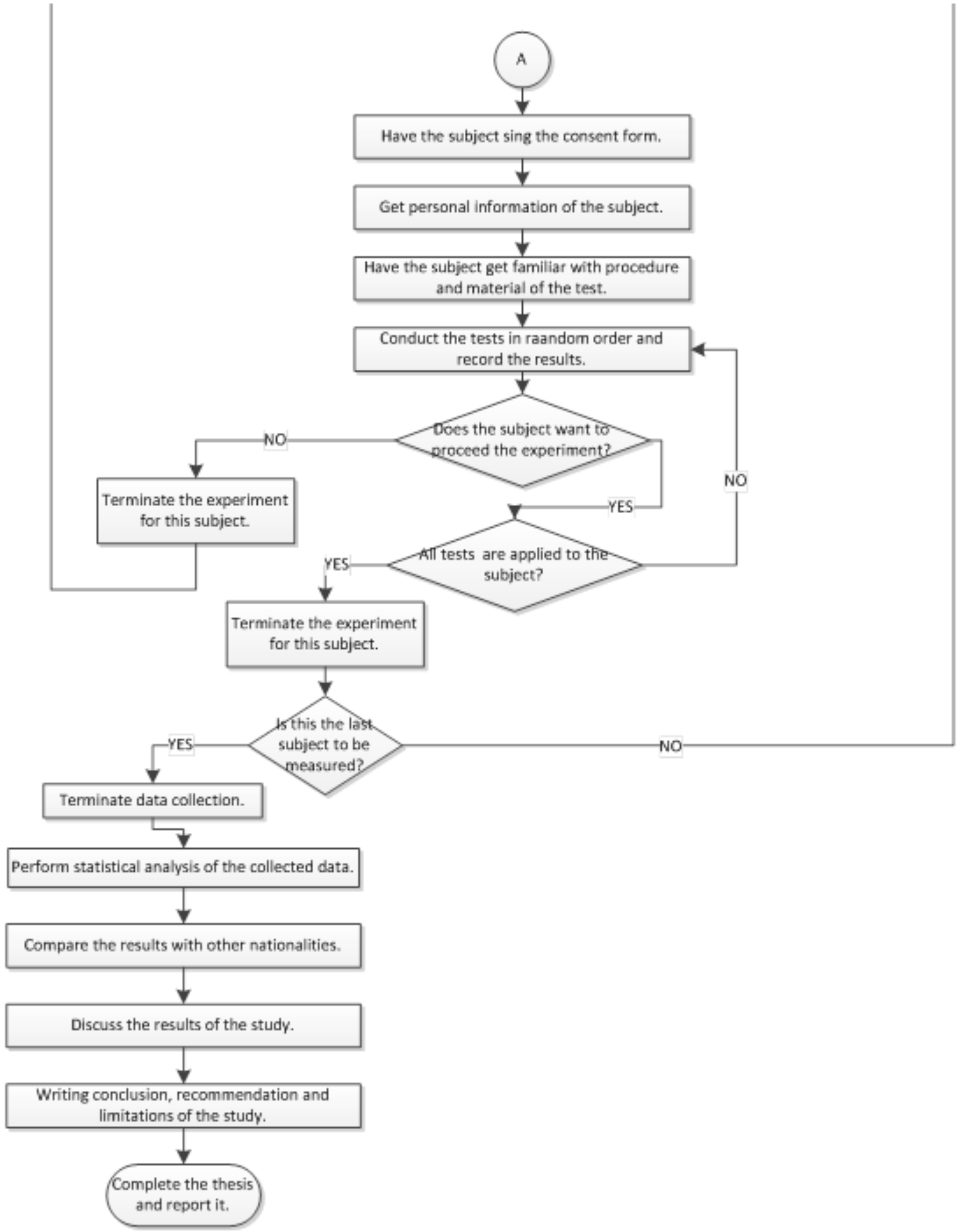


Figure 4.1. Flow chart showing the steps of the study (cont.)

4.1. Subjects

The sample of this study included 252 healthy male participants with age range of 18 to 93 years, different education levels and family origins from different regions of Turkey. Because of the fact that Istanbul is metropolitan city and composed of people from different regions of Turkey, it is assumed that population of Istanbul represents the population of Turkey. Table 4.2 shows the regional distribution of the subjects' family origin.

Table 4.1 Distribution of the subjects' family origins

Regions	**Subjects**
Marmara	72
Black Sea	40
Mediterranean	27
Aegean	43
Eastern Anatolia	28
Central Anatolia	30
Southeastern Anatolia	12
Total	252

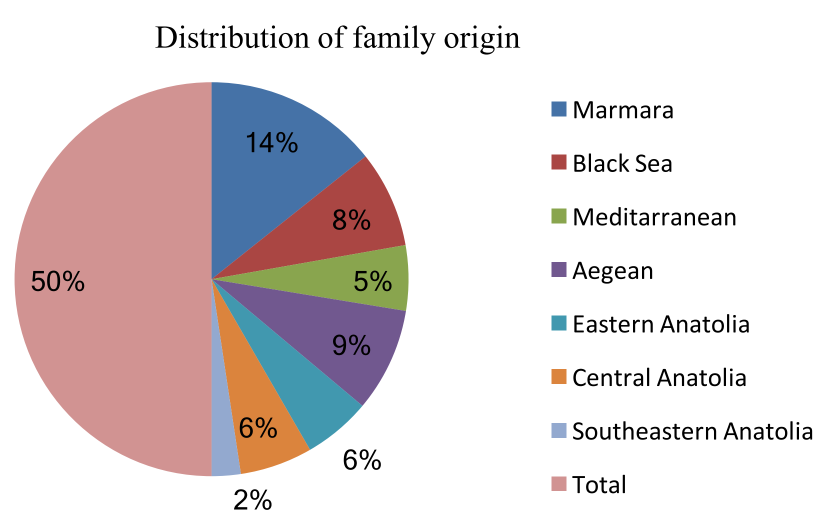


Figure 4.2. Distribution of family origin regions of the subjects

Subjects are divided into six different groups by their age (18-30, 31-40, 41-50, 51-60, 61-70, 71+). All in all, the tests are conducted to 252 healthy male participants which have family origin from different regions of Turkey.

Before the beginning of the tests, Health Survey and Personal Consent Form which consists of Brief Medical History Form and Personal Data Form are filled by participants (Appendix A). Subjects' demographic information is gathered by this form such as birthplace, city of family origin, age, education level of subjects and education level of subjects' parents, income level, marital status, handedness, smoking preference.

The mean and standard deviations of demographic factors of subjects are shown in Table 4.2.

Table 4.2. Subject information

Factor		**Age (years)**		**Education (years)**		**Education of Mother (years)**		**Education of Father (years)**	
Age Groups	n	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total	252	46.88	18.86	14.30	4.34	9.39	5.14	10.54	4.79
18 - 30	51	24.14	3.72	15.01	2.78	12.09	3.78	13.27	4.18
31 - 40	50	34.70	3.25	15.58	3.50	10.50	3.96	11.60	4.09
41 - 50	51	44.04	2.59	16.13	4.03	11.16	5.46	11.57	4.29
51 - 60	50	55.24	2,96	14.48	3.63	8.90	4.39	10.20	3.98
61 - 70	16	64.18	2,90	13.43	5.60	6.06	3.17	8.18	4.40
71 - 93	34	82.73	5.54	8.76	3.82	3.38	4.05	4.97	3.67

Income status was divided to three groups which are low income containing income up to 1000 Turkish liras per month, medium income meaning between 1000 TL and 5000 TL and high income expressing higher than 5000 TL per month. Participants evaluate their total family income according to defined ranges and choose one of low, medium and high-income levels.

Medical history form is filled by participants to be sure that all subjects are healthy and do not have any medical history such as heart disease, psychological illness, drug addiction etc. In conclusion, this form helps us to prevent experimental error by excluding subjects who have serious health problems.

4.2. Tests, Equipment, Tools

In this study, six different most widely-known neuropsychological tests have been applied to the participants from different age groups and education levels. These tests are:

(i) Digit Span Test (for attention, learning and short-term memory),
(ii) Corsi Block Tapping Test (for short-term memory and learning),
(iii) Stroop Color Word Test (for attention, concentration and speed),
(iv) Raven Standard Progressive Matrices (for intellectual functions like problem solving),
(v) Reaction Time Test (for motor functions),
(vi) Purdue Pegboard Test (for motor functions).

Tests have been applied in a silent place in order to provide comfortable atmosphere to participant. The place is important to let subjects concentrate on tests.

Firstly, necessary information about this study such as aim of this research, importance of providing normative data of Turkish population etc. is given to the subject. Secondly, Personal Consent Form and Personal Data Form (Appendix A) are filled by participant to provide information about participant’s health situation, medical history and demographic information. After all, tests are conducted to the participant in a random order, individually. Being participants in neutral position while doing tests is important to provide accurate data. An example test session is shown in Figure 4.3. During an experiment, if participant needs a break, tasks stop until participants feel ready to continue.

Figure 4.3. A participant conducting Purdue Pegboard test

4.2.1. Digit Span Test

This test is used to measure attention and short-term memory ability. There are two versions of the test: (i) Forward, (ii) Backward.

First of all, information about Digit Span Test is given to participant. Instructions for forward version is: listen recorded digits and try to repeat them in the same order.

Since voice and pronunciation can affect test results, voice recorder is used to list number in the same tone. Subject listens the recorded digits and repeats them back in the same order.

According to test procedure, test begins with three digits and increases by one digit until maximum of ten digits. Digits are recorded at intervals of one second.

The same method is used for backward version of Digit Span Test. The difference between forward and backward version is repeat order. Subjects repeat digits in the reverse order (Hebb, 1961).

Digit span test begins with the following instruction:

(i) For forward version: "I am going to read you a list of digits, and I expect from you to repeat the digits in the same order you listened." Then, an example list is read to the participant. After that given the procedure was applied.

(ii) For backward version: "I am going to read you a list of digits, and I expect from you to repeat the digits in the reverse order you listened." Then, an example list is read to the participant. After that given procedure was applied.

(iii) If they repeat the given list correctly, a digit longer another list is read to the participants. On the other hand, if they are unsuccessful to repeat the given list, another list with the same length will be given. If they are successful in second trial, one digit longer another list will be given. But, if subjects are unsuccessful again in second trial, task will be finished. The number of digits in the longest list repeated successfully is the participant's digit span (Hebb, 1961).

The lists used for the forward and backward versions of the Digit span tests are given in Table 4.3.

Table 4.3. Forward and backward versions of Digit Span Test (Hebb, 1961)

List (forward)	**Result (√ or ×)**	**List (backward)**	**Result (√ or ×)**
For Span = 3		**For Span = 3**	
829		928	
132		231	
152		251	
For Span = 4		**For Span = 4**	
6241		1426	
2359		9532	
7132		2317	
For Span = 5		**For Span = 5**	
84132		23148	
62143		34126	
97438		83479	
For Span = 6		**For Span = 6**	
587261		162785	
261384		483162	
632147		741236	
For Span = 7		**For Span = 7**	
2941378		8731492	
1285394		4935821	
8693735		5373968	
For Span = 8		**For Span = 8**	
65148279		97284156	
18472913		31927481	
42785921		12958724	
For Span = 9		**For Span = 9**	
679174382		283471976	
746231958		859132647	
398724615		516727893	
For Span = 10		**For Span = 10**	
4982176453		3546712894	
5731298426		6248921375	
8182397465		5647932818	

4.2.2. Corsi Span Test

This test is used to measure visual-spatial short-term memory and learning ability. Corsi Span Test equipment and application procedure were established by Philip Corsi (Milner, 1971).

For Corsi Span Test, nine cardboard white blocks (4 cm) which are fixed to a white cardboard (30 cm × 35 cm) are used as in Figure 4.4 (Milner, 1971). The cubes are placed about the locations as arranged in Figure 4.4 due to the fact that the exact positions of the cubes are not clarified. Each side of the cube has a number and these numbers can solely be seen by the examiner. The experimenter shows with his/her index finger the order of the cubes to the participant. Each block is shown to the participant for one second. The examiner then shown the order of the cubes to the participant through using her finger (Milner, 1971).

Experiment begins with the dab of the experimenter with sequence of three blocks. Then, the participant repeats them. Experimenter dab each block only one time with one-second interval in any sequence. Random sequences are done by the experimenter (Pagulayan *et al.*, 2007). Table 4.4 shows sequences from 3 to 9 lengths.

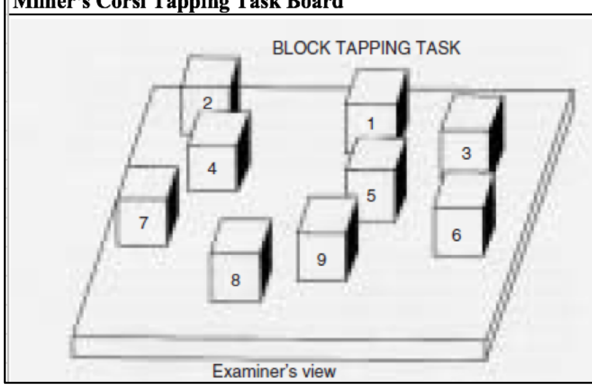
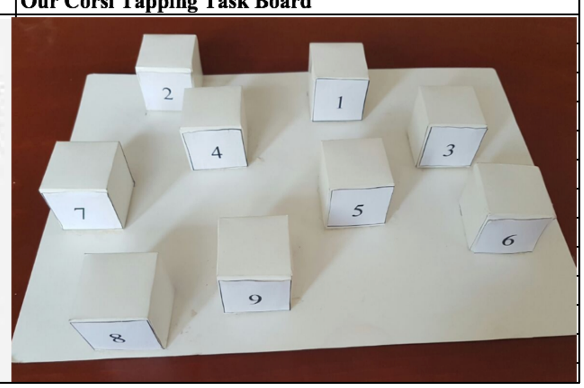
Milner's Corsi Tapping Task Board	Our Corsi Tapping Task Board
	

Figure 4.4. Corsi Block Tapping Apparatus (Milner, 1971)

The same method is used for backward version of Corsi Span Test. The difference between forward and backward version is repeat order. Subjects repeat blocks in the reverse order (Monaco *et al.*, 2012).

The number of block in the longest sequence repeated successfully is the participant's corsi span (Pagulayan *et al.*, 2007).

Table 4.4. Sequence of Corsi Span Test (Milner, 1971)

Span	**Forward**		**Backward**	
	Sequence 1	**Sequence 2**	**Sequence 1**	**Sequence 2**
3	5,8,2	6,9,4	6,2,9	4,1,5
4	6,4,3,9	7,2,8,6	3,2,7,9	1,9,6,8
5	4,2,7,3,1	7,5,8,3,6	1,5,2,8,6	6,1,8,4,3
6	6,1,9,4,7,2	3,9,2,4,8,7	5,39,4,1,8	7,2,4,8,5,6
7	5,9,1,7,4,2,8	4,1,7,9,3,8,6	8,1,2,9,3,6,5	4,7,3,9,1,2,8
8	5,8,1,9,2,6,4,7	3,8,2,9,5,1,7,4	9,4,3,7,6,2,5,6	7,2,8,1,9,6,5,2
9	2,7,5,8,6,2,5,8,4	7,1,3,9,4,2,5,6,8		

Corsi Span Test will begin with following instruction:

(i) For forward version: "I am going to tab a sequence of three blocks, and I expect from you to repeat dabs in the same order you see." Then, an example sequence is shown to the participants. After that given procedure was applied.

(ii) For backward version: "I am going to tab a sequence of three blocks, and I expect from you to repeat dabs in the reverse order you see." Then, an example sequence is shown to the participants. After that given procedure was applied.

(iii) If they repeat the given dab sequence correctly, sequence of dab will be one block longer. On the other hand, if they are unsuccessful to repeat the given sequence, another sequence with the same length will be given. If they are successful in second trial, one block longer sequence will be given. But, if subjects are unsuccesful again in second trial, task will be finished. The number of block in the longest sequence repeated successfully is the participant's corsi span (Postma *et al.*, 2004).

4.2.3. Stroop Color and Word Test

A Turkish adaptation of this test is used to measure attention, information running speed and concentration. This is TBAG version of Stroop Color Test based on Golden and Victoria versions (Karakaş, 2011). This version has four 14.0 x 21.5 cm sized white cards. This version contains ordered 4 columns at 6 rows, total of 24 items on each card.

The cards are used to give tasks to a participant. There are five tasks and test score is calculated for each task separately (Karakaş, 2011). Blue, green, red and yellow colored items are used in the cards. The tasks in the test are shown in Table 4.5.

Table 4.5. Parts of Stroop Color Word Test (Karakaş, 2011)

Parts	**Stimuli**	**Content**	**Tasks**
I	Card 1	Color names in Black	Reading color names, reading words
II	Card 2	Color names in different colors	Reading color names, reading words
III	Card 3	Circles in colors	Reading color of item
IV	Card 4	Neutral words in colors	Reading color of item
V	Card 2	Color names in different colors	Reading color of item

Card 1: consists of 24 color names with black on white background (Karakaş, 2011).

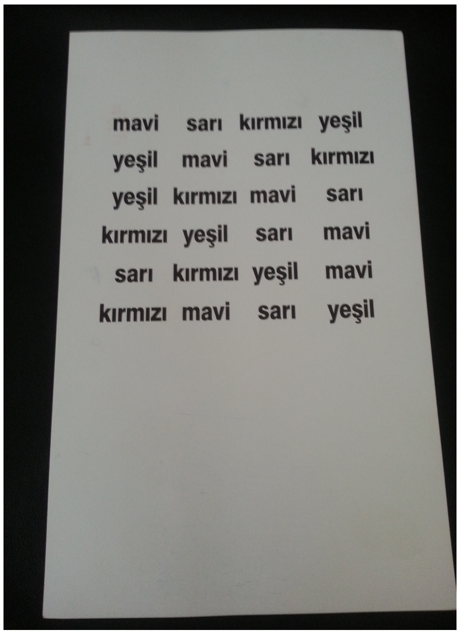
Card 2: has 24 color names with yellow, green, blue and red colored ink. Each color name is written with a color ink different from itself; 6 for each. (Karakaş, 2011).

Card 3: consists of 24 circles with yellow, green, blue and red colored ink; each color is represented with 6 circles (Karakaş, 2011).

Card 4: consists of colored 24 neutral words (not color names) (Karakaş *et al.*, 2011).

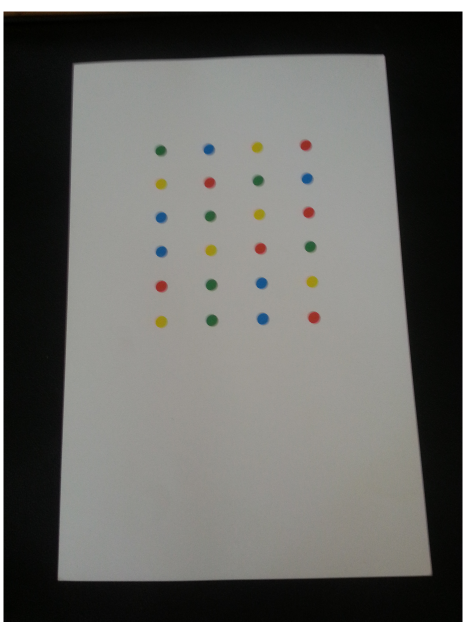
There are five tasks in test. Their details can be seen in Figure 4.5. Note that Card 2 is used for both Task 2 and Task 5.

There are three factors for Stroop Color Word test are covered by the tasks. First one is saying the colors (in Tasks 1 and 3), second one is factor interference effect (in card 2 and 3) and last one is the speed (in task 1) (Karakaş *et al.*, 2011). Response variables for each task is completion time of the related task.



Card 1

Card 2



Card 3

Card 4

Figure 4.5. The cards that are used in the experiment (Karakaş, 2011).

Stopwatch is used to measure completion time of each tasks. Test results are saved in standard record form which can be seen at Appendix A. The test is conducted to the participants individually and in standard order which is given in TBAG version by following instructions (Karakaş, 2011).

The test consists of five tasks. For each task, the experimenter presses stopwatch with command of "Start" and stops when participant complete the task. Total completion time is entered on the record form.

Examiner holds the physical card at the eye level of the participant. Stroop Color Word Test will begin with the following instruction;

(i) "I am going to show you some cards and then I give you a task such as reading the words or the color of the words on the cards. I expect from you to complete task as fast as you can. There is no correction need for all tasks, you can move on."

Stroop Color Word Test task 1 will begin with the following instruction;

(ii) "Now, I want you to read the words on the card (1) as fast as you can, starting at the beginning of the first row" .

Stroop Color Word Test task 2 will begin with the following instruction;

(iii) "Now, I want you to read name of the colors on the card (2) as fast as you can starting at the beginning of the first row. Just read the words, not the color name".

Stroop Color Word Test task 3 will begin with the following instruction;

(iv) "Now, I want you to say the colors of the circles on the card (3) as fast as you can starting at the beginning of the first row."

Stroop Color Word Test task 4 will begin with the following instruction;

(v) “Now, I want you to say the colors of the words on the card (4) as fast as you can starting at the beginning of the first row.”

The last task (Task 5) will begin with the following instruction;

(vi) “Now, I want you to say the colors of words on the card (2) as fast as you can starting at the beginning of the first row. Just say the color on.”

(vii) For the each task, the response variable is the completion time (Karakaş, 2011).

4.2.4. Reaction Time

This test is used to measure processing speed and ability of motor functions. Simple reaction time test has one stimuli and one response. In this project to record simple visual reaction time, a computer-based program has been used (Ritesh and Tejas, 2012).

The subjects sit comfortably in front of the screen (Figure 4.6). The visual stimulus is a green circle. Subject is asked to press any button when tiny red circle turns into a big green circle on the screen. When circle turns green, the program starts counting of time. When subjects press any button, program stops counting of time and give the reaction time. In this test, a visual stimulus has been given five times and average of five trials has been taken as the final reaction time (Ritesh and Tejas, 2012).

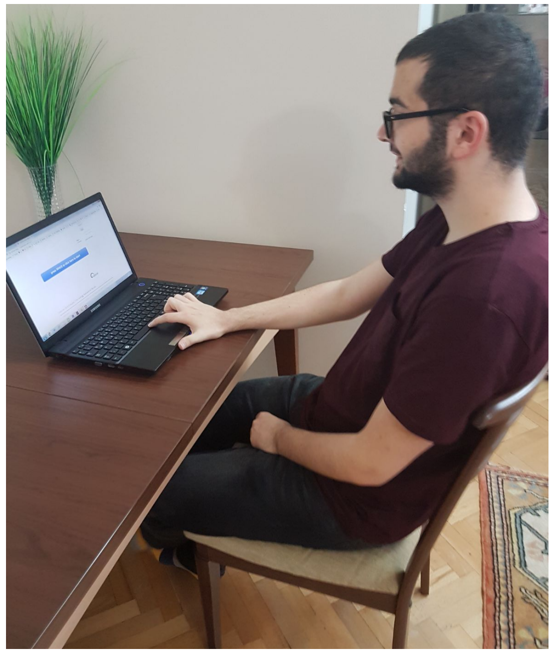


Figure 4.6. Reaction time test is applied to a participant

The following instructions are given to subjects;

(i) The first screen containing the ‘tiny red circle’ is shown to the subject (Figure 4.7). First instruction: ‘Click button when you are ready to start the test’.

(ii) “Wait for the red circle turns to big green circle.”

(iii) When big green circle appears on the screen, the programme starts counting reaction time automatically. Press the putton as fast as you can. When you press, programme stops counting.

(iv) “We will repeat it five times. You can take a rest if you need in between trials.”

In Figure 4.6 forth picture shows the screen which show reaction time after subject presses the button.

The subjects make 5 trials for both hands and average of 5 trials for each hand calculates as a final reaction time.

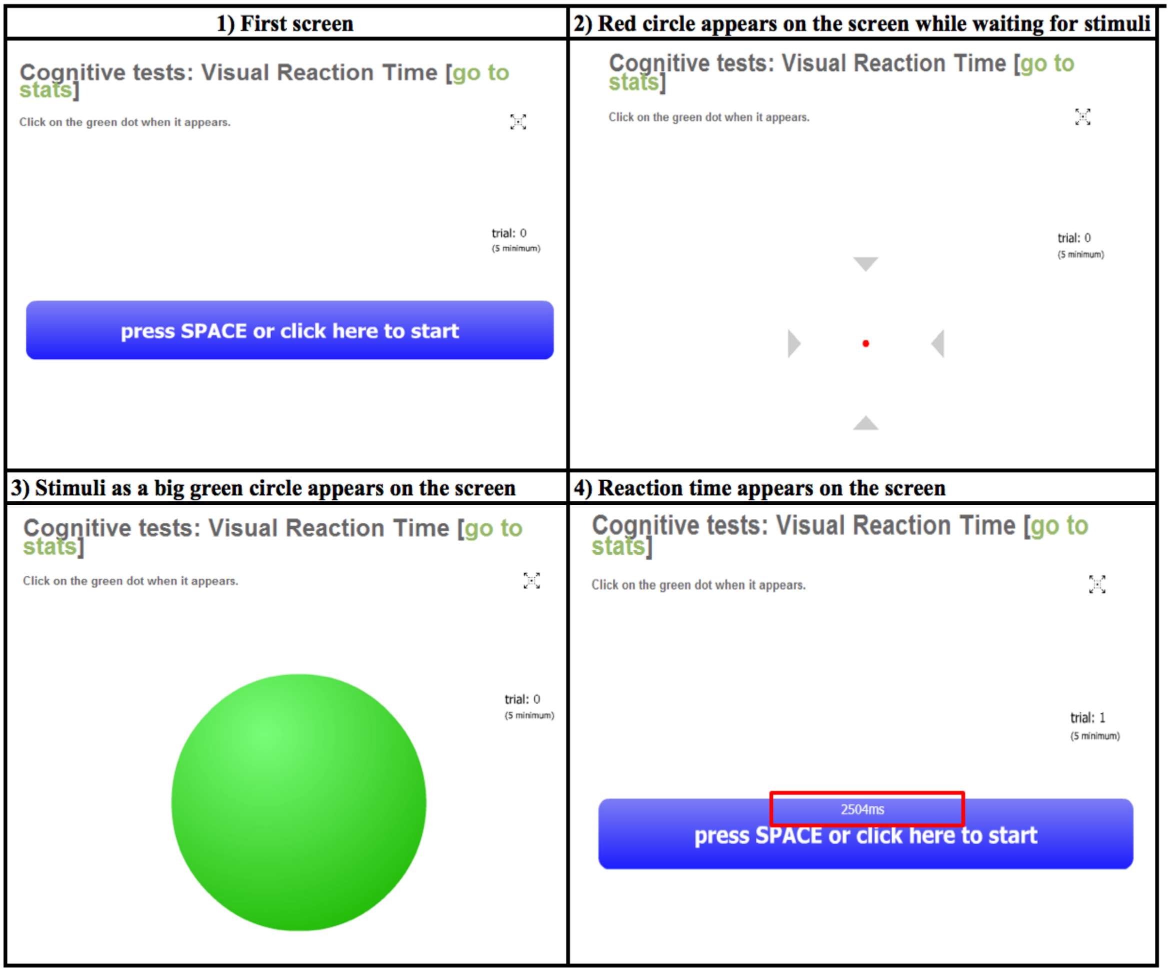


Figure 4.7. Screens of computer-based reaction time test (Shadmehr and Amiri, 2012)

4.2.5. Purdue Pegboard Test

This test is used to measure motor functions. In this part of research, Purdue Pegboard Test Model 32020 from Lafayette Instrument Company which contains 1 test board, 50 pins, 40 collars, 40 washers and score sheets has been applied to the subjects. Stopwatch was used to keep seconds.

Figure 4.8 and Figure 4.9 show the material called testing board, pins, washers and collars used in this part.

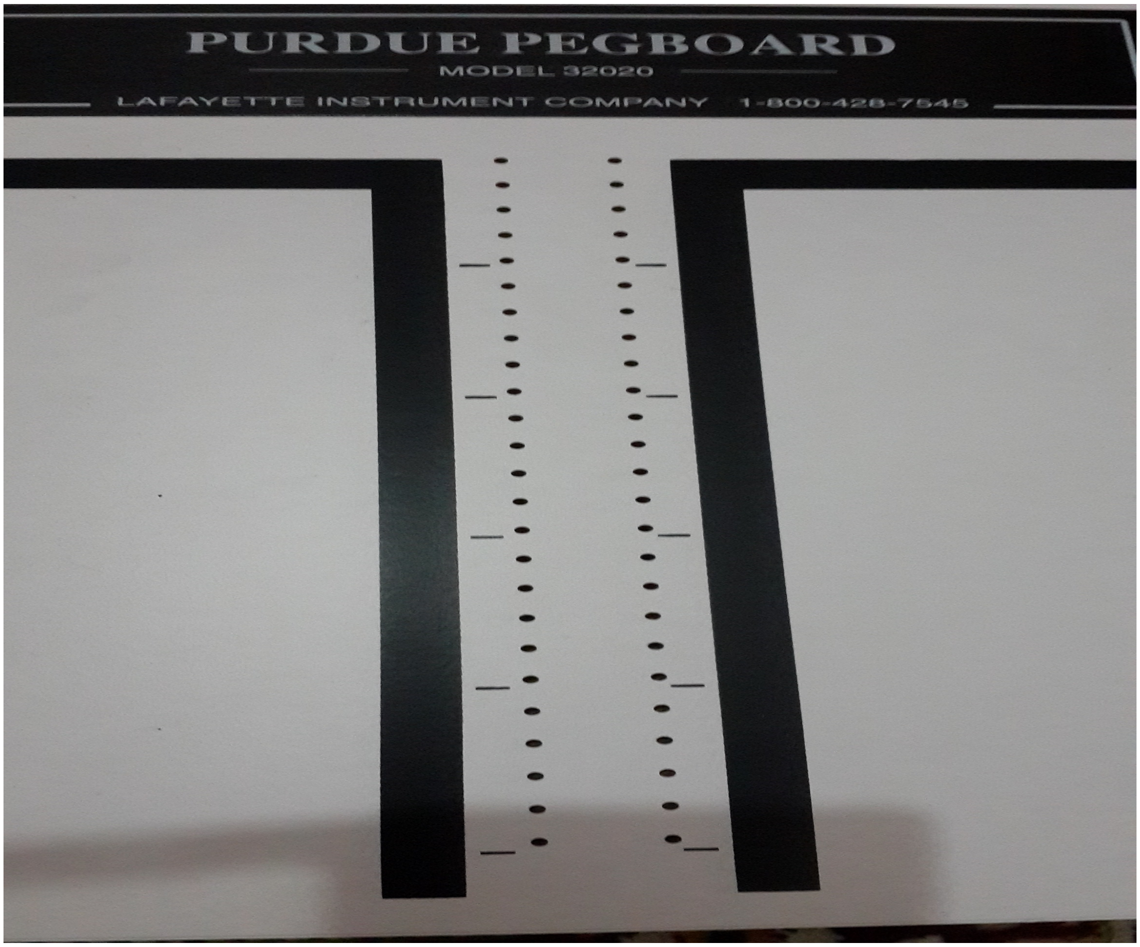


Figure 4.8. Purdue Pegboard Test Model 32020 testing board

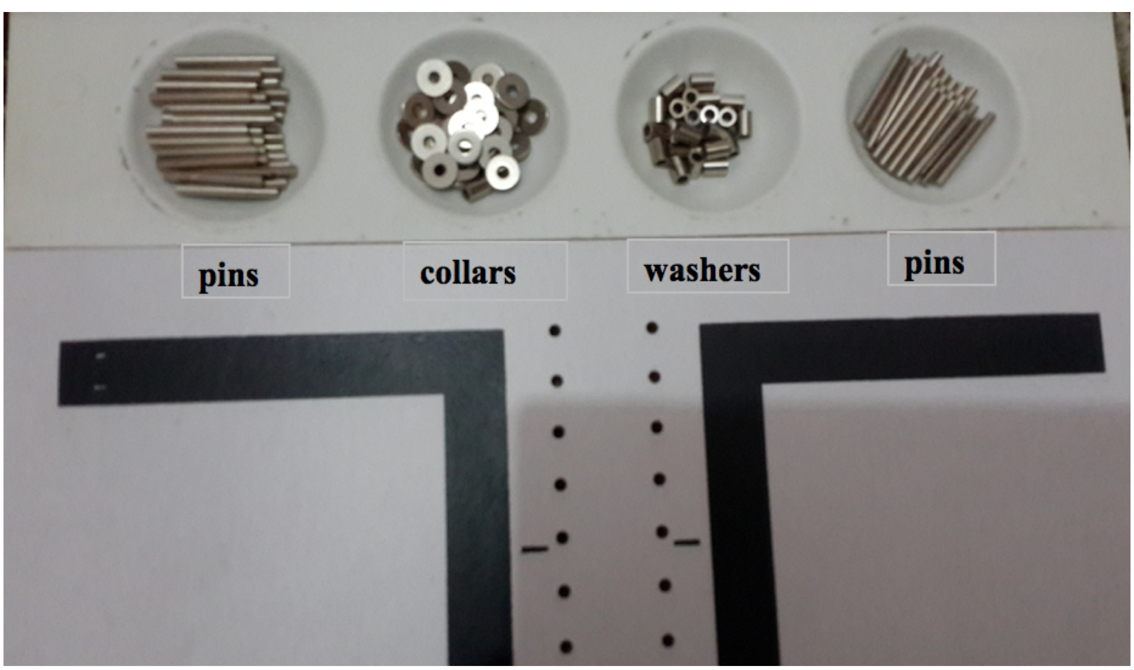


Figure 4.9. Pins, washers and collars

The subjects should be seated comfortably at a table with the Purdue Pegboard on the table in front of him/her. There are 4 cups and two vertical rows of 25 small holes on the testing board. 50 pins take parts in two cups. Each cup contains 25 pins. A cup contains 40 washers and the last one contains 40 collars.

The Purdue Pegboard Test consists of five subtests. The subjects have to perform subtests in the order outlined below (Tiffin and Asher, 1948).

The subjects can practice each subtest until feeling comfortable. Each subtest has to be repeated at least two times (Tiffin and Asher, 1948).

Subtest 1: The score of the first subtest is the average number of pins placed in the dominant hand column using the dominant hand in 30 seconds (Tiffin and Asher, 1948).

Subtest 2: Task 2 is achieved with only non-dominant hand. The score of the second task is the average number of pins placed in the non-dominant column using the non-dominant hand in 30 seconds (Tiffin and Asher, 1948).

Subtest 3: Third task has to be completed by using both hands. The score is the average number of pairs of pins placed in both columns using both hands in 30 seconds (Tiffin and Asher, 1948).

Subtest 4: Forth task is not actual task; it is the total number of previous three tasks which are right hand, left hand and both hands.

Subtest 5: And the last task called assembly takes 60 seconds. Score is the average number of pins, washer and collars assembled in 60 seconds (Tiffin and Asher, 1948).

Procedure and instructions take part in guideline focus on first version developed by Tiffin. According to instruction manual takes a part in Purdue Pegboard Test Model 32020, the following instructions are given to the subjects by experimenter (Tiffin and Asher, 1948).

When subject is seated he/she is asked whether he/she is ready to begin. When ready, the short explanation about the test is given. Before a subject begins each subtest, he/she is given opportunity to practice and be sure the subject understands what to do (Tiffin and Asher, 1948).

For the first part of the test the administrator should instruct the subject as follows.

(i) "Pick one pin at a time with your dominant hand from the cup which is at the direction of your dominant hand. Starting from the top of test board, place each pin in hole. You can practice if you want. Do not pick up a pin if you drop. You can continue by taking another pin" (Tiffin and Asher, 1948).

Experimenter wants subject make practice. When subject completes practice and ready to go real test, experimenter gives following instructions:

(ii) "With my 'Begin' command place pins the row at the direction of your dominant hand as quickly as you can until I notice time is over" (Tiffin and Asher, 1948).

(iii) After time is over, the experimenter count the number of pins and record. Subjects leave the pins in the holes. The subtest is repeated once again. The final score is average of two trials (Tiffin and Asher, 1948).

(iv) Same instructions for non-dominant hand are given to subjects. After completion of second battery, third task contains both hands starts.

(v) "This time you will use both of your hands. I want you pick up a pin with your right hand at the same time pick up a pin with you left hand. Then place the pins in holes simultaneously. You can make a few practices" (Tiffin and Asher, 1948)..

(vi) "When I say 'begin', place pins with your both hands as possible as you can. You have 30 seconds for this part and I will inform you when time is over" (Tiffin and Asher, 1948).

(vii) Instructions above are given for third part of the test called both hands (Instrument, 2002). Participant make two trials, the score is the average number of pair of the pins not the total number of pins (Tiffin and Asher, 1948).

(viii) Forth task is not a real task. It is only sum of the three previous tasks' scores (Tiffin and Asher, 1948).

Last part of the test occurs assembling of pins, washers and collars (Tiffin and Asher, 1948). In order to be sure, the subjects understand what to do, experimenter gives following instructions.

(ix) "Pick up one pin with your dominant hand from the cup and while putting it in hole pick up a washer with your non-dominant hand. Drop the washer over the pin as soon as the pin has been placed. Pick up a collar with the dominant hand while the washer is being placed over the pin with the non-dominant hand. While the collar is being dropped over the pin, pick up another washer with the non-dominant hand and drop it over the collar. This placement called as assembly" (Tiffin and Asher, 1948).

The most critical point to be sure that participant understand that use both hands to operate all process all of the time, one picking up a pin, one a washer, one a collar, and so on (Tiffin and Asher, 1948).

The score of assembly part is the total number of pins, washers and collars. Make subject complete two trials and take average of them as a final score (Tiffin and Asher, 1948).

4.2.6. The Raven Standard Progressive Test

This test is used to measure intellectual function like decision making and problem-solving abilities. Standard Raven Progressive Matrices is conducted to the subjects. The Raven Standard Progressive Matrices Test consists of multiple choice questions of abstract reasoning (Raven *et al.*, 2005). In each test item, a participant is asked to determine the lacking piece required to complete a larger pattern. This test includes 60 questions to be completed in 40 minutes (Raven *et al.*, 2005).

The subjects are seated in quiet and comfortable place in order to focus on the questions. The experimenter gives the papers containing 60 questions, pencils and water. The experimenter gives information about test time and the number of the question on the test. After 40 minutes, the experimenter gets the papers from the subjects.

The following instructions are given:

“This test contains 60 questions. Each question asks to identify missing element to complete a pattern of the shapes. You can start from any questions you want. You have 40 minutes to perform. As soon as time is over, I will get the papers from you.”

The questions and answers are given at Appendix B. The score of the test is the number of correct answers.

4.3. Experimental Design and Statistical Analysis

4.3.1. Experimental Variables

Characteristics of the subjects like; age-group, education, income, smoking preference and marital status are selected as independent variables. Classification factors can be seen in Table 4.6.

Table 4.6. Classification factors and their levels

Classification Factor	Number of Levels	Levels
Age	6	(1) 18 - 30
		(2) 31 - 40
		(3) 41 - 50
		(4) 51 - 60
		(5) 61 - 70
		(6) 71 - 93
Education	4	(1) 0-5 year
		(2) 6-12 year
		(3) 13-16 year
		(4) 17 +
Income	3	(1) Low
		(2) Medium
		(3) High
Smoking	2	(1) Smoker
		(2) Non-smoker
Marital Status	2	(1) Single
		(2) Married

The dependent (response) variables for this study are different for each experiment.

Response variables and experimental factors can be seen in Table 4.7.

Table 4.7. Test, response and independent variables

Test	Test Type	Response Variables	Type	Classification Factor	Number of Levels
Digit Span	Forward	Number of Digits (Higher is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Backward	Number of Digits	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Corsi Span	Forward	Length of Sequence (Higher is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Backward	Length of Sequence	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Stroop Color and Word	Part 1	Completation Time (Shorter is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 2	Completation Time	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 3	Completation Time	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 4	Completation Time	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 5	Completation Time	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2

Table 4.7. Test, response and independent variables (cont.)

Test	Test Type	Result Variables	Type	Classification Factor	Number of Levels
Reaction Time	Dominant Hand	Time (Shorter is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Non Dominant Hand	Time	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Purdue Pegboard	Dominant Hand	Number of Pins (Higher is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Non Dominant Hand	Number of Pins	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Both Hand	Number of Pins	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Total	Number of Pins	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Assembly	Number of Assemblied Parts	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Raven Test		Number of Correct Answers (Higher is the better)	Continous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2

4.4. Experimental Model

Completely Randomized Design (CRD) has been applied in this study since there is only classification factors. In this study, it was assumed that factors do not interact in any major way (it is shown from ANOVA results) for any of the response variables. The statistical models of these no interaction CRDs are presented below.

(i) Digit Span Test (for both Forward and Backward):

According to ANOVA results, there is no interaction effect and age, education and income level have an effect on test results. The experimental model;

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + \varepsilon_{ijk} \tag{1.1}$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)

j = 1, 2, 3, 4 (Education Levels)

k = 1, 2, 3 (Income Levels)

Y_{ijk}: ijk^{th} number of digits

μ: The overall response mean (mean of maximum number of digits)

α_i: The effect of i^{th} level of age

β_j: The effect of the j^{th} level of education

τ_k: The effect of the k^{th} level of income

ε_{ijk}: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{72}$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(ii) Corsi Span Forward Test (for both Forward and Backward):

According to ANOVA results, there is no interaction effect and age and education factors have an effect on test results. The experimental model;

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \qquad (1.2)$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)

j = 1, 2, 3, 4 (Education Levels)

Y_{ij}: ij^{th} number of digits

μ: The overall response mean (mean of maximum length of sequence)

α_i: The effect of i^{th} level of age

β_j: The effect of the j^{th} level of education

ε_{ij}: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{24}$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(iii) Raven Test:

According to ANOVA results, there is no interaction effect and age, education and income level have an effect on Raven test results. The experimental model;

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \tau_k + \varepsilon_{ijk} \qquad (1.3)$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)

j = 1, 2, 3, 4 (Education Levels)

k = 1, 2, 3 (Income Levels)

Y_{ijk}: ijk^{th} number of correct answers

μ: The overall response mean (mean of correct answers)

α_i: The effect of i^{th} level of age

β_j: The effect of the j^{th} level of education

τ_k: The effect of the k^{th} level of income

ε_{ijk}: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{72}$
$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(iv) Reaction Time Test (for both Dominant and Non-Dominant Hand):

According to ANOVA results, there is no interaction effect. There is only age factor effect on Reaction Time Hand test results. The experimental model;

$$Y_i = \mu + \alpha_i + \varepsilon_i \tag{1.4}$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)

Y_i: i^{th} time in seconds
μ: The overall response mean (mean of time in seconds)
α_i: The effect of i^{th} level of age
ε_i: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_6$
$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(v) Stroop Color and Word Test (for all 5 parts):

According to ANOVA results, there is no interaction effect and age and education factors have an effect on Stroop Color Word test results. The experimental model;

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \tag{1.5}$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)
j = 1, 2, 3, 4 (Education Levels)

Y_{ij}: ij^{th} time in seconds
μ: The overall response mean (mean of time in seconds)

α_i: The effect of i^{th} level of age

β_j: The effect of the j^{th} level of education

ε_{ij}: Random error component NID (0, σ^2)

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{24}$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(vi) Purdue Pegboard Test (for both Dominant, Non-Dominant Hand, Both)

According to ANOVA results, there is no interaction effect. There is only age factor effect on Purdue Pegboard Dominant/Non-Dominant, Both Hand test results. The experimental model;

$$Y_i = \mu + \alpha_i + \varepsilon_i \qquad (1.6)$$

for i = 1, 2, 3, 4, 5, 6 (Age Levels)

Y_i: i^{th} number of pins

μ: The overall response mean (mean of number of pins)

α_i: The effect of i^{th} level of age

ε_i: Random error component NID (0, σ^2)

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_6$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(vii) Purdue Pegboard Total Test:

According to ANOVA results, there is no interaction effect. Age and income factors have an effect on test result. The experimental model;

$$Y_{iiklm} = \mu + \alpha_i + \tau_k + \varepsilon_{ik} \qquad (1.7)$$

for $i = 1, 2, 3, 4, 5, 6$ (Age Levels)

$j = 1, 2, 3, 4$ (Education Levels)

$k = 1, 2, 3$ (Income Levels)

Y_{ik}: ik^{th} number of pins

μ: The overall response mean (mean of number of pins)

α_i: The effect of i^{th} level of age

τ_k: The effect of the k^{th} level of income

ε_{ik}: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{18}$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

(viii) Purdue Pegboard Assembly Test:

According to ANOVA results, there is no interaction effect. Age and education factors have an effect on test result. The experimental model;

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \tag{1.8}$$

for $i = 1, 2, 3, 4, 5, 6$ (Age Levels)

$j = 1, 2, 3, 4$ (Education Levels)

Y_{ij}: ij^{th} number of pins, collars and washers

μ: The overall response mean (mean of number of pins, collars and washers)

α_i: The effect of i^{th} level of age

β_j: The effect of the j^{th} level of education

ε_{ij}: Random error component NID $(0, \sigma^2)$

The hypothesis of interest is:

$H_0 = \mu_1 = \mu_2 = \ldots.. = \mu_{24}$

$H_1 = \mu_i \neq \mu_j$ for ar least one pair (i,j)

4.5. Pilot Study

A pilot study with randomly selected 30 male subjects from different age and education groups was conducted for the purpose of the following:

- Find out average time to complete six experiments,
- Get familiar with the equipment and test procedures,
- Observe subject reactions during experiments,
- Obtain the necessary statistical parameter values (mean, standard deviation) in order to determine the required minimum sample size.

Table 4.8. shows the results of pilot study.

Table 4.8. Descriptive statistics of pilot study

Test	**n**	**Mean**	**SD**	**CV (s/ $\bar{x}$)**
Digit Forward (maximum number of digits)	30	5.4	0.88	16.29
Digit Backward (maximum number of digits)	30	4.43	1.09	24.49
Corsi Forward (maximum length of sequence)	30	5.20	1.19	22.97
Corsi Backward (maximum length of sequence)	30	4.37	0.98	22.50
Reaction Time (dominant hand) (time)	30	294.13	45.16	15.35
Reaction Time (non-dominant hand) (time)	30	319.02	50.76	15.91
Raven Test (number of correct answers)	30	40.90	13.72	33.54
Purdue Pegboard (DH) (number of pins)	30	12.52	3.19	25.51
Purdue Pegboard (NDH) (number of pins)	30	11.23	3.09	27.48
Purdue Pegboard (both hand) (number of pins)	30	11.18	2.53	22.64
Purdue Pegboard (total) (number of pins)	30	34.93	8.65	24.76
Purdue Pegboard (assembly) (number of pins, collars and washers)	30	36.22	9.32	25.74
Stroop Color-Word Test Part I (time in seconds)	30	11.59	3.92	33.81
Stroop Color-Word Test Part II (time in seconds)	30	13.15	4.68	35.61
Stroop Color-Word Test Part III (time in seconds)	30	16.47	5.41	32.84
Stroop Color -Word Test Part IV (time in seconds)	30	21.64	8.14	37.60
Stroop Color-Word Test Part V (time in seconds)	30	41.86	25.11	59.99

4.6. Sample Size Determination

The sample size must be large enough to receive reliable results. On the other hand, it must be small enough to complete the study in a reasonable time as well.

Sample size estimation relies customarily on a precision-based method to estimate the true population 5th and 95th percentiles with 95% confidence and a certain percentage of relative accuracy [ISO 15535, 2012].

We estimated our sample size based on the results of our pilot study of 30 male subjects from different age and education groups.

Sample size calculation formula for normative data studies is given in the ISO standards for establishing databases as the following (ISO 15535:2006):

$$N = \left(\frac{1.96 \times CV}{a}\right)^2 \times 1.534^2 \quad (1)$$

1.96 is the critical Z value from a standard normal distribution for a 95% confidence interval, CV is the coefficient of variation, a is the percentage of relative accuracy desired (CI is to be no larger than ± some percentage of the mean). CV is defined as the following: $CV=(SD/\bar{x}) \times 100$ where, $\bar{x}$ is the sample mean and SD is the sample standard deviation.

In this study, true mean and standard deviation of the population are unknown, so pilot study is used to decide sample size. Relative accuracy is decided to be at least 5%.

Table 4.9. Minimum sample size of experiments

Result Variable	**Required Sample Size by Pilot Study (30 subjects)**	**Required sample size based on 252 subject data**	**Accuracy (α) of the Study (%) by full data**
Digit Forward	96	151	3.86
Digit Backward	217	233	4.80
Corsi Forward	191	181	4.23
Corsi Backward	183	195	4.39
Reaction Time Dominant Hand	85	28	1,66
Reaction Time Non-Dominant Hand	92	56	2.37
Raven Test	407	314	5.57
Purdue Pegboard Dominant Hand	235	206	4.51
Purdue Pegboard Non-Dominant Hand	273	205	4.50
Purdue Pegboard Both Hand	185	183	4.25
Purdue Pegboard Total	222	185	4.28
Purdue Pegboard Assembly	237	235	4.81
Stroop Color-Word Test Part I	413	304	5.48
Stroop Color-Word Test Part II	459	397	6.26
Stroop Color-Word Test Part III	390	453	6.69
Stroop Color-Word Test Part IV	511	620	7.83
Stroop Color-Word Test Part V	1300	1806	13.35

This study includes 252 male participants. Table 4.9 shows the accuracy which is calculated by using the same formula (1) with n=252. Desired alpha value is decided to be at least 5%.

4.7. Repeatability Study

Test reliability is important issue to provide accurate normative data of one population. The aim of repeatability study is to measure test reliability by applying the same tests under the same conditions to the same subjects.

In order to test the repeatability, 30 subjects from the pilot study conducted the tests once more at least a week later from the first trail.

Table 4.10 shows mean, standard deviation and coefficient of variation of both first and second trial.

Table 4.10. Results of repeatability study

Test	n	Mean		SD (Sample SD)		CV	
		Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Digit Forward	30	5.4	5.37	0.88	0.85	16.29	15.84
Digit Backward	30	4.43	4.70	1.09	0.92	24.49	19.48
Corsi Forward	30	5.2	5.27	1.19	1.14	22.97	21.70
Corsi Backward	30	4.37	4.43	0.98	0.86	22.5	19.36
Reaction Time DH	30	294.13	293.89	45.16	46.84	15.35	15.94
Reaction Time NDH	30	319.02	318.57	50.76	51.00	15.91	16.01
Raven Test	30	40.9	41.87	13.72	13.65	33.54	32.59
Purdue Pegboard DH	30	12.52	12.77	3.19	3.06	25.51	23.94
Purdue Pegboard NDH	30	11.23	11.52	3.09	3.26	27.48	28.33
Purdue Pegboard Both Hand	30	11.18	11.32	2.53	2.75	22.64	24.27
Purdue Pegboard Total	30	34.93	35.60	8.65	8.90	24.76	25.00
Purdue Pegboard Assembly	30	36.22	37.07	9.32	9.40	25.74	25.35
Stroop Color-Word Test Part I	30	11.59	12.02	3.92	4.16	33.81	34.65
Stroop Color-Word Test Part II	30	13.15	13.51	4.68	4.98	35.61	36.85
Stroop Color-Word Test Part III	30	16.47	16.98	5.41	5.66	32.84	33.34
Stroop Color-Word Test Part IV	30	21.64	21.96	8.14	8.32	37.6	37.87
Stroop Color-Word Test Part V	30	41.86	41.90	25.11	25.81	59.99	61.59

First of all, F-Test is used to test the null hypothesis that the variances of two populations are equal. Since p-value was >0.05, paired t-test was used by assuming equal variances. Otherwise, paired t-test would be applied by assuming unequal variances. Results of F-Test can be seen at Table 4.11.

Table 4.11. F test results of all test results

Test Name	**F Critical**	**F**	**P value**
Digit Span Forward Test	1.86	1.11	0.39
Digit Span Backward Test	1.86	1.46	0.16
Corsi Span Forward Test	1.86	1.13	0.37
Corsi Span Backward Test	1.86	1.35	0.21
Reaction Time Dominant Hand	0.53	0.96	0.45
Reaction Time Non-Dominant Hand	1.86	1.02	0.47
Purdue Pegboard Dominant Hand	1.86	1.13	0.37
Purdue Pegboard Non-Dominant Hand	0.54	0.93	0.42
Purdue Pegboard Both Hand	0.54	0.88	0.36
Purdue Pegboard Total	0.54	0.98	0.47
Purdue Pegboard Assembly	1.86	1.02	0.48
Stroop Color-Word Test I	0.54	0.92	0.41
Stroop Color-Word Test II	0.54	0.91	0.41
Stroop Color-Word Test III	0.54	0.95	0.44
Stroop Color-Word Test IV	0.54	0.99	0.49
Stroop Color-Word Test V	0.54	0.98	0.48
Raven Test	1.86	1.04	0.45

Then, a paired t-test is used to determine whether means are different or not.

Therefore, the hypotheses for the t-test are:

H_0: $\mu1 - \mu2 = 0$

H_1: $\mu1 - \mu2 \neq 0$

Results for each test can be seen from Table 4.12. According to all test results, measurements are reliable. There is no significant difference between means. So, null hypothesis is accepted.

Table 4.12. Paired t test results of all tests

Response variable	T obs	T critical	p-value	Result
Digit Span Forward (maximum number of digits)	0.15	2.00	0.88	insignificant
Digit Span Backward (maximum number of digits)	-1.02	2.00	0.31	insignificant
Corsi Span Forward (maximum length of sequence)	-0.22	2.00	0.83	insignificant
Corsi Span Backward (maximum length of sequence)	-0.28	2.00	0.78	insignificant
Reaction Time Test Dominant Hand (time in milliseconds)	0.02	2.00	0.98	insignificant
Reaction Time Test Non-Dominant Hand (time in milliseconds)	0.03	2.00	0.97	insignificant
Raven Test (number of correct answers)	-0.27	2.00	0.79	insignificant
Purdue Pegboard Test Dominant Hand (number of pins)	-0.31	2.00	0.76	insignificant
Purdue Pegboard Test Non-Dominant Hand (number of pins)	-0.34	2.00	0.73	insignificant
Purdue Pegboard Test Both Hand (number of pins)	-0.19	2.00	0.85	insignificant
Purdue Pegboard Test Total (right+left+Both Hand) (number of pins)	-0.29	2.00	0.77	insignificant
Purdue Pegboard Test Assembly (number of pins, collars and washers)	-0.35	2.00	0.73	insignificant
Stroop Color and Word Part 1 (time in seconds)	-0.40	2.00	0.69	insignificant
Stroop Color and Word Part 2 (time in seconds)	-0.29	2.00	0.77	insignificant
Stroop Color and Word Part 3 (time in seconds)	-0.36	2.00	0.72	insignificant
Stroop Color and Word Part 4 (time in seconds)	-0.15	2.00	0.88	insignificant
Stroop Color and Word Part 5 (time in seconds)	-0.01	2.00	1.00	insignificant

4.8. Statistical Analysis

All statistical analyses were performed by Minitab 18.0. Both descriptive and inferential statistical analyses were performed.

4.8.1. Descriptive Statistics

Mean, standard deviation, confidence intervals, percentages, ranges were calculated in descriptive statistics section.

4.8.2. Inferential Statistics

For inferential statistics, Pearson correlation coefficients were calculated. Analysis of variances (ANOVA) were performed to examine the effects of variables on the responses. A p-value < 0.05 was accepted as significance for all the inferential statistical analyses. Tukey's test which is recommended by Hochberg and Tamhane (1987) is applied for post hoc analysis.

There are some conditions to be satisfied before using parametric ANOVA. If homogeneity of variance assumption of ANOVA is violated, non-parametric ANOVA (Welch's ANOVA) are applied (Montgomery, 2005). Games and Howel test was preferred to perform post-hoc analysis instead of Tukey since it is used as nonparametric pairwise comparison test. As a check, in this study both parametric and non-parametric versions of the tests are applied and the similar results are obtained. Due to its power, parametric ANOVA results are reported. Prediction models were also developed through Stepwise Regression Analyses.

5. RESULTS

5.1. Overview

In this part of the study, the collected data from 252 male subjects by applying six different tests were analysed. Descriptive statistics of test results, correlation analysis, analysis of variance results with multiple comparisons, and regression analysis can be found in this section.

5.2. Descriptive Statistics

5.2.1. Descriptive Statistics of Responses

Descriptive statistics of test results are shown in Table 5.1. Mean, Std. Error of the Mean, Standard Deviation, Coefficient of Variation, Minimum value, Maximum value and Median are shown. The percentile values are presented in Table 5.2. Also, Box – Plot Diagrams for every test results are drawn (Figure 5.1- Figure 5.17).

Table 5.1 Descriptive statistics of test results

Test	**n**	**$\bar{x}$**	**s**	**Std. Er of $\bar{x}$**	**CV ($s/\bar{x}$)**	**Min-Max**	**Median**
Digit Forward (number of digits)	252	5.33	1.09	0.07	20.44	2.00.-7.00	5.00
Digit Backward (number of digits)	252	4.56	1.16	0.07	25.41	2.00-7.00	5.00
Corsi Forward (length of sequences)	252	5.06	1.13	0.07	22.39	2.00-7.00	5.00
Corsi Backward (length of sequences)	252	4.32	1.00	0.06	23.24	2.00-7.00	4.00
Reaction Time (DH) (millisecond)	252	278.8	24.56	1.55	8.81	222.2-424.4	273.50
Reaction Time (NDH Hand)	252	291.3	36.56	2.30	12.55	228.2-678.3	285.35
Raven Test (number of correct answers)	252	42.2	12.44	0.78	29.47	10.00-59.00	45.00
Purdue Pegboard (Dominant Hand) (number of pins)	252	12.1	2.88	0.18	23.90	4.5-18.5	12.50
Purdue Pegboard (NDH Hand)	252	11.1	2.64	0.17	23.81	4.00-17.00	11.50
Purdue Pegboard (Both Hand)	252	10.9	2.46	0.16	22.50	4.00-16.50	11.50
Purdue Pegboard (Total)	252	34.1	7.72	0.49	22.65	12.50-50.00	35.00
Purdue Pegboard (Assembly) (number of pins, collars, washers)	252	41.9	10.68	0.67	25.48	11.00-58.50	45.00
Stroop Color-Word Test Part I (seconds)	252	11.6	3.36	0.21	28.99	6.53-29.35	10.98
Stroop Color-Word Test Part II	252	13.16	4.36	0.28	33.15	5.55-35.15	12.34
Stroop Color-Word Test Part III	252	16.13	5.72	0.36	35.42	8.65-40.15	15.03
Stroop Color-Word Test Part IV	252	21.75	9.01	0.57	41.44	10.00-52.00	18.43
Stroop Color- Word Test Part V	252	37.66	26.62	1.68	70.69	15.6-135.42	27.66

Percentile values of test results are shown in Table 5.2.

Table 5.2 Percentile values of response variables

Percentiles	**5**	**25**	**50**	**75**	**95**
Digit Forward Result (number of digits)	3.00	5.00	5.33	6.00	7.00
Digit Backward Result (number of digits)	2.00	4.00	4.56	5.00	6.00
Corsi Forward Result (length of sequences)	3.00	4.00	5.06	6.00	7.00
Corsi Backward Result (length of sequences)	3.00	4.00	4.32	5.00	6.00
Reaction Time Dominant Hand Result(millisecond)	247.22	261.99	278.8	292.82	317.35
Reaction Time Non-Dominant Hand Result (millisecond)	259.71	271.93	291.3	300.23	334.12
Raven Test Result (number of correct answers)	15.00	36.00	42.20	51.00	58.00
Purdue Pegboard Dominant Hand Result (number of pins)	6.50	10.50	12.10	14.00	16.50
Purdue Pegboard Non-Dominant Hand Result (number of pins)	5.50	10.00	11.10	12.50	15.00
Purdue Pegboard Both Hand Result (number of pins)	5.50	10.00	10.90	12.50	14.50
Purdue Pegboard Total (R+L+B Hand) Result (number of pins)	18.78	31.38	34.10	39.50	44.73
Purdue Pegboard Assembly Result (number of pins, collars, washers)	19.50	37.00	41.90	50.00	54.45
Stroop Color-Word Test Part I (Time-Seconds)	7.56	9.16	11.60	13.24	18.23
Stroop Color-Word Test Part II (Time -Seconds)	8.43	10.14	13.16	15.00	20.84
Stroop Color-Word Test Part III (Time -Seconds)	9.84	12.14	16.13	18.00	29.47
Stroop Color-Word Test Part IV (Time -Seconds)	13.00	15.60	21.75	25.23	42.25
Stroop Color-Word Test Part V (Time -Seconds)	17.53	21.00	37.66	41.66	102.97

5.2.2. Box Plot Diagrams of Test Results

Examination of experimental data by using graphic is a good method. Boxplot diagrams for each test results can be found below. The box plots show the distribution of data based on minimum, first quartile, median, third quartile and mean. All test responses except Corsi Span Forward, Reaction Time Non-Dominant and Stroop Color Word (Part I, II, III), boxplots show that data are skewed. That means majority of data located in one side of the graph. Skewness shows that the data may not be normally distribuated (Montogomery, 2005).

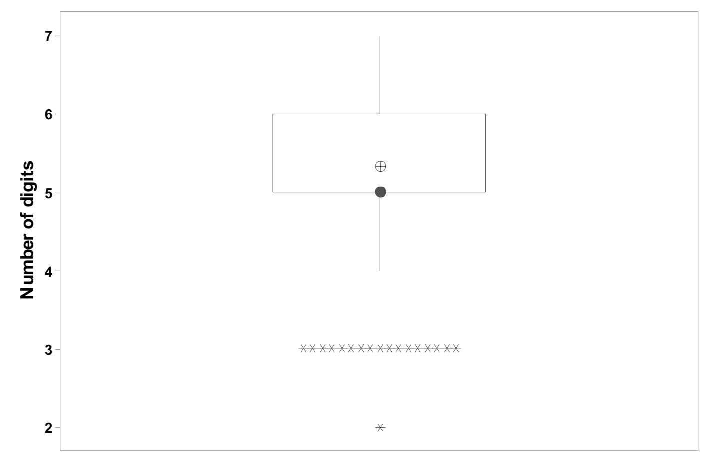


Figure 5.1. Box plot of Digit Span Forward test results

(⊕ : Mean ●: Median)

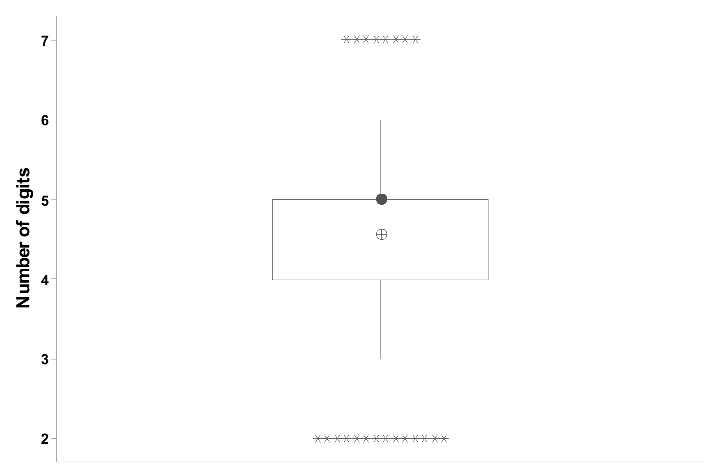


Figure 5.2. Box plot of Digit Span Backward test results

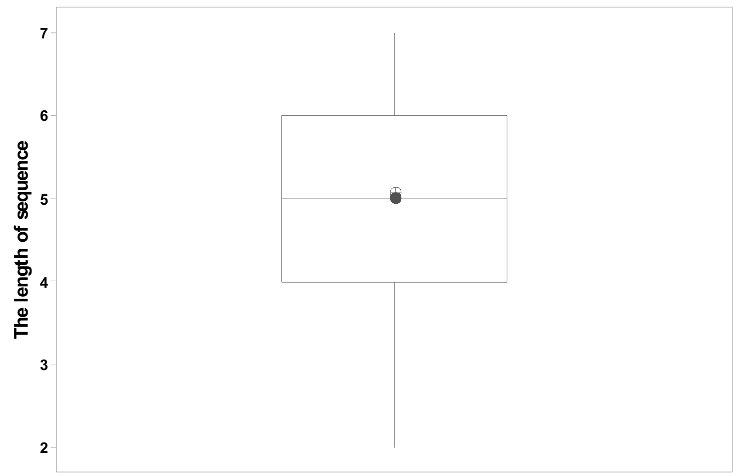


Figure 5.3. Box plot of Corsi Span Forward test results

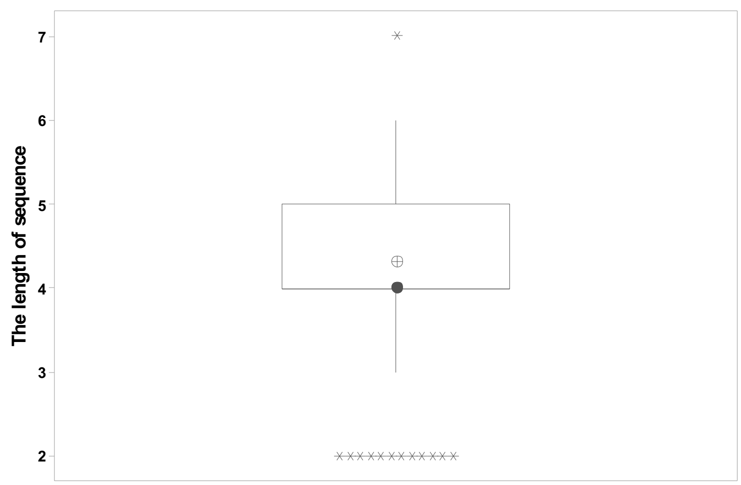


Figure 5.4. Box plot of Corsi Span Backward test results

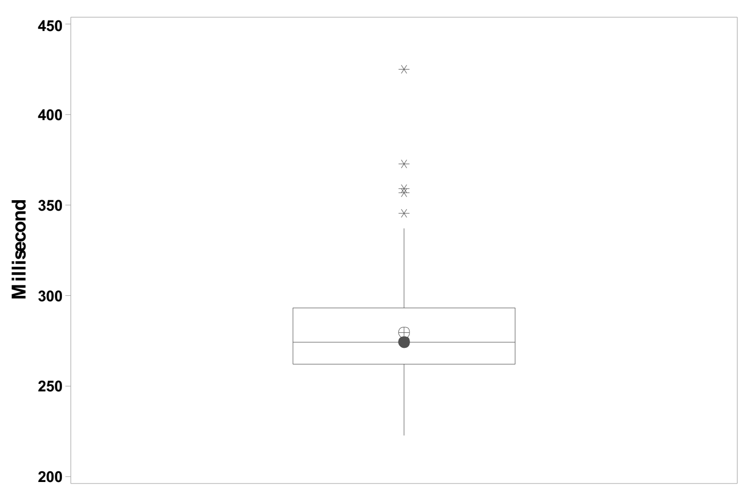


Figure 5.5. Box plot of Reaction Time Dominant Hand test results

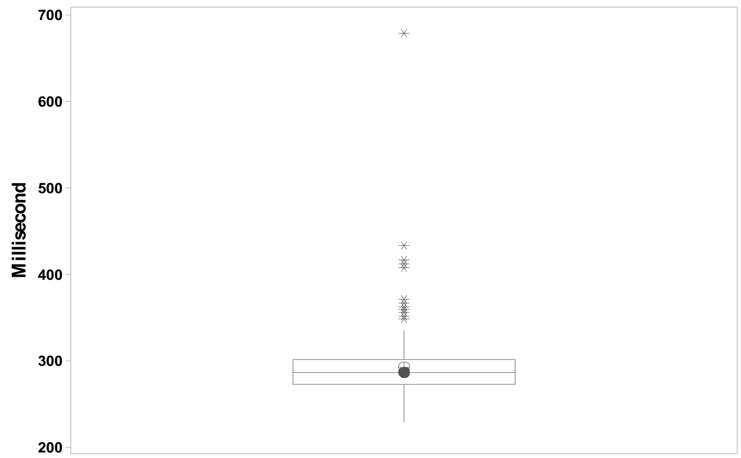


Figure 5.6. Box plot of Reaction Time Non-Dominant Hand test results

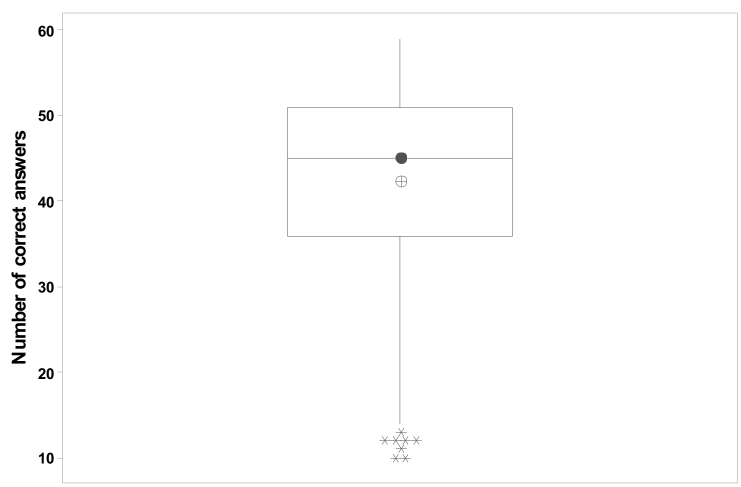


Figure 5.7. Box plot of Raven test results

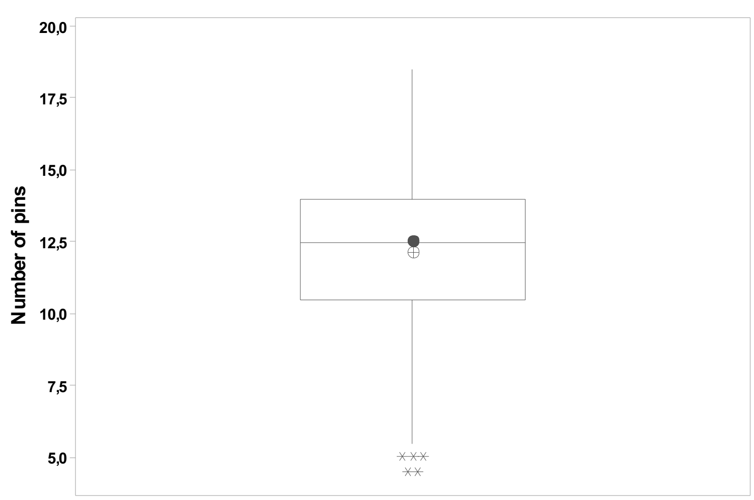


Figure 5.8. Box plot of Purdue Pegboard Dominant Hand test results

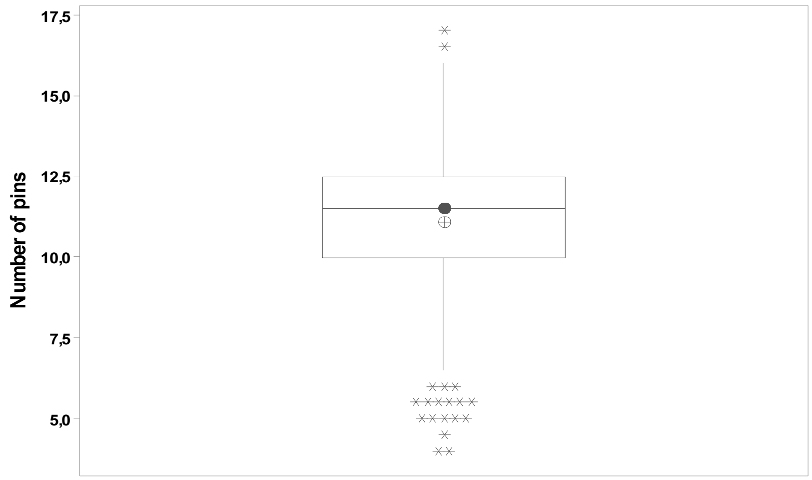


Figure 5.9. Box plot of Purdue Pegbooard Non-Dominant Hand test results

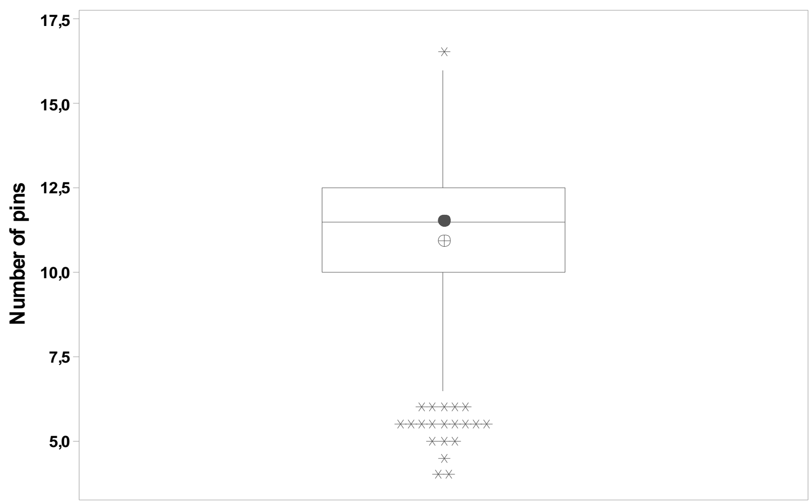


Figure 5.10. Box plot of Purdue Pegbooard Both Hand test results

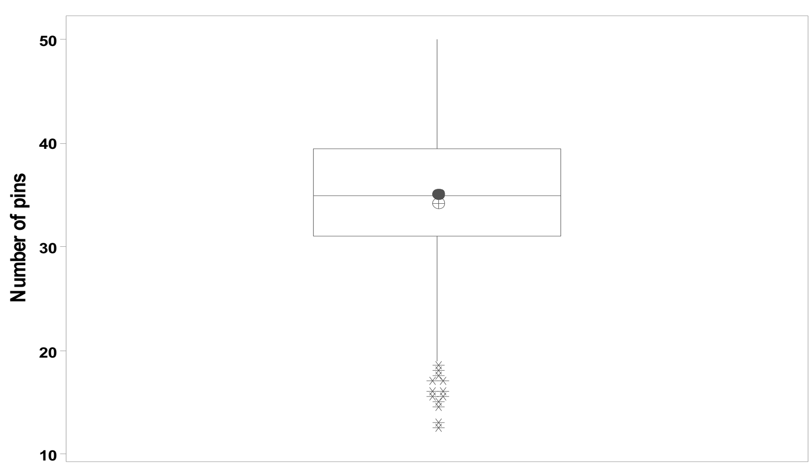


Figure 5.11. Box plot of Purdue Pegbooard Total test results

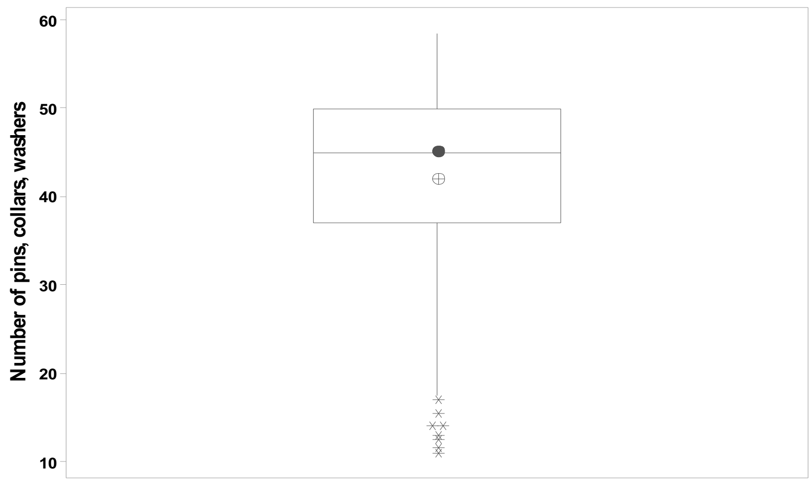


Figure 5.12. Box plot of Purdue Pegbooard Assembly test results

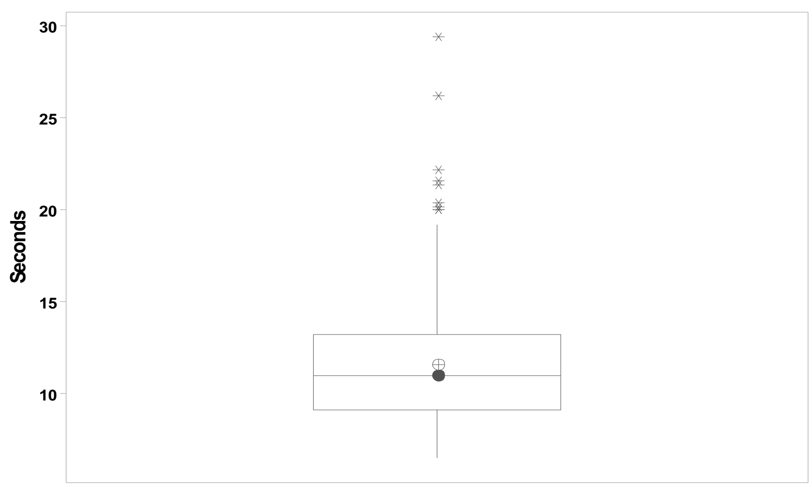


Figure 5.13. Box plot of Stroop Color Word Part 1 test results

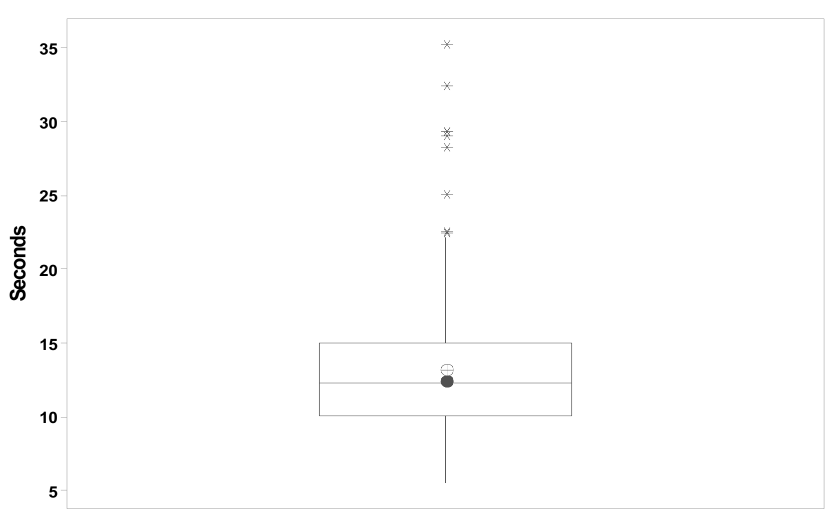


Figure 5.14. Box plot of Stroop Color Word Part 2 test results

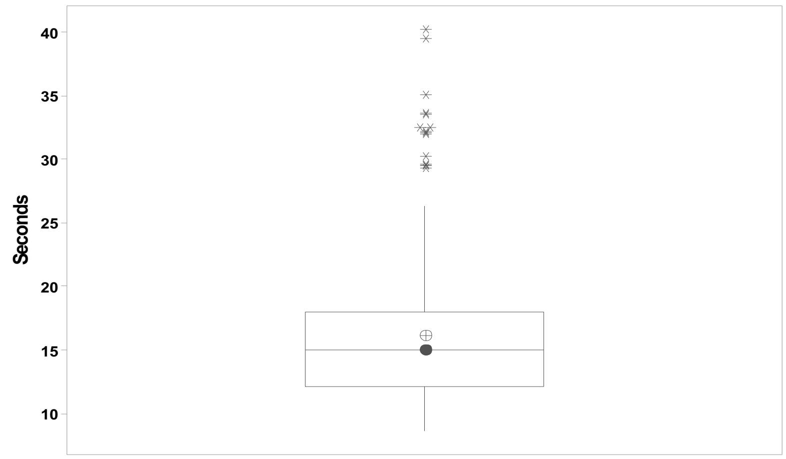


Figure 5.15. Box plot of Stroop Color Word Part 3 test results

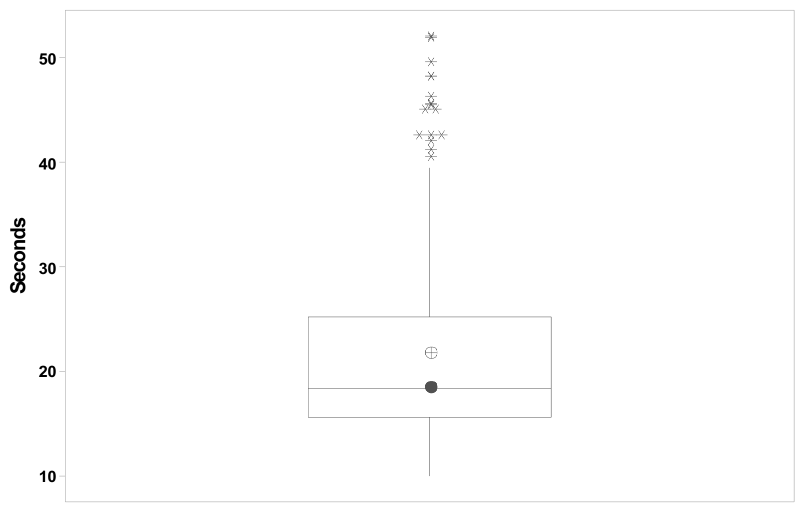


Figure 5.16. Box plot of Stroop Color Word Part 4 test results

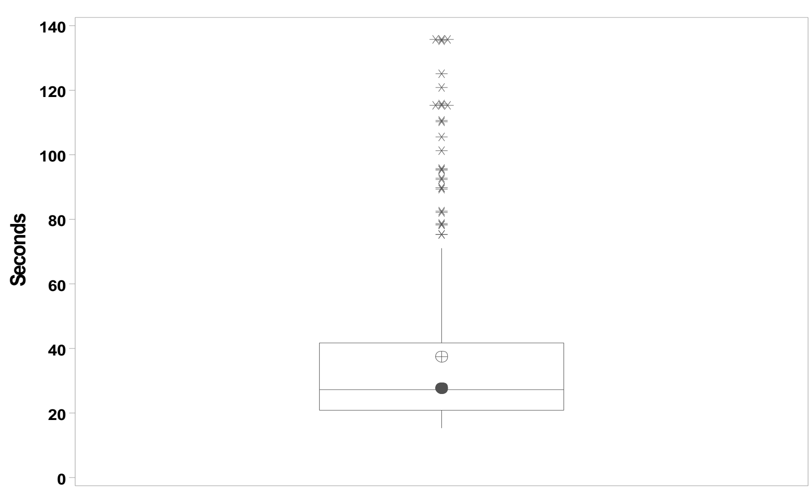


Figure 5.17. Box plot of Stroop Color Word Part 5 test results

5.2.3. Independent Variable Groups

It can be seen from Table 5.3 that demographic variables were divided into two groups as continuous and categorical variables.

Table 5.3. Details of independent variables

Variables	Continious Variable	Categorical Variable	Group	Range	Sample Size
Age (years)	X		1	18-30	51
			2	31-40	50
			3	41-50	51
			4	51-60	50
			5	61-70	16
			6	71-93	34
Education (years)	X		1	0-5	12
			2	6-12	81
			3	13-16	99
			4	>17	60
Income		X	1	Low	55
			2	Medium	143
			3	High	54
Maritial Status		X	1	Married	159
			2	Single	93
Smoking Habbit		X	1	Smoker	83
			2	Non smoker	169

5.2.4. Descriptive Statistics of Independent Variable Groups

Table 5.4. Descriptive statistics for Age Factor

Response Variable	Age Group	n	x̄	s	Std Error of x̄	CV (s/x̄)	Min-Max	Median
Digit Span Forward (number of digits)	18 - 30 years	51	6.08	0.77	0.11	0.13	4.00-7.00	6.00
	31 - 40 years	50	5.82	0.69	0.10	0.12	4.00-7.00	6.00
	41 - 50 years	51	5.71	0.81	0.11	0.14	4.00-7.00	6.00
	51 - 60 years	50	5.02	0.68	0.10	0.14	3.00-6.00	5.00
	61 - 70 years	16	4.87	0.81	0.20	0.17	4.00-7.00	5.00
	71 - 93 years	34	3.56	0.71	0.12	0.20	2.00-5.00	3.50
Digit Span Backward (number of digits)	18 - 30 years	51	5.16	0.92	0.13	0.18	4.00-7.00	5.00
	31 - 40 years	50	5.24	0.74	0.11	0.14	4.00-7.00	5.00
	41 - 50 years	51	5.00	0.80	0.11	0.16	4.00-7.00	5.00
	51 - 60 years	50	4.34	0.77	0.11	0.18	3.00-6.00	4.00
	61 - 70 years	16	3.69	0.70	0.18	0.19	3.00-5.00	4.00
	71 - 93 years	34	2.71	0.68	0.12	0.25	2.00-4.00	3.00
Corsi Span Forward (length of sequences)	18 - 30 years	51	5.63	0.77	0.11	0.14	4.00-7.00	6.00
	31 - 40 years	50	5.52	0.79	0.11	0.14	4.00-7.00	6.00
	41 - 50 years	51	5.37	0.87	0.12	0.16	4.00-7.00	5.00
	51 - 60 years	50	5.14	0.90	0.13	0.18	3.00-7.00	5.00
	61 - 70 years	16	4.44	0.81	0.20	0.18	3.00-6.00	4.50
	71 - 93 years	34	3.24	0.82	0.14	0.25	2.00-5.00	3.00
Corsi Span Backward (length of sequences)	18 - 30 years	51	4.82	0.65	0.09	0.14	3.00-6.00	5.00
	31 - 40 years	50	4.78	0.76	0.11	0.16	3.00-6.00	5.00
	41 - 50 years	51	4.67	0.84	0.12	0.18	3.00-7.00	5.00
	51 - 60 years	50	4.18	0.75	0.11	0.18	3.00-5.00	4.00
	61 - 70 years	16	3.88	0.81	0.20	0.21	3.00-5.00	4.00
	71 - 93 years	34	2.77	0.65	0.11	0.24	2.00-4.00	3.00
Reaction Time Dominant Hand (millisecond)	18 - 30 years	51	259.05	11.58	1.62	0.04	240.28-312.20	259.20
	31 - 40 years	50	265.03	13.99	1.98	0.05	222.20-302.24	264.40
	41 - 50 years	51	277.46	24.07	3.37	0.09	234.20-424.44	272.80
	51 - 60 years	50	282.42	12.58	1.78	0.04	242.80-301.00	285.50
	61 - 70 years	16	308.67	27.32	6.83	0.09	280.00-372.20	301.55
	71 - 93 years	34	311.88	13.37	2.29	0.04	291.40-356.00	308.90
Reaction Time Non-Dominant Hand (millisecond)	18 - 30 years	51	269.40	11.18	1.57	0.04	228.20-294.60	267.40
	31 - 40 years	50	285.47	58.95	8.34	0.21	247.80-678.30	274.90
	41 - 50 years	51	284.72	16.77	2.35	0.06	258.60-371.00	283.30
	51 - 60 years	50	295.09	21.57	3.05	0.07	258.80-411.80	294.10
	61 - 70 years	16	319.70	40.10	10.00	0.13	280.40-415.40	305.00
	71 - 93 years	34	323.57	24.95	4.28	0.08	296.20-431.80	315.96
Raven Test (number of correct answers)	18 - 30 years	51	48.69	6.79	0.95	0.14	29.00-58.00	50.00
	31 - 40 years	50	47.54	8.10	1.15	0.17	25.00-59.00	48.50
	41 - 50 years	51	47.47	8.08	1.13	0.17	25.00-59.00	49.00
	51 - 60 years	50	41.96	9.20	1.30	0.22	19.00-55.00	44.50
	61 - 70 years	16	36.56	9.99	2.50	0.27	18.00-51.00	38.00
	71 - 93 years	34	19.88	7.78	1.33	0.39	10.00-41.00	18.50
Purdue Pegboard Dominant Hand (number of pins)	18 - 30 years	51	14.38	1.79	0.25	0.12	10.50-18.50	14.50
	31 - 40 years	50	13.66	1.81	0.26	0.13	9.50-17.50	13.50
	41 - 50 years	51	12.56	1.53	0.21	0.12	9.50-15.50	12.50
	51 - 60 years	50	11.86	1.68	0.24	0.14	8.50-17.50	11.50
	61 - 70 years	16	10.00	1.25	0.31	0.13	8.00-13.50	10.00
	71 - 93 years	34	6.81	1.41	0.24	0.21	4.00-11.00	6.75

5.4. Descriptive statistics for Age Factor (cont.)

Response Variable	Age Group	n	$\bar{x}$	s	Std Error of $\bar{x}$	CV (s/ $\bar{x}$)	Min-Max	Median
Purdue Pegboard Non-Dominant Hand (number of pins)	18 - 30 years	51	13.06	1.76	0.25	0.13	10.00-17.00	13.00
	31 - 40 years	50	12.40	1.60	0.23	0.13	9.00-15.50	12.00
	41 - 50 years	51	11.68	1.50	0.21	0.13	8.50-15.00	11.50
	51 - 60 years	50	11.25	1.47	0.21	0.13	9.00-16.50	11.00
	61 - 70 years	16	8.94	1.33	0.33	0.15	6.50-12.00	9.00
	71 - 93 years	34	6.24	1.28	0.22	0.20	4.00-10.50	6.25
Purdue Pegboard Both Hand (number of pins)	18 - 30 years	51	12.42	1.58	0.22	0.13	10.00-16.50	12.00
	31 - 40 years	50	12.16	1.42	0.20	0.12	9.00-15.00	12.00
	41 - 50 years	51	11.59	1.52	0,21	0.13	8.50-15.00	11.50
	51 - 60 years	50	11.11	1.25	0.18	0.11	8.50-14.50	11.00
	61 - 70 years	16	9.34	1.67	0.42	0.18	7.50-13.50	9.25
	71 - 93 years	34	6.27	1.38	0.24	0.22	4.00-9.50	6.00
Purdue Pegboard Total (number of pins)	18 - 30 years	51	39.86	4.68	0.66	0.12	31.50-50.00	40.00
	31 - 40 years	50	38.22	4.27	0.60	0.11	27.50-47.50	37.75
	41 - 50 years	51	35.82	3.98	0.56	0.11	28.00-43.50	35.50
	51 - 60 years	50	34.22	4.02	0.57	0.12	27.00-48.50	33.75
	61 - 70 years	16	28.28	3.99	0.99	0.14	22.00-39.00	28.00
	71 - 93 years	34	19.31	3.80	0.65	0.20	12.50-31.00	19.00
Purdue Pegboard Assembly (number of pins, collars, washers)	18 - 30 years	51	50.26	4.12	0.58	0.08	41.50-57.50	51.00
	31 - 40 years	50	47.48	5.47	0.77	0.12	32.00-58.50	47.50
	41 - 50 years	51	45.19	5.34	0.75	0.12	32.00-56.00	46.00
	51 - 60 years	50	41.70	5.11	0.72	0.12	27.50-53.50	41.50
	61 - 70 years	16	32.72	6.14	1.53	0.19	25.50-45.50	31.00
	71 - 93 years	34	20.94	5.71	0.98	0.27	11.00-31.50	20.00
Stroop Color Word Test Part I (time-seconds)	18 - 30 years	51	9.06	1.40	0.20	0.15	6.53-12.50	8.68
	31 - 40 years	50	9.92	1.56	0.22	0.16	7.02-13.42	9.57
	41 - 50 years	51	10.92	1.96	0.27	0.18	7.51-15.90	11.00
	51 - 60 years	50	11.94	1.77	0.25	0.15	8.90-15.60	12.13
	61 - 70 years	16	13.56	3.07	0.77	0.23	9.25-20.12	12.63
	71 - 93 years	34	17.46	3.52	0.60	0.20	12.50-29.35	15.65
Stroop Color Word Test Part II (time–seconds)	18 - 30 years	51	10.11	1.70	0.24	0.17	7.50-14.00	9.57
	31 - 40 years	50	11.12	1.88	0.27	0.17	7.67-16.00	11.26
	41 - 50 years	51	12.03	2.26	0.32	0.19	5.55-16.00	12.14
	51 - 60 years	50	13.57	2.38	0.34	0.18	9.12-18.90	13.58
	61 - 70 years	16	15.37	3.88	0.97	0.25	10.12-22.50	14.33
	71 - 93 years	34	20.75	5.23	0.90	0.25	13.50-35.15	18.75
Stroop Color Word Test Part III (time-seconds)	18 - 30 years	51	12.05	2.32	0.32	0.19	8.65-17.80	11.40
	31 - 40 years	50	13.28	2.51	0.36	0.19	9.12-19.00	12.53
	41 - 50 years	51	14.91	2.74	0.38	0.18	8.71-19.25	15.26
	51 - 60 years	50	16.90	3.47	0.49	0.21	10.40-24.35	16.30
	61 - 70 years	16	19.79	6.11	1.53	0.31	13.32-32.50	18.29
	71 - 93 years	34	25.44	6.90	1.18	0.27	15.35-40.15	25.50
Stroop Color Word Test Part IV (time-seconds)	18 - 30 years	51	15.26	2.87	0.40	0.19	10.00-23.25	15.00
	31 - 40 years	50	17.69	4.18	0.59	0.24	11.22-32.00	16.75
	41 - 50 years	51	19.83	5.18	0.73	0.26	10.31-31.00	18.33
	51 - 60 years	50	23.15	7.39	1.04	0.32	15.00-38.90	19.38
	61 - 70 years	16	26.90	9.30	2.32	0.35	17.23-45.45	23.35
	71 – 93 years	34	35.87	10.06	1.73	0.28	20.00-52.00	35.33

5.4. Descriptive statistics for Age Factor (cont.)

Response Variable	Age Group	n	x̄	s	Std Error of x̄	CV (s/ x̄)	Min-Max	Median
Stroop Color Word Test Part V (time-seconds)	18 - 30 years	51	20.89	3.31	0.46	0.16	16.25-29.55	20.00
	31 - 40 years	50	25.36	8.06	1.14	0.32	15.89-50.20	22.30
	41 - 50 years	51	28.37	7.87	1.10	0.28	16.65-45.20	28.32
	51 - 60 years	50	34.80	10.61	1.50	0.31	15.60-71.00	35.00
	61 - 70 years	16	47.07	22.05	5.51	0.47	21.95-100.90	43.06
	71 - 93 years	34	94.63	24.44	4.19	0.26	55.15-135.42	92.33

Table 5.5. Descriptive statistics for Education Factor

Response Variable	Education Group	n	x̄	s	Std Error of x̄	CV (s/ x̄)	Min-Max	Median
Digit Span Forward (number of digits)	0 - 5 years	12	3.42	0.67	0.19	0.20	3.00-5.00	3.00
	6 - 12 years	81	4.72	1.03	0.11	0.22	2.00-7.00	5.00
	13 - 16 years	99	5.64	0.76	0.08	0.14	3.00-7.00	6.00
	1 7+ years	60	6.02	0.81	0.10	0.14	4.00-7.00	6.00
Digit Span Backward (number of digits)	0 - 5 years	12	2.33	0.49	0.14	0.21	2.00-3.00	2.00
	6 - 12 years	81	3.98	0.99	0.11	0.25	2.00-6.00	4.00
	13 - 16 years	99	4.82	0.85	0.09	0.18	3.00-7.00	5.00
	17 + years	60	5.35	0.95	0.12	0.18	3.00-7.00	5.00
Corsi Span Forward (length of sequences)	0 - 5 years	12	2.92	0.79	0.23	0.27	2.00-4.00	3.00
	6 - 12 years	81	4.42	0.96	0.11	0.22	2.00-7.00	5.00
	13 - 16 years	99	5.35	0.82	0.08	0.15	3.00-7.00	5.00
	17 + years	60	5.87	0.81	0.10	0.14	4.00-7.00	6.00
Corsi Span Backward (length of sequences)	0 - 5 years	12	2.58	0.67	0.19	0.26	2.00-4.00	2.50
	6 - 12 years	81	3.78	0.92	0.10	0.24	2.00-6.00	4.00
	13 - 16 years	99	4.58	0.80	0.08	0.17	3.00-7.00	5.00
	17 + years	60	4.97	0.66	0.09	0.13	3.00-6.00	5.00
Reaction Time Dominant Hand (millisecond)	0 - 5 years	12	326.78	19.98	5.77	0.06	306.50-372.20	318.65
	6 - 12 years	81	283.19	21.90	2.43	0.08	240.60-356.00	284.20
	13 - 16 years	99	275.69	22.89	2.30	0.08	241.84-424.44	272.00
	17 + years	60	268.74	19.04	2.46	0.07	222.20-336.84	268.05
Reaction Time Non-Dominant Hand (millisecond)	0 - 5 years	12	341.43	35.88	10.36	0.11	311.00-415.40	324.00
	6 - 12 years	81	293.59	25.68	2.85	0.09	251.80-431.80	290.20
	13 - 16 years	99	288.43	44.38	4.46	0.15	228.20-678.30	282.60
	17 + years	60	282.87	25.99	3.35	0.09	247.80-411.80	278.99
Raven Test (number of correct answers)	0 - 5 years	12	14.92	3.65	1.05	0.25	10.00-20.00	15.00
	6 - 12 years	81	32.62	9.77	1.09	0.30	12.00-52.00	35.00
	13 - 16 years	99	46.60	5.77	0.58	0.12	27.00-58.00	48.00
	17 + years	60	53.43	5.78	0.75	0.11	20.00-59.00	55.00
Purdue Pegboard DH (number of pins)	0 - 5 years	12	6.38	1.87	0.54	0.29	4.00-10.50	6.25
	6 - 12 years	81	11.22	3.04	0.34	0.27	4.50-17.00	11.50
	13 - 16 years	99	12.85	2.17	0.22	0.17	6.50-18.50	12.50
	17 + years	60	13.08	2.18	0.28	0.17	7.50-17.50	13.00
Purdue Pegboard NDH (number of pins)	0 - 5 years	12	5.92	1.12	0.32	0.19	4.50-8.00	5.75
	6 - 12 years	81	10.34	2.84	0.32	0.27	4.00-16.00	10.50
	13 - 16 years	99	11.75	1.95	0.20	0.17	5.50-17.00	11.50
	17 + years	60	12.12	2.06	0.27	0.17	5.50-16.50	12.00

Table 5.5. Descriptive statistics for Education Factor (cont.)

Response Variable	Education Group	n	$\bar{x}$	s	Std Error of $\bar{x}$	CV (s/ $\bar{x}$)	Min-Max	Median
Purdue Pegboard BH (number of pins)	0 - 5 years	12	5.79	1.27	0.37	0.22	4.00-8.50	5.50
	6 - 12 years	81	10.35	2.73	0.30	0.26	4.00-15.00	11.00
	13 - 16 years	99	11.55	1.87	0.19	0.16	6.00-16.50	11.50
	17 + years	60	11.66	1.57	0.20	0.13	7.50-14.50	12.00
Purdue Pegboard Total (number of pins)	0 - 5 years	12	18.08	4.05	1.17	0.22	13.00-25.50	17.00
	6 - 12 years	81	31.91	8.39	0.93	0.26	12.50-47.50	33.00
	13 - 16 years	99	36.15	5.57	0.56	0.15	19.00-50.00	36.00
	17 + years	60	36.85	5.48	0.71	0.15	21.50-48.50	37.25
Purdue Pegboard Assembly (number of pins, collars, washers)	0 - 5 years	12	19.58	6.39	1.84	0.33	11.00-30.00	19.25
	6 - 12 years	81	37.91	11.82	1.31	0.31	11.50-56.00	40.50
	13 - 16 years	99	45.06	7.05	0.71	0.16	22.00-58.50	46.50
	17 + years	60	46.60	6.57	0.85	0.14	20.00-57.00	47.50
Stroop Color Word Test Part I (time-seconds)	0 - 5 years	12	19.19	3.94	1.14	0.21	15.22-29.35	18.25
	6 - 12 years	81	12.74	3.47	0.39	0.27	6.53-26.19	12.33
	13 - 16 years	99	10.78	1.96	0.20	0.18	7.51-15.26	10.50
	17 + years	60	9.89	2.20	0.28	0.22	7.02-20.01	9.25
Stroop Color Word Test Part II (time-seconds)	0 - 5 years	12	24.55	5.64	1.63	0.23	17.80-35.15	23.60
	6 - 12 years	81	14.38	4.18	0.46	0.29	7.50-32.35	13.65
	13 - 16 years	99	12.09	2.39	0.24	0.20	5.55-18.22	12.00
	17 + years	60	10.99	2.58	0.33	0.23	7.67-20.42	10.25
Stroop Color Word Test Part III (time-seconds)	0 - 5 years	12	29.69	6.00	1.73	0.20	19.50-39.45	31.18
	6 - 12 years	81	17.63	6.05	0.67	0.34	9.12-40.15	16.50
	13 - 16 years	99	14.93	3.55	0.36	0.24	8.65-26.35	15.00
	17 + years	60	13.38	3.33	0.43	0.25	9.12-24.00	12.83
Stroop Color Word Test Part IV (time-seconds)	0 - 5 years	12	39.79	9.95	2.87	0.25	20.55-52.00	40.00
	6 - 12 years	81	23.93	9.68	1.08	0.40	10.22-49.52	20.32
	13 - 16 years	99	20.20	6.91	0.69	0.34	10.31-42.55	18.25
	17 + years	60	17.77	5.30	0.68	0.30	10.00-38.25	16.21
Stroop Color Word Test Part V (time-seconds)	0 - 5 years	12	102.01	25.87	7.47	0.25	44.02-135.42	110.25
	6 - 12 years	81	46.73	29.43	3.27	0.63	16.25-135.25	35.85
	13 - 16 years	99	30.13	15.27	1.53	0.51	15.60-105.50	25.00
	17 + years	60	24.98	10.68	1.38	0.43	15.89-89.56	21.98

Table 5.6. Descriptive statistics for Income Factor

Response Variable	Income Group	n	$\bar{x}$	s	Std Error of $\bar{x}$	CV (s/ $\bar{x}$)	Min-Max	Median
Digit Span Forward (number of digits)	High Level	54	5.89	0.79	0.11	0.13	4.00-7.00	6.00
	Medium Level	143	5.30	1.08	0.09	0.20	2.00-7.00	5.00
	Low Level	55	4.84	1.12	0.15	0.23	3.00-7.00	5.00
Digit Span Backward (number of digits)	High Level	54	5.22	0.90	0.12	0.17	3.00-7.00	5.00
	Medium Level	143	4.52	1.11	0.09	0.24	2.00-7.00	5.00
	Low Level	55	4.00	1.20	0.16	0.30	2.00-6.00	4.00
Corsi Span Forward (length of sequences)	High Level	54	5.85	0.79	0.11	0.13	4.00-7.00	6.00
	Medium Level	143	4.94	1.11	0.09	0.22	2.00-7.00	5.00
	Low Level	55	4.58	1.12	0.15	0.24	2.00-7.00	5.00

Table 5.6. Descriptive statistics for Income Factor (cont.)

Response Variable	Income Group	n	x̄	s	Std Error of x̄	CV (s/ x̄)	Min-Max	Median
Corsi Span Backward (length of digits)	High Level	54	4.94	0.66	0.09	0.13	3.00-6.00	5.00
	Medium Level	143	4.23	0.98	0.08	0.23	2.00-7.00	4.00
	Low Level	55	3.93	1.07	0.14	0.27	2.00-6.00	4.00
Reaction Time DH (millisecond)	High Level	54	272.00	18.41	2.51	0.07	222.20-315.05	271.60
	Medium Level	143	281.98	26.82	2.24	0.10	240.28-424.44	276.20
	Low Level	55	277.59	22.59	3.05	0.08	240.60-331.00	269.80
Reaction Time NDH (millisecond)	High Level	54	283.47	23.93	3.26	0.08	247.80-411.80	282.00
	Medium Level	143	292.76	29.86	2.50	0.10	228.20-431.80	286.40
	Low Level	55	295.14	56.77	7.66	0.19	252.30-678.30	287.90
Raven Test (number of correct answers)	High Level	54	53.28	4.06	0.55	0.08	41.00-59.00	53.00
	Medium Level	143	41.43	11.51	0.96	0.28	10.00-58.00	45.00
	Low Level	55	33.42	12.33	1.66	0.37	10.00	36.00
Purdue Pegboard DH (number of pins)	High Level	54	12.95	2.13	0.29	0.16	7.00-17.50	13.00
	Medium Level	143	11.99	2.83	0.24	0.24	4.50-18.50	12.50
	Low Level	55	11.40	3.45	0.47	0.30	4.00-17.50	12.00
Purdue Pegboard NDH (number of pins)	High Level	54	12.03	1.98	0.27	0.16	6.50-16.50	12.00
	Medium Level	143	11.04	2.71	0.23	0.25	4.00-17.00	11.00
	Low Level	55	10.38	2.83	0.38	0.27	5.00-16.00	11.00
Purdue Pegboard BH (number of pins)	High Level	54	11.56	1.60	0.22	0.14	7.00-14.50	12.00
	Medium Level	143	10.91	2.51	0.21	0.23	4.00-16.50	11.00
	Low Level	55	10.31	2.86	0.39	0.28	4.00-15.00	11.00
Purdue Pegboard Total (number of pins)	High Level	54	36.54	5.36	0.73	0.15	20.50-48.50	37.00
	Medium Level	143	33.94	7.79	0.65	0.23	12.50-50.00	34.50
	Low Level	55	32.09	8.90	1.20	0.28	13.00-46.50	34.50
Purdue Pegboard Assembly (number of pins, washers, collars)	High Level	54	45.31	6.65	0.90	0.15	22.50-57.00	45.50
	Medium Level	143	41.26	10.64	0.89	0.26	11.50-58.50	43.50
	Low Level	55	40.28	13.18	1.78	0.33	11.00-57.00	46.00
Stroop Color Word Test Part I (time-second)	High Level	54	10.42	2.06	0.28	0.20	7.02-15.26	10.40
	Medium Level	143	11.88	3.44	0.29	0.29	6.53-26.19	11.20
	Low Level	55	12.04	3.93	0.53	0.33	7.55-29.35	10.61
Stroop Color Word Test Part II (time-second)	High Level	54	11.67	2.44	0.33	0.21	7.67-18.90	11.58
	Medium Level	143	13.47	4.45	0.37	0.33	5.55-32.35	12.50
	Low Level	55	13.79	5.26	0.71	0.38	7.85-35.15	12.35
Stroop Color Word Test Part III (time-second)	High Level	54	14.42	3.74	0.51	0.26	9.12-26.14	15.00
	Medium Level	143	16.74	5.82	0.49	0.35	8.71-40.15	15.40
	Low Level	55	16.24	6.73	0.91	0.41	8.65-39.45	13.80
Stroop Color Word Test Part IV (time-second)	High Level	54	19.44	6.03	0.82	0.31	11.22-41.25	17.68
	Medium Level	143	22.65	9.37	0.78	0.41	10.00-52.00	19.22
	Low Level	55	21.68	10.17	1.37	0.47	10.33-48.26	17.16
Stroop Color Word Test Part V (time-second)	High Level	54	27.72	11.88	1.62	0.43	15.89-92.15	24.30
	Medium Level	143	39.46	26.50	2.22	0.67	15.60-135.25	31.00
	Low Level	55	42.77	34.27	4.62	0.80	16.25-135.42	25.35

Table 5.7. Descriptive statistics for Marital Status Factor

Response Variable	Marital Status	n	x̄	s	Std Error of x̄	CV (s/x̄)	Min-Max	Median
Digit Span Forward (number of digits)	Single	93	5.77	0.97	0.10	0.17	3.00-7.00	6.00
	Married	159	5.06	1.07	0.08	0.21	2.00-7.00	5.00
Digit Span Backward (number of digits)	Single	93	5.08	1.03	0.11	0.20	2.00-7.00	5.00
	Married	159	4.25	1.12	0.09	0.26	2.00-7.00	4.00
Corsi Span Forward (length of sequences)	Single	93	5.45	1.04	0.11	0.19	2.00-7.00	6.00
	Married	159	4.83	1.13	0.09	0.23	2.00-7.00	5.00
Corsi Span Backward (length of sequences)	Single	93	4.66	0.88	0.09	0.19	2.00-6.00	5.00
	Married	159	4.12	1.02	0.08	0.25	2.00-7.00	4.00
Reaction Time DH (millisecond)	Single	93	266.97	17.90	1.86	0.07	222.20-331.00	264.00
	Married	159	285.85	25.32	2.01	0.09	234.20-424.44	284.20
Reaction Time NDH (millisecond)	Single	93	282.28	44.78	4.64	0.16	228.20-678.30	273.40
	Married	159	296.56	29.66	2.35	0.10	247.80-431.80	290.40
Raven Test (number of correct answers)	Single	93	46.90	9.93	1.03	0.21	11.00-59.00	50.00
	Married	159	39.48	12.96	1.03	0.33	10.00-59.00	42.00
Purdue Pegboard DH (number of pins)	Single	93	13.38	2.40	0.25	0.18	4.00-18.50	13.50
	Married	159	11.30	2.87	0.23	0.25	4.50-17.50	11.50
Purdue Pegboard NDH (number of pins)	Single	93	12.24	2.18	0.23	0.18	5.00-17.00	12.00
	Married	159	10.45	2.68	0.21	0.26	4.00-16.50	11.00
Purdue Pegboard BH (number of pins)	Single	93	11.73	2.00	0.21	0.17	4.00-16.50	11.50
	Married	159	10.44	2.57	0.20	0.25	4.00-16.00	11.00
Purdue Pegboard Total (number of pins)	Single	93	37.35	6.21	0.64	0.17	13.00-50.00	37.00
	Married	159	32.19	7.90	0.63	0.25	12.50-48.50	33.00
Purdue Pegboard Assembly (number of pins, collars, washers)	Single	93	46.21	7.97	0.83	0.17	11.00-57.50	47.00
	Married	159	39.40	11.27	0.89	0.29	11.50-58.50	42.50
Stroop Color Word Test Part I (time-second)	Single	93	10.22	3.28	0.34	0.32	6.53-29.35	9.55
	Married	159	12.41	3.15	0.25	0.25	7.51-22.15	12.16

Table 5.7. Descriptive statistics for Marital Status Factor (cont.)

Response Variable	Marital Status	n	x̄	s	Std Error of x̄	CV (s/x̄)	Min-Max	Median
Stroop Color Word Test Part II (time-second)	Single	93	11.34	3.48	0.36	0.31	7.50-35.15	10.90
	Married	159	14.21	4.48	0.36	0.32	5.55-32.35	13.50
Stroop Color Word Test Part III (time-second)	Single	93	13.61	4.39	0.46	0.32	8.65-39.45	13.00
	Married	159	17.61	5.89	0.47	0.33	8.71-40.15	16.37
Stroop Color Word Test Part IV (time-second)	Single	93	17.67	6.76	0.70	0.38	10.00-48.26	15.90
	Married	159	24.14	9.32	0.74	0.39	10.31-52.00	20.10
Stroop Color Word Test Part V (time second)	Single	93	27.24	20.66	2.14	0.76	15.60-135.42	21.22
	Married	159	43.76	27.85	2.21	0.64	16.56-135.25	35.00

Table 5.8. Descriptive statistics for Smoking Habbit Factor

Response Variable	Smoking Habit	n	x̄	s	Std Error of x̄	CV (s/x̄)	Min-Max	Median
Digit Span Forward (number of digits)	Smoker	83	5.57	0.91	0.10	0.16	3.00-7.00	6.00
	Non-Smoker	169	5.21	1.15	0.09	0.22	2.00-7.00	5.00
Digit Span Backward (number of digits)	Smoker	83	4.86	0.96	0.11	0.20	3.00-7.00	5.00
	Non-Smoker	169	4.41	1.22	0.09	0.28	2.00-7.00	5.00
Corsi Span Forward (length of sequences)	Smoker	83	5.37	0.88	0.10	0.16	3.00-7.00	5.00
	Non-Smoker	169	4.91	1.21	0.09	0.25	2.00-7.00	5.00
Corsi Span Backward length of sequences)	Smoker	83	4.53	0.74	0.08	0.16	3.00-6.00	5.00
	Non-Smoker	169	4.21	1.10	0.08	0.26	2.00-7.00	4.00
Reaction Time Dominant Hand (millisecond)	Smoker	83	272.66	16.32	1.79	0.06	240.28-307.30	269.90
	Non-Smoker	169	281.94	27.29	2.10	0.10	222.20-424.44	276.20
Reaction Time Non-Dominant Hand (millisecond)	Smoker	83	289.00	45.79	5.03	0.16	252.30-678.30	284.80
	Non-Smoker	169	292.41	31.14	2.40	0.11	228.20-431.80	286.40
Raven Test (number of correct answers)	Smoker	83	45.30	8.93	0.98	0.20	19.00-59.00	47.00
	Non-Smoker	169	40.71	13.62	1.05	0.33	10.00-59.00	45.00
Purdue Pegboard Dominant Hand (number of pins)	Smoker	83	12.66	2.13	0.23	0.17	7.50-17.50	12.50
	Non-Smoker	169	11.78	3.16	0.24	0.27	4.00-18.50	12.50
Purdue Pegboard Non-Dominant Hand (number of pins)	Smoker	83	11.57	2.02	0.22	0.17	5.50-17.00	11.50
	Non-Smoker	169	10.88	2.88	0.22	0.26	4.00-16.50	11.50

Table 5.8. Descriptive statistics for Smoking Habbit Factor (cont.)

Response Variable	Smoking Habit	n	$\bar{x}$	s	Std Error of $\bar{x}$	CV (s/ $\bar{x}$)	Min-Max	Median
Purdue Pegboard Both Hand (number of pins)	Smoker	83	11.42	1.86	0.20	0.16	6.00-16.50	11.50
	Non-Smoker	169	10.67	2.67	0.21	0.25	4.00-15.00	11.50
Purdue Pegboard Total (number of pins)	Smoker	83	35.64	5.69	0.62	0.16	19.00-50.00	35.00
	Non-Smoker	169	33.33	8.45	0.65	0.25	12.50-48.50	35.00
Purdue Pegboard Assembly (number of pins, collars, washers)	Smoker	83	44.14	7.67	0.84	0.17	20.00-57.00	46.00
	Non-Smoker	169	40.82	11.75	0.90	0.29	11.00-58.50	44.00
Stroop Color Word Test Part I (time-second)	Smoker	83	10.91	1.95	0.21	0.18	7.55-15.50	10.61
	Non-Smoker	169	11.93	3.83	0.29	0.32	6.53-29.35	11.00
Stroop Color Word Test Part II (time-second)	Smoker	83	12.24	2.36	0.26	0.19	7.85-18.02	12.33
	Non-Smoker	169	13.61	5.01	0.39	0.37	5.55-35.15	12.45
Stroop Color Word Test Part III (time-second)	Smoker	83	15.24	3.72	0.41	0.24	9.12-25.65	15.06
	Non-Smoker	169	16.57	6.44	0.50	0.39	8.65-40.15	15.00
Stroop Color Word Test Part IV (time-second)	Smoker	83	20.96	7.64	0.84	0.36	10.00-45.45	18.33
	Non-Smoker	169	22.14	9.62	0.74	0.43	10.22-52.00	18.90
Stroop Color Word Test Part V(time-second)	Smoker	83	31.90	16.41	1.80	0.51	15.60-100.50	26.21
	Non-Smoker	169	40.50	30.04	2.31	0.74	15.89-135.42	28.55

5.2.5. Box Plots of Responses w.r.t. Independent Variable Groups

Bowplots for each level of experimental factors which are age, education, income level, smoking habit and maritial status can be found below.

Boxplot in Figure 5.18 shows the decrease in digit span after the age of 50.

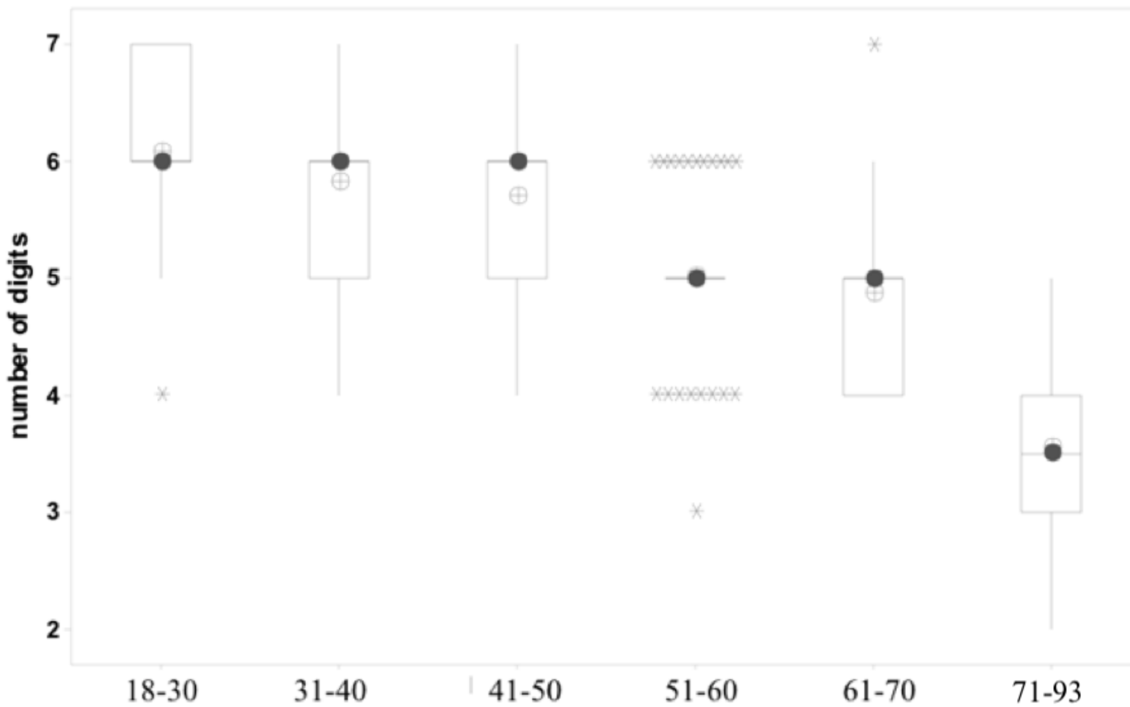


Figure 5.18. Box plot of Digit Forward Test according to age group (in years)

Boxplot in Figure 5.19 shows the decrease in digit backward span after the age of 50.

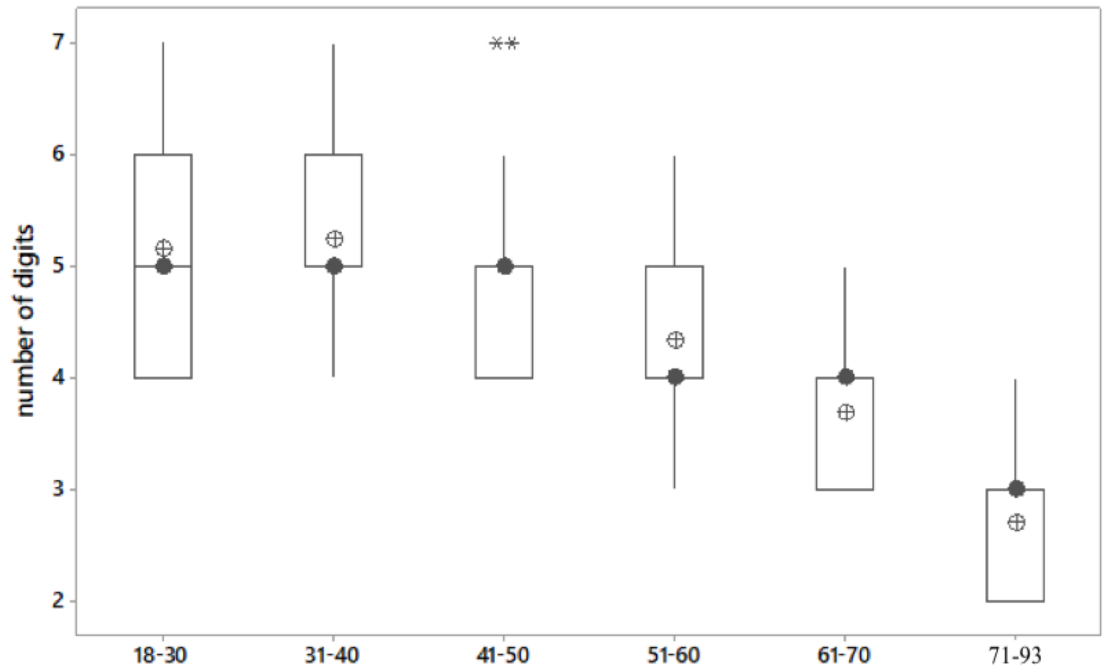


Figure 5.19. Box plot of Digit Backward Test according to age groups

According to boxplot in Figure 5.20, there is a decreasing trend after the age of 50.

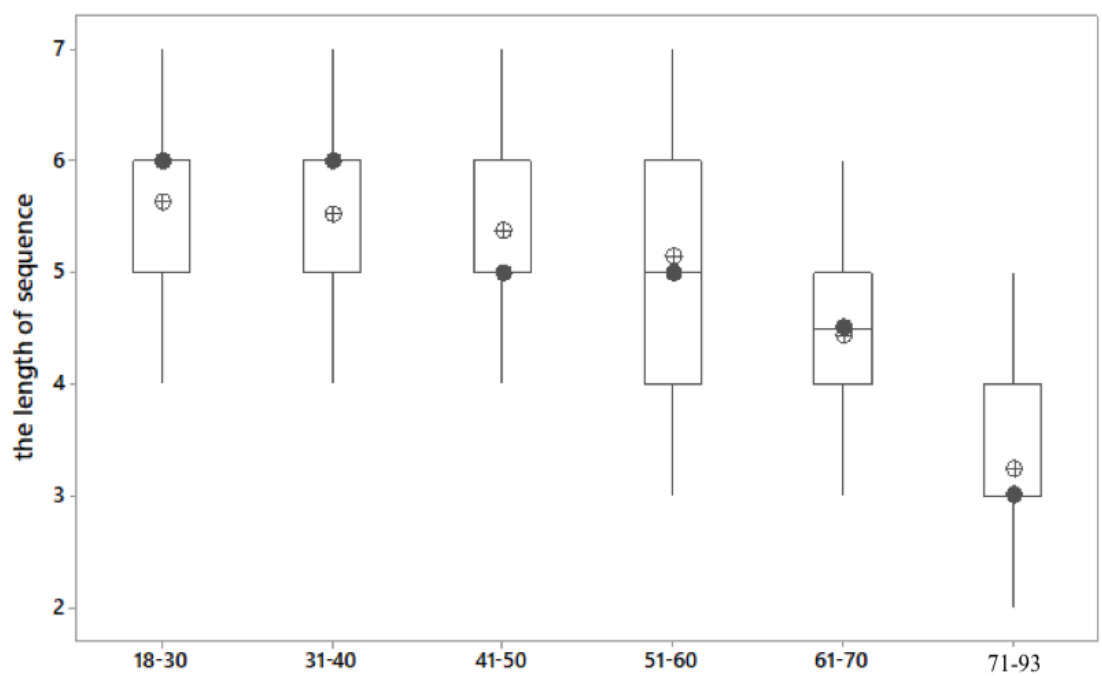


Figure 5.20. Box plot of Corsi Forward Test according to age group

According to boxplot in Figure 5.21, there is a decreasing trend after the age of 50.

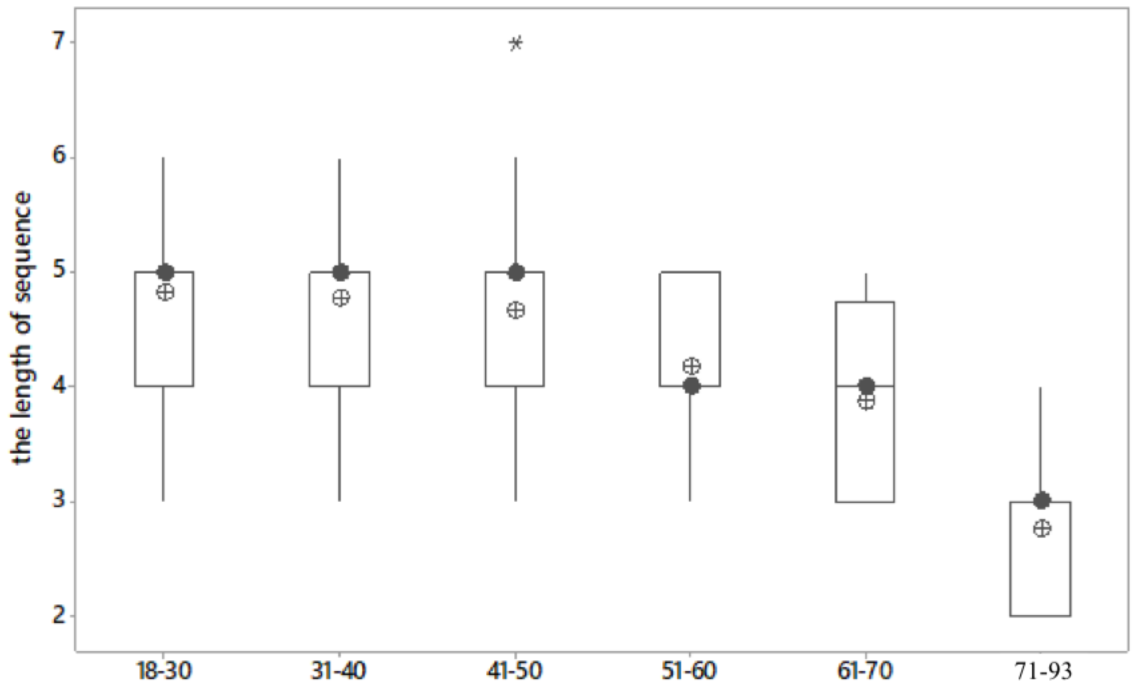


Figure 5.21. Box plot of Corsi Backward Test according to age groups

Boxplot in Figure 5.22 shows the increase in reaction time with aging.

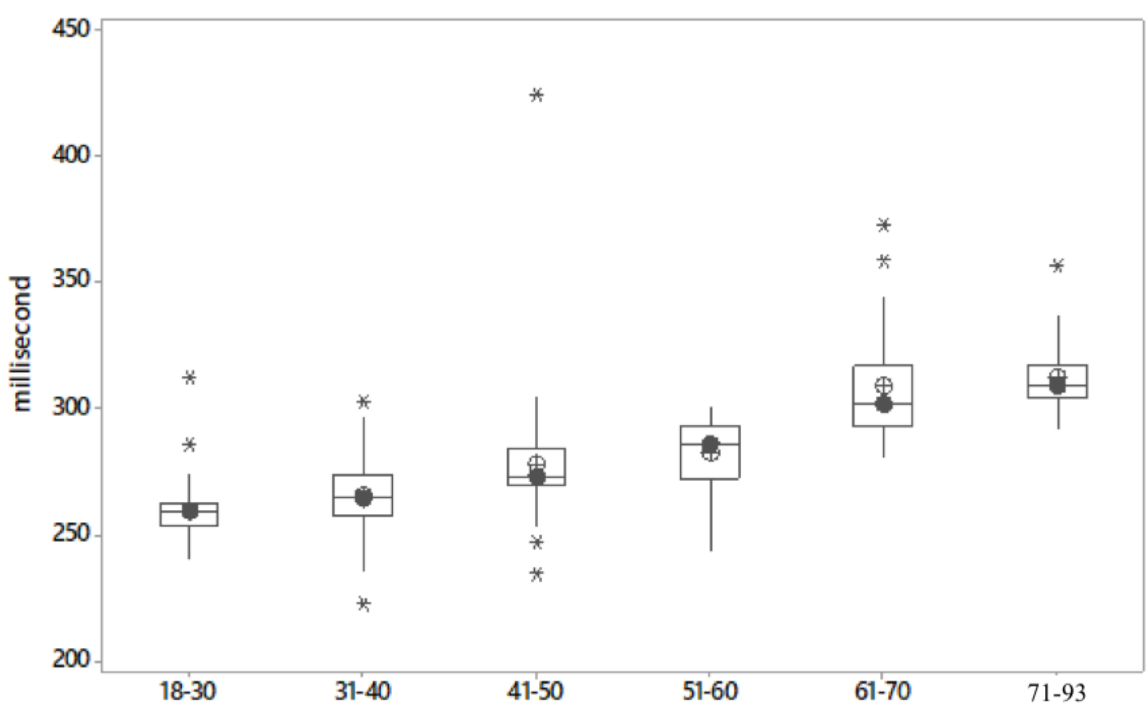


Figure 5.22. Box plot of Reaction Time (Dominant Hand) according to age groups

According to boxplot in 5.23, there is an increasing trend in reaction time with aging.

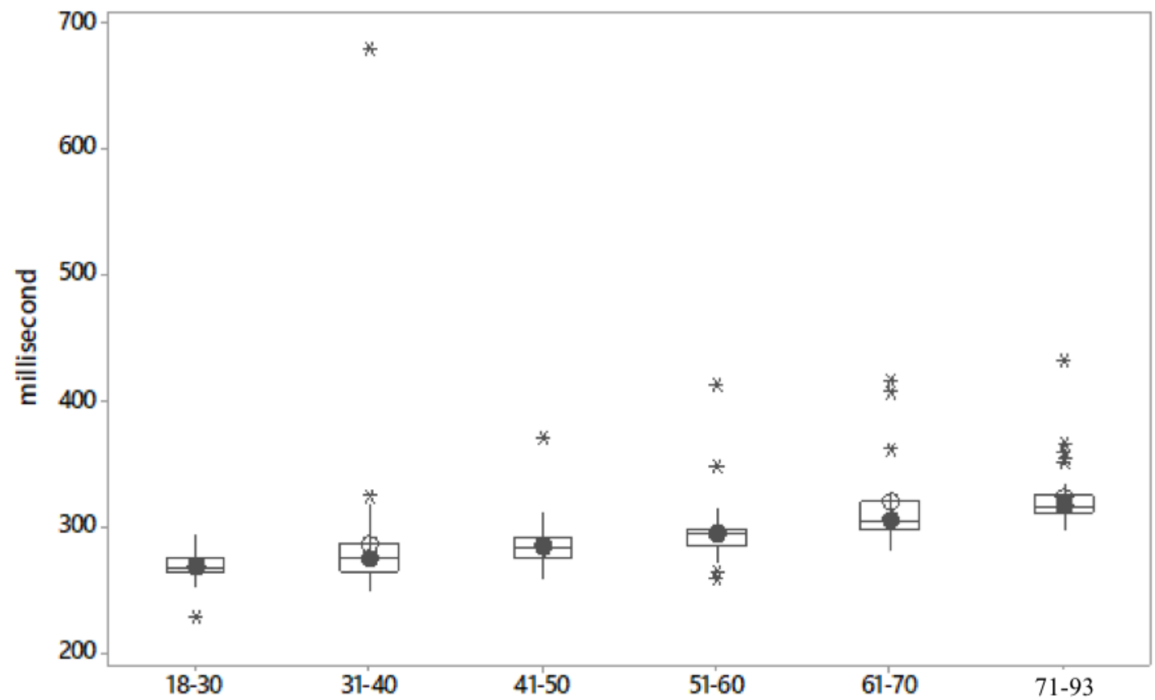


Figure 5.23. Box plot of Reaction Time (Non-Dominant Hand) according to age group

According to boxplot in Figure 5.24, there is a decreasing trend after the age of 50.

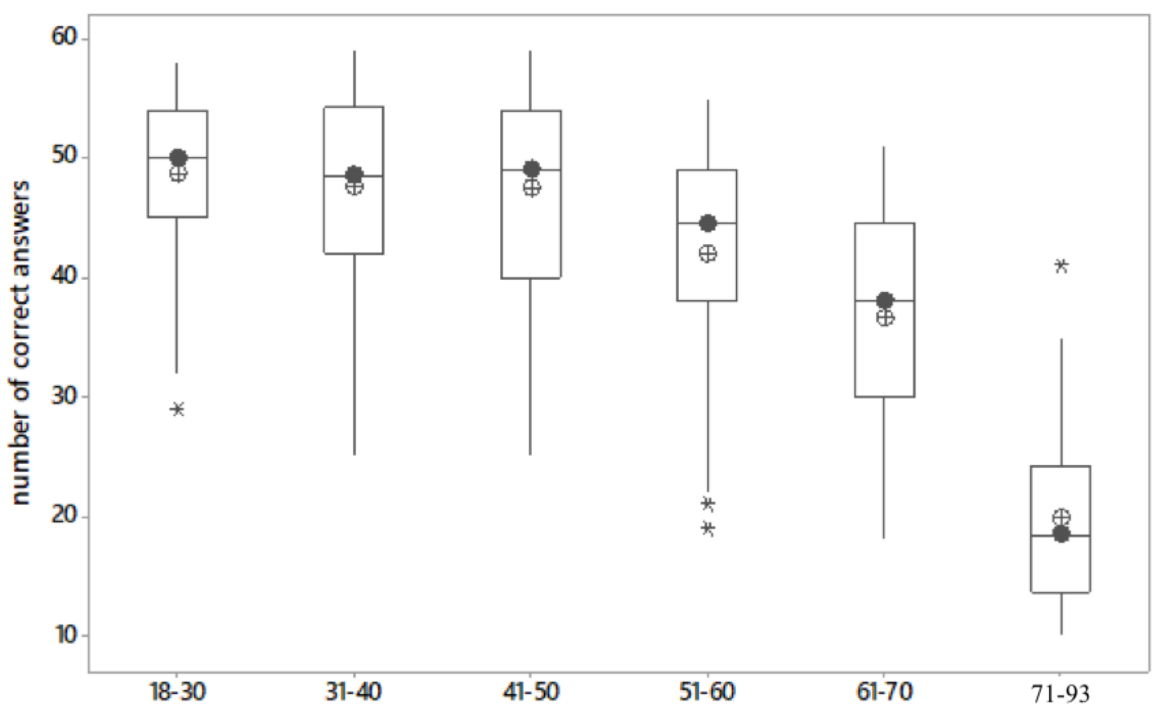


Figure 5.24. Box plot of Raven Test according to age group

According to boxplots between 5.26-5.29, there is an decreasing trend in number of pins with aging.

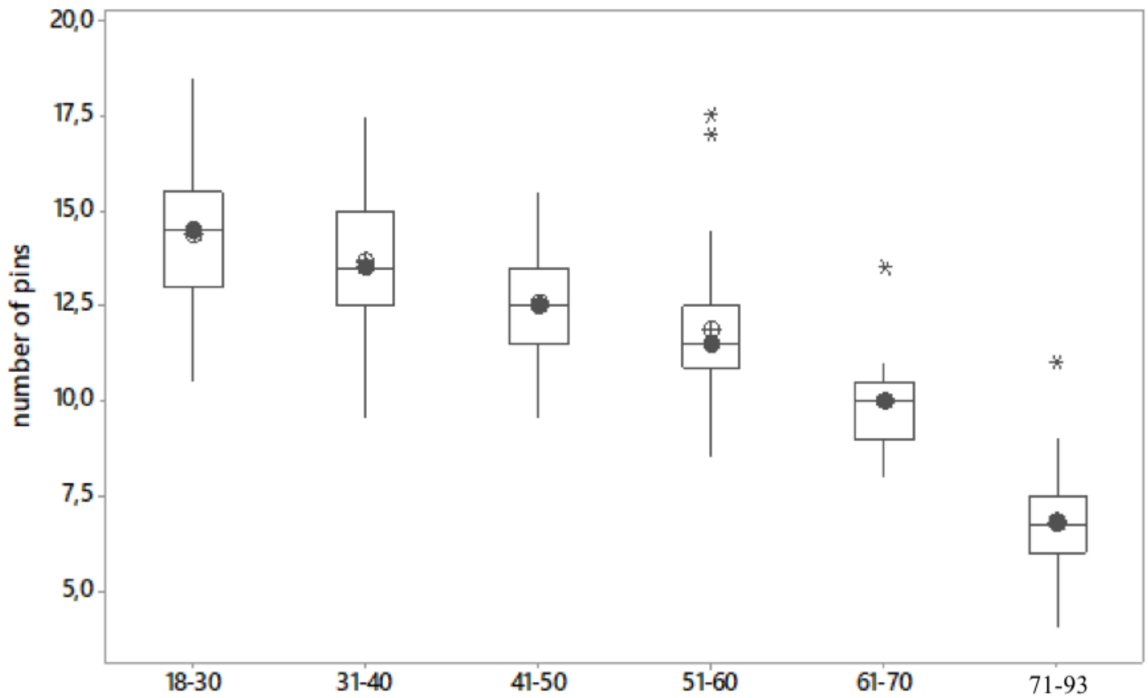


Figure 5.25. Box plot of Purdue Pegboard (Dominant Hand) according to age group

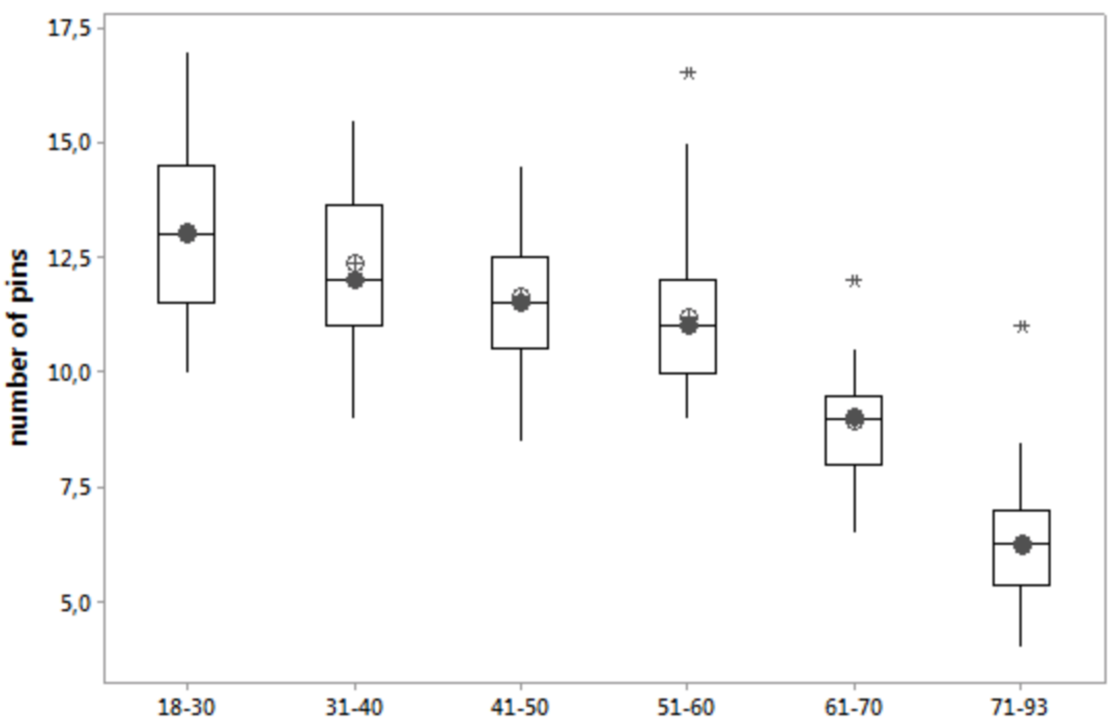


Figure 5.26. Box plot of Purdue Pegboard (Non-Dominant Hand) according to age group

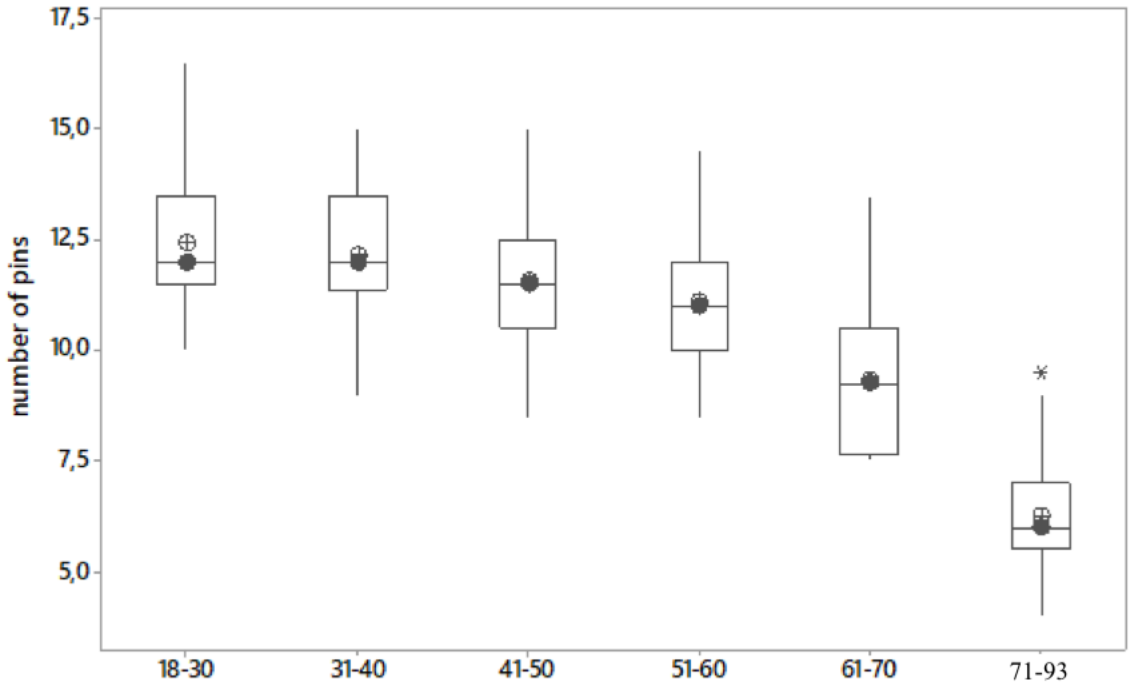


Figure 5.27. Box plot of Purdue Pegboard (Both Hand) according to age group

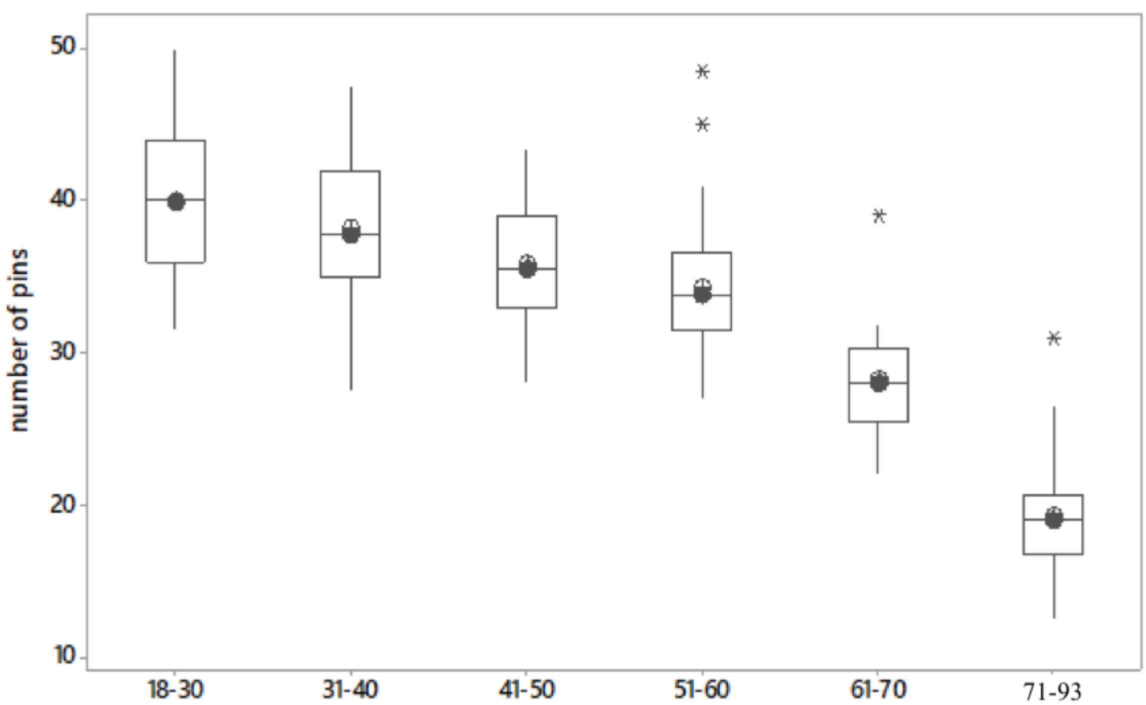


Figure 5.28. Box plot of Purdue Pegboard (Total) according to age group

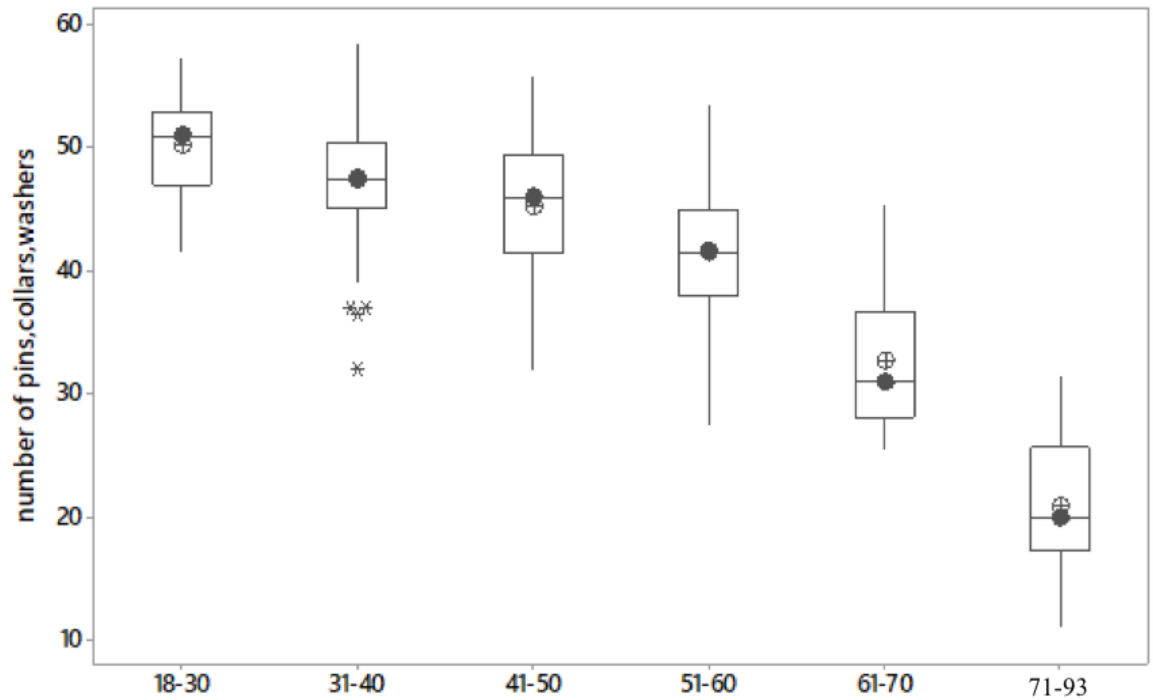


Figure 5.29. Box plot of Purdue Pegboard (Assembly) according to age group

According to boxplots between 5.30-5.34, there is an increasing trend in completion time in seconds with aging.

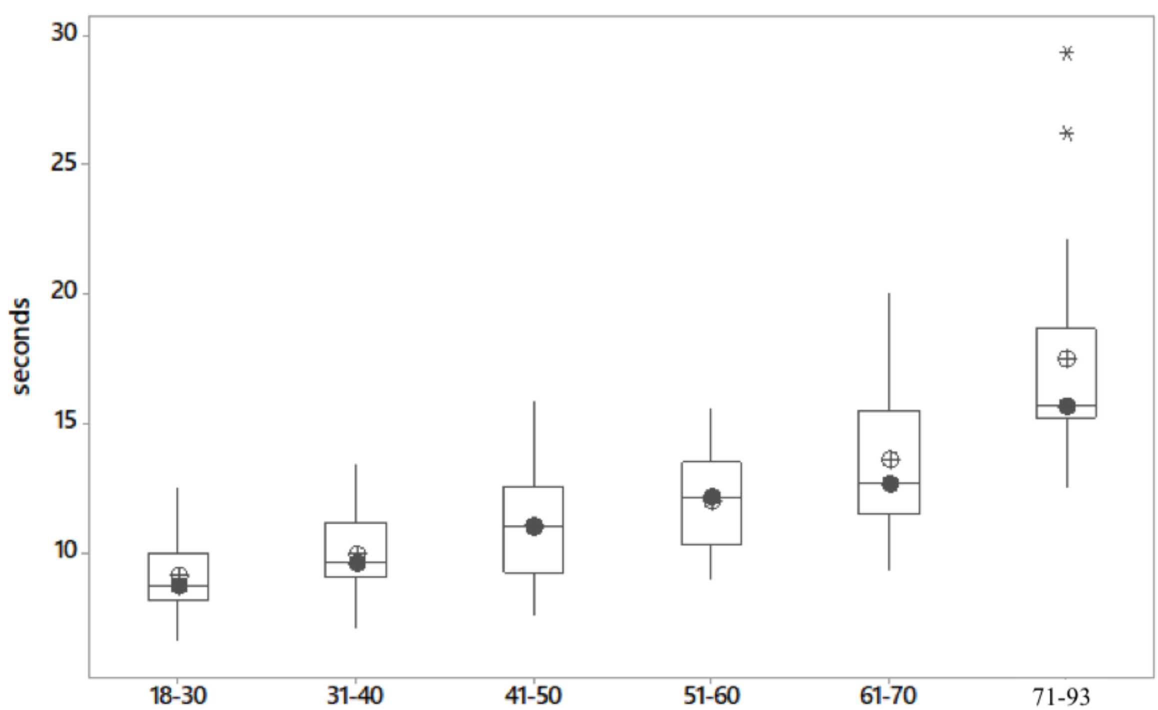


Figure 5.30. Box plot of Stroop Color Word Test Part I according to age group

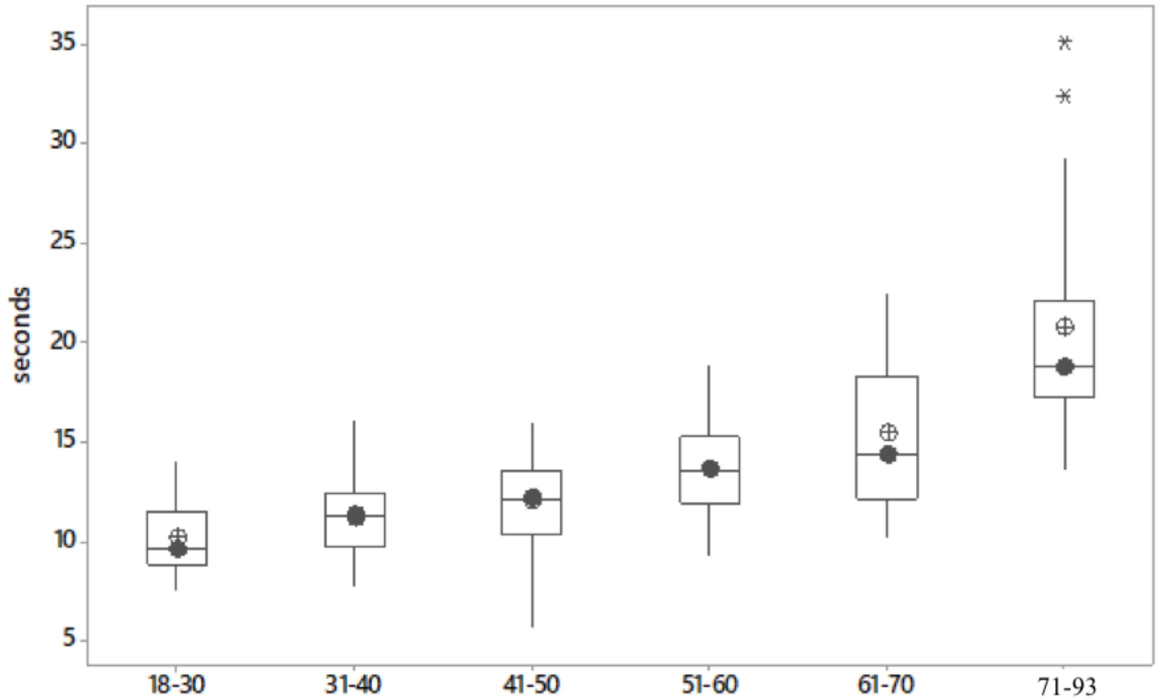


Figure 5.31. Box plot of Stroop Color Word Test Part II according to age group

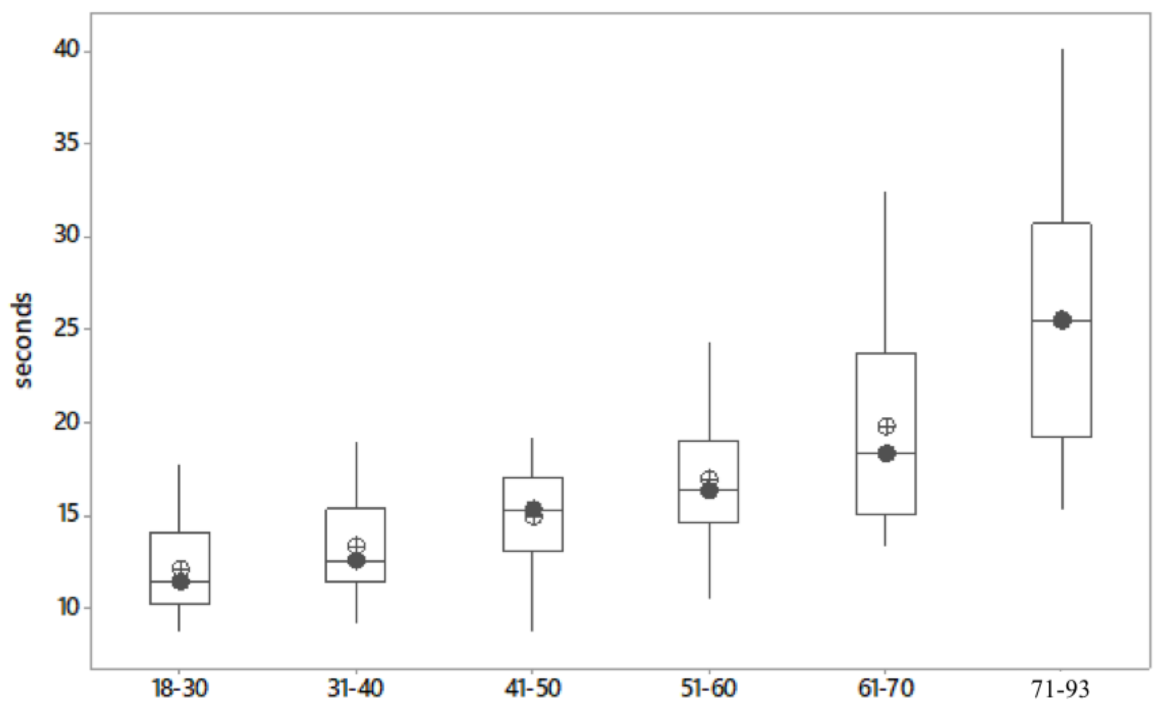


Figure 5.32. Box plot of Stroop Color Word Test Part III according to age group

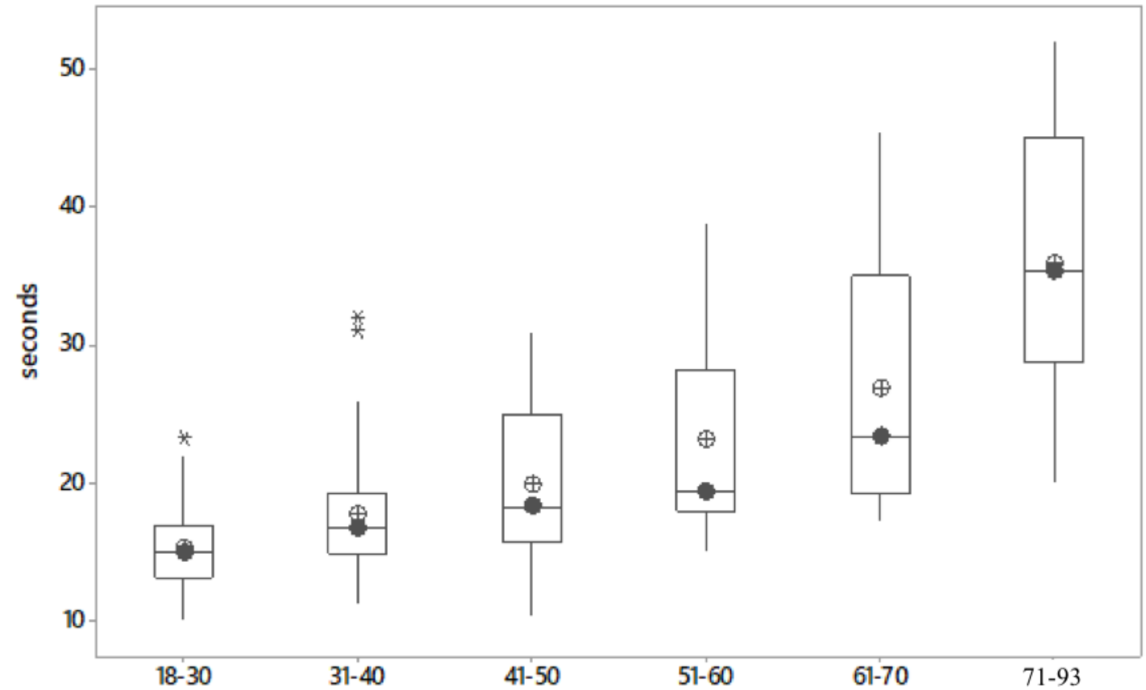


Figure 5.33. Box plot of Stroop Color Word Test Part IV according to age group

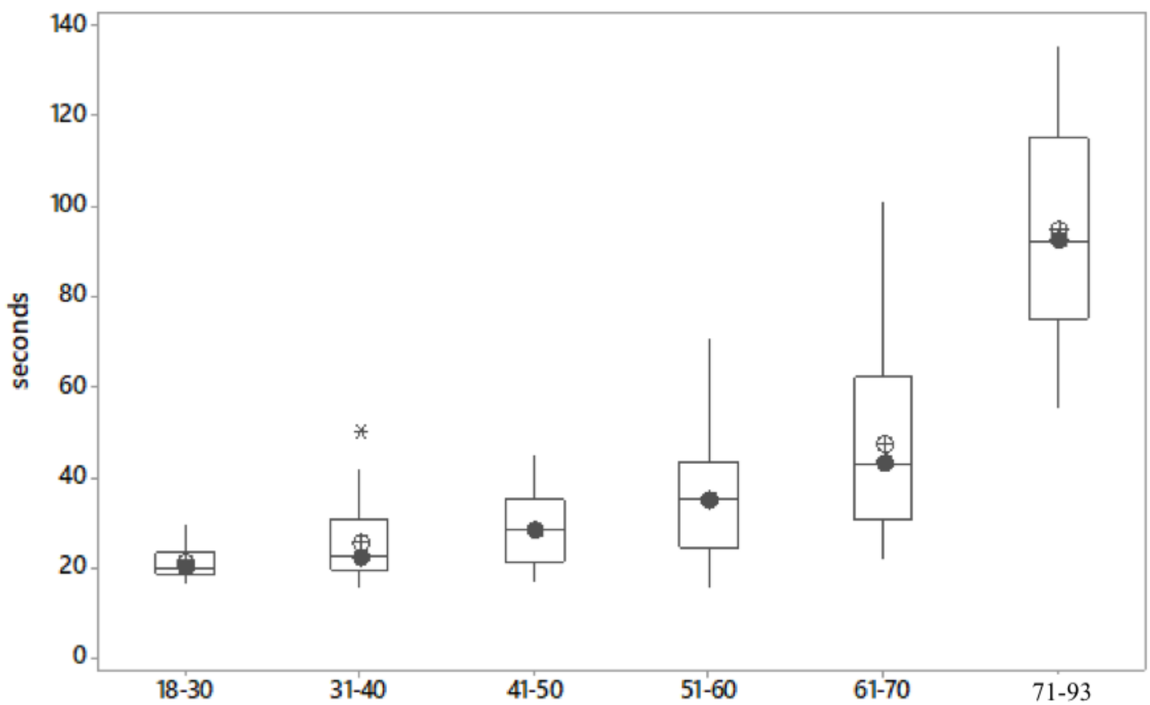


Figure 5.34. Box plot of Stroop Color Word Test Part V according to age group

Boxplot in Figure 5.35 shows the increase in digit span with education.

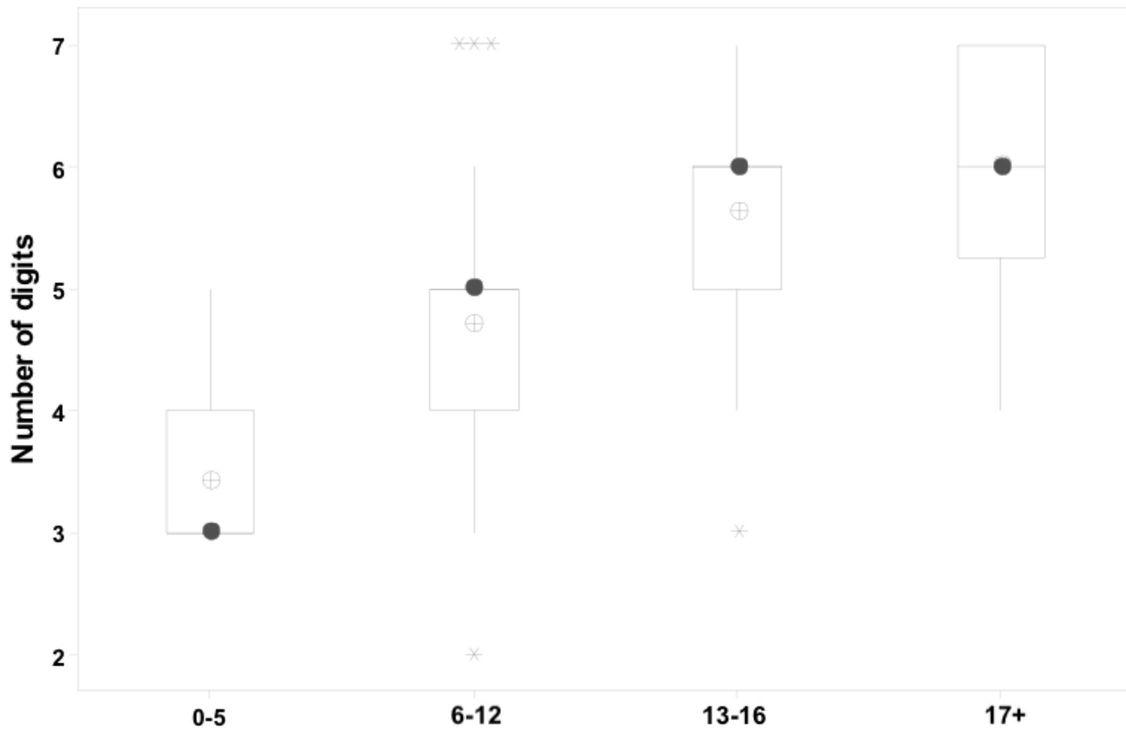


Figure 5.35. Box plot of Digit Forward Test according to education groups (in years)

According to boxplot in Figure 5.36, there is an increasing trend.

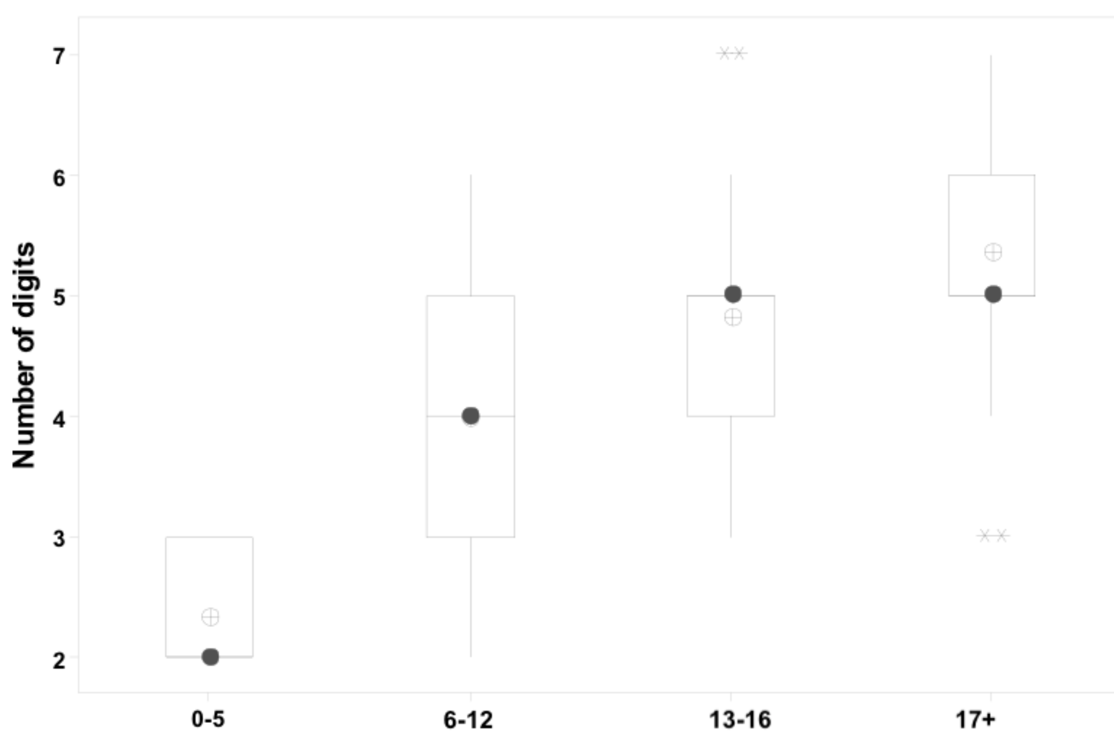


Figure 5.36. Box plot of Digit Backward Test according to education groups

Boxplots in Figure 5.37 and 5.38 show the increase in corsi span with education.

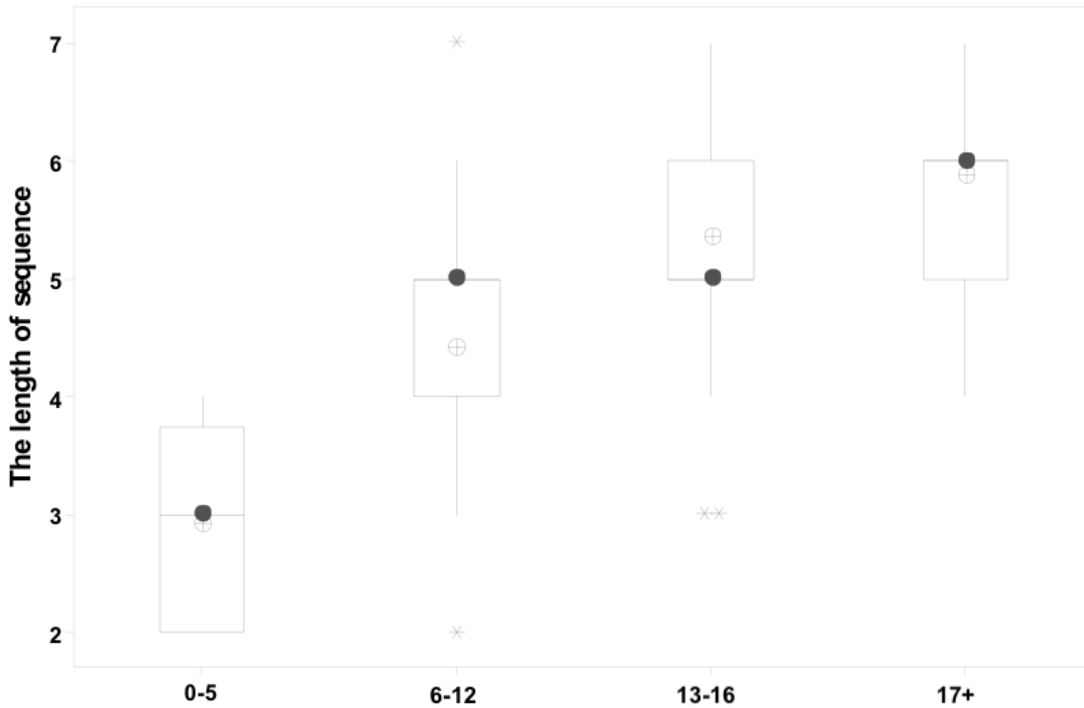


Figure 5.37. Box plot of Corsi Forward Test according to education groups

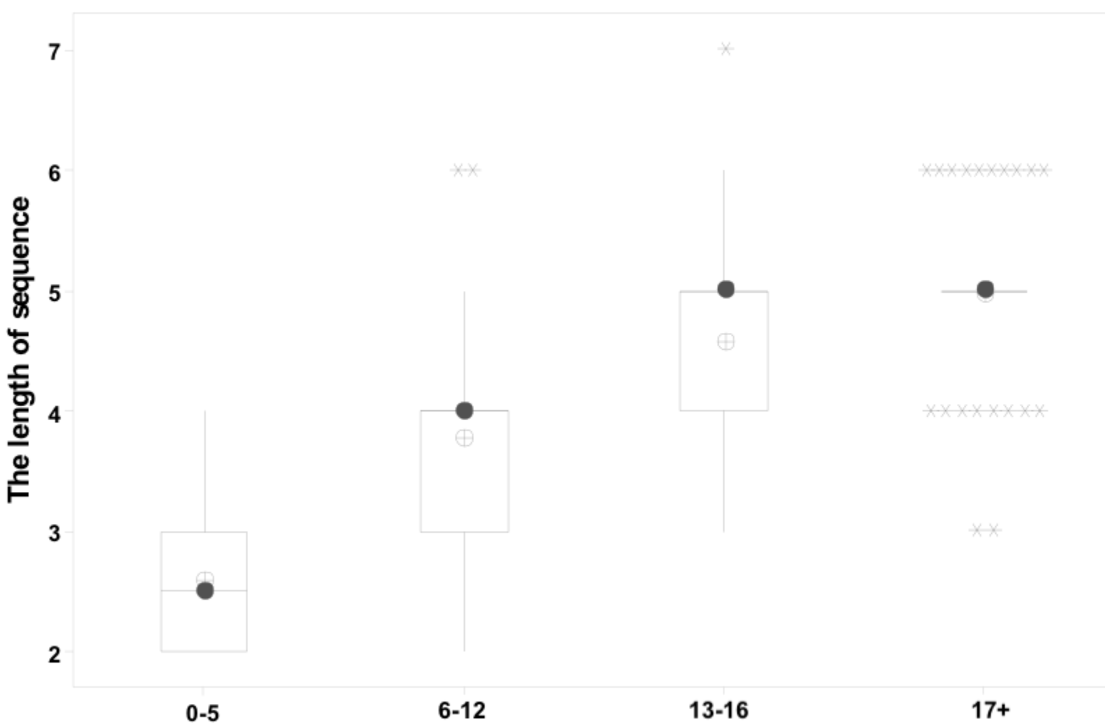


Figure 5.38. Box plot of Corsi Backward Test according to education groups

According to boxplots in Figure 5.39 and 5.40, there is a decreasing trend in reaction time after the 5 years of education. But after that, there is not any decresing trend with education.

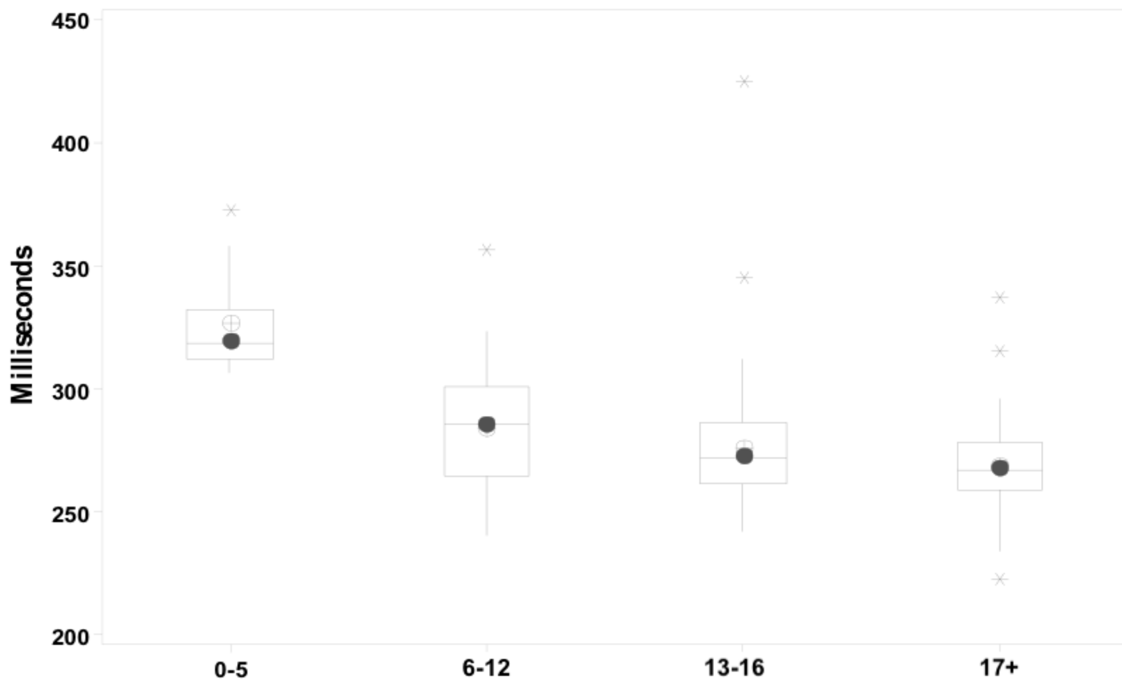


Figure 5.39. Box plot of Reaction Time (Dominant Hand) according to education groups

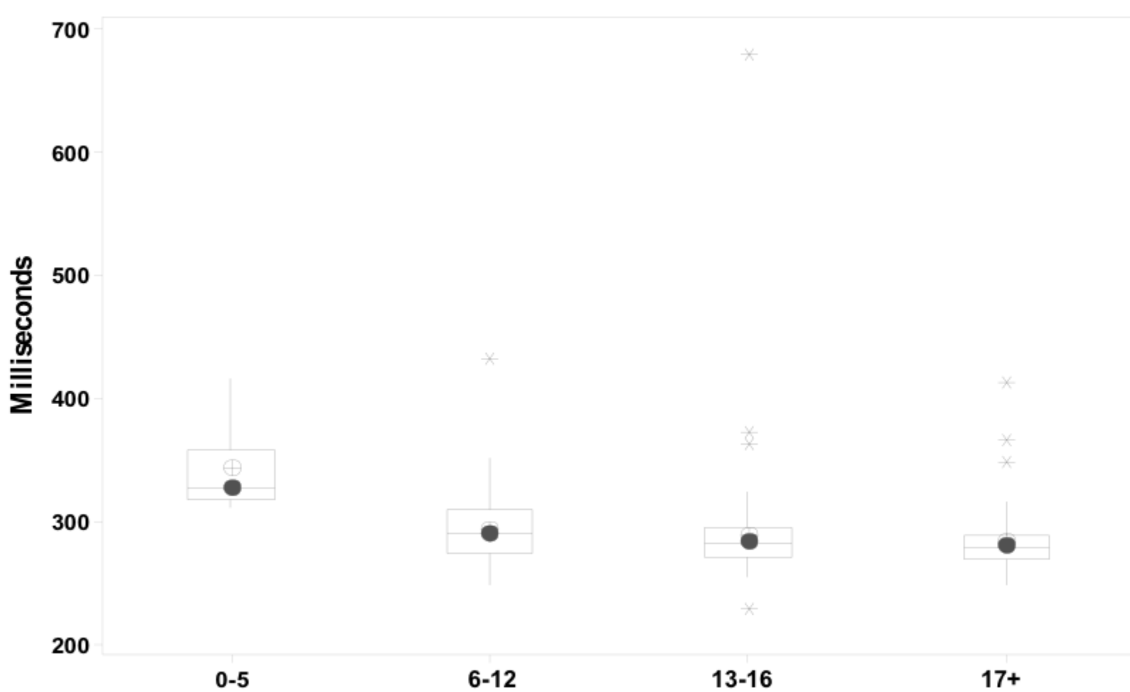


Figure 5.40. Box plot of Reaction Time (Non Dominant Hand) according to education groups

Boxplot in Figure 5.41 shows the increse in number of correct answers with education year.

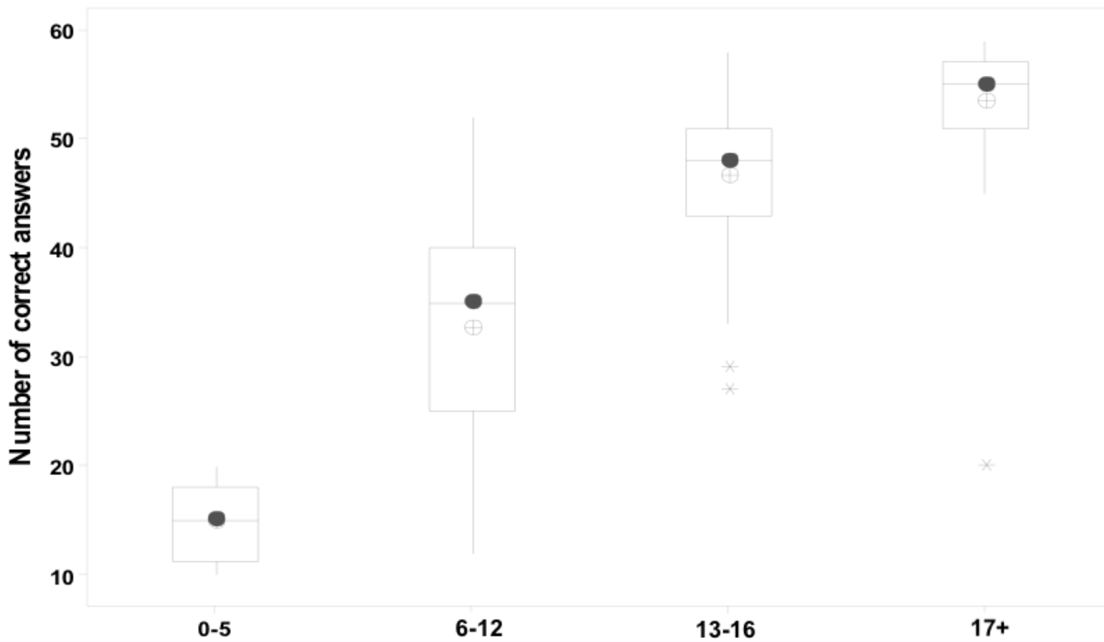


Figure 5.41. Box plot of Raven Test Results according to education groups

According to boxplots between Figure 5.42-5.45, there is an icreasing trend in number of pins after the 5 years of education. But after that, there is not any increasing trend with education.

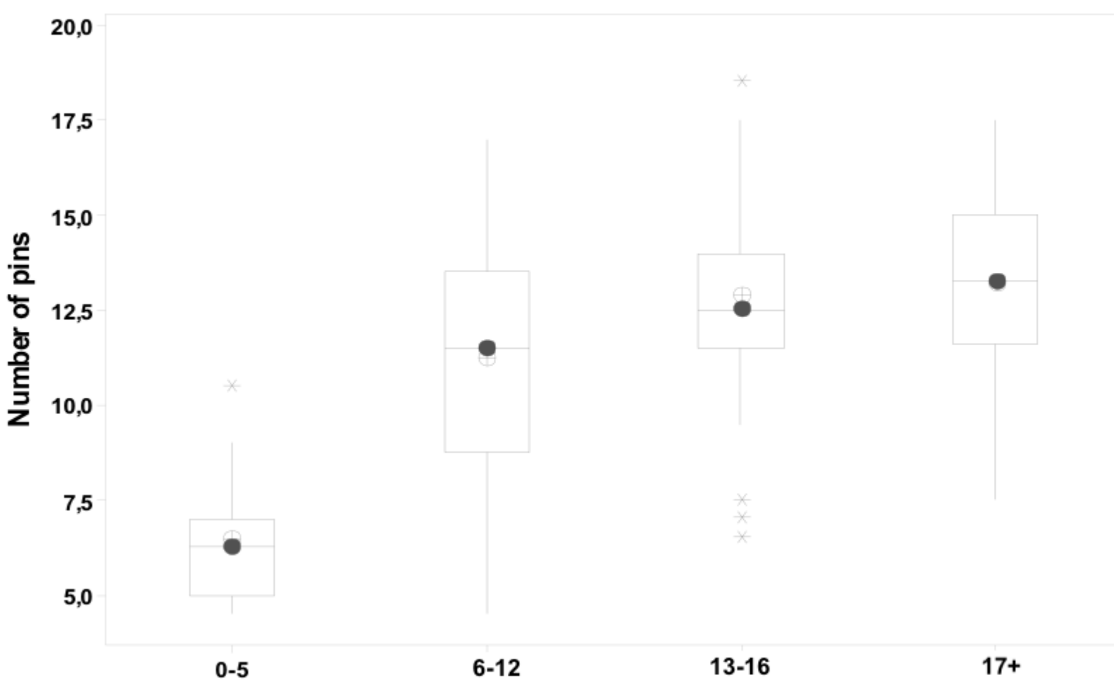


Figure 5.42. Box plot of Purdue Pegboard (Dominant Hand) according to education groups

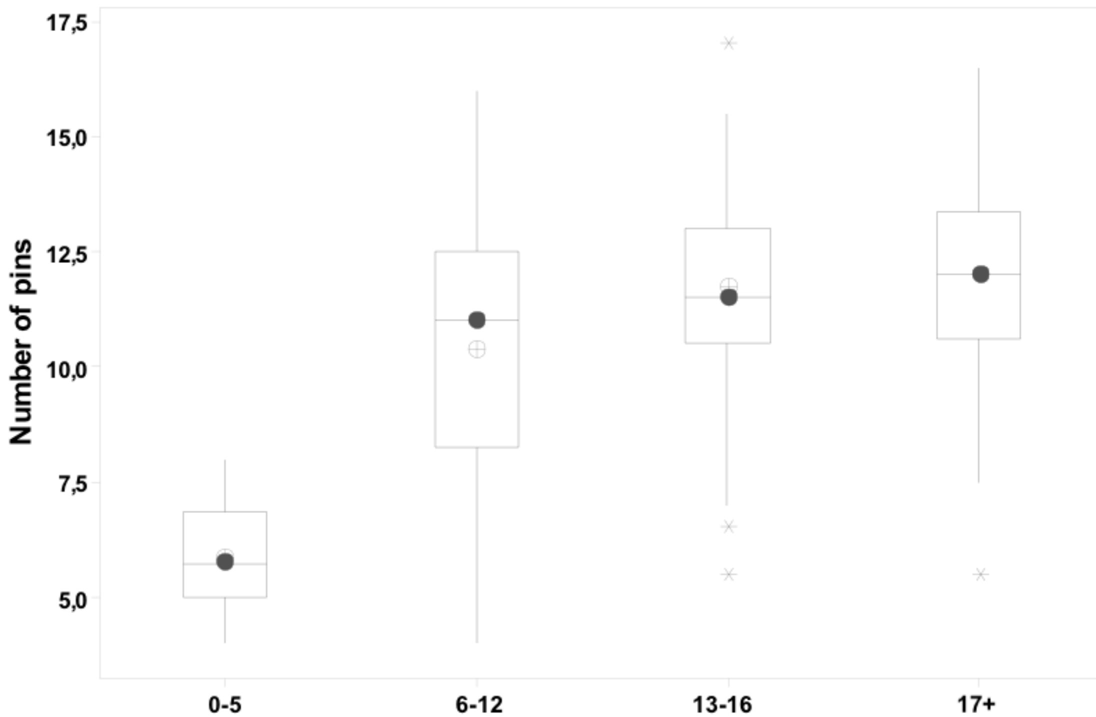


Figure 5.43. Box plot of Purdue Pegboard (Non-Dominant Hand) according to education groups

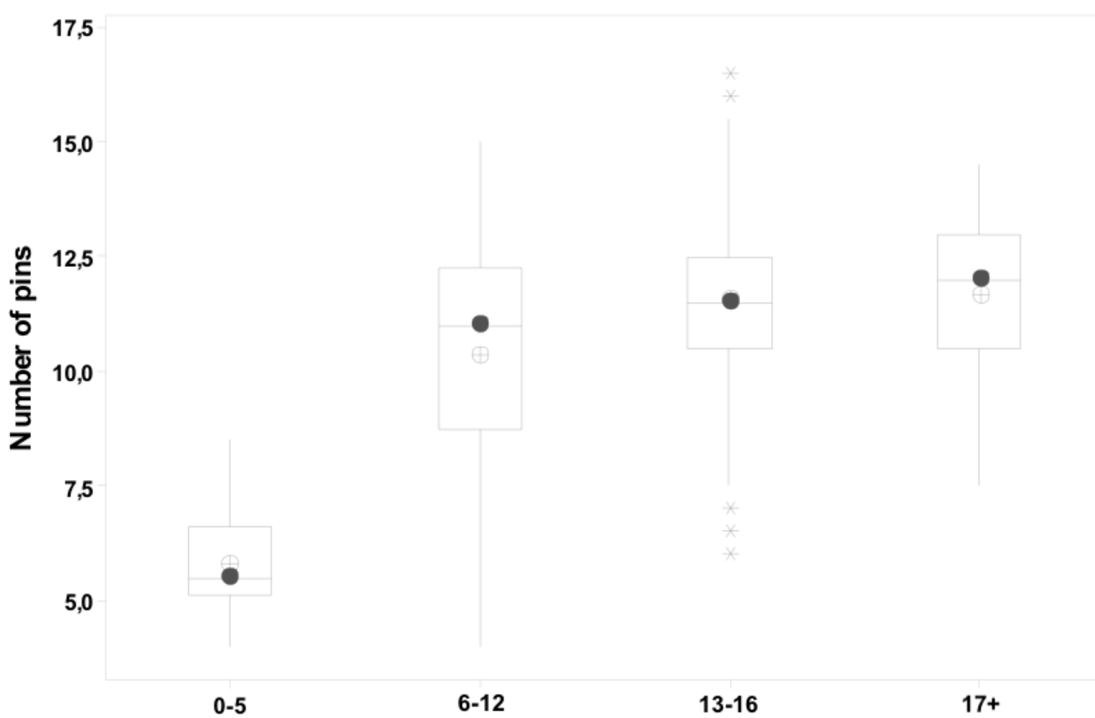


Figure 5.44. Box plot of Purdue Pegboard (Both Hand) according to education groups

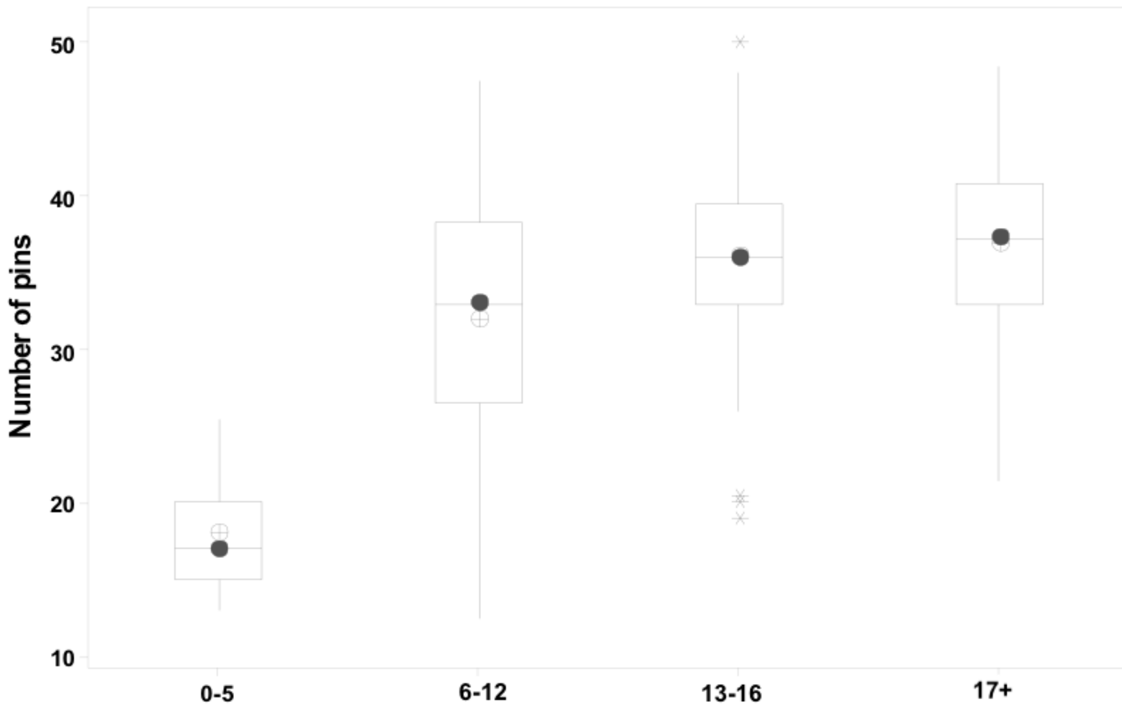


Figure 5.45. Box plot of Purdue Pegboard (Total) according to education groups

Boxplot in Figure 5.46 shows the increase in number of pins, collars ans washers with education

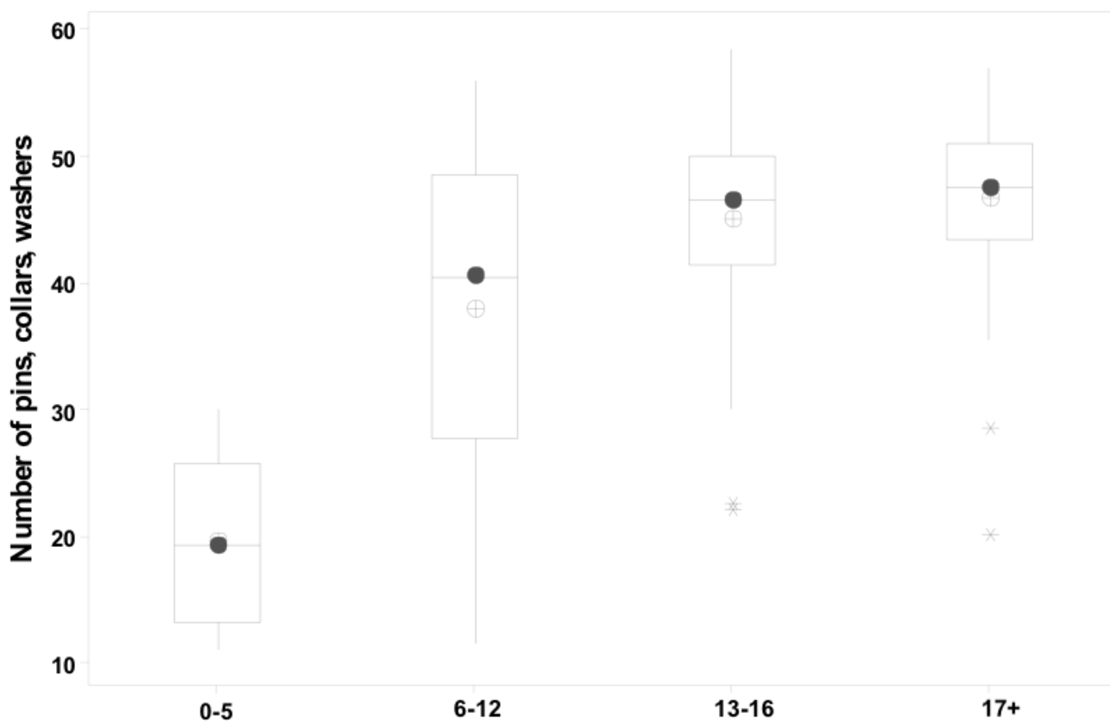


Figure 5.46. Box plot of Purdue Pegboard (Assembly) according to education groups

According to boxplots between Figure 5.47-5.51, there is a decreasing trend in completion time after the 5 years of education. But after that, there is not any decreasing trend with education.

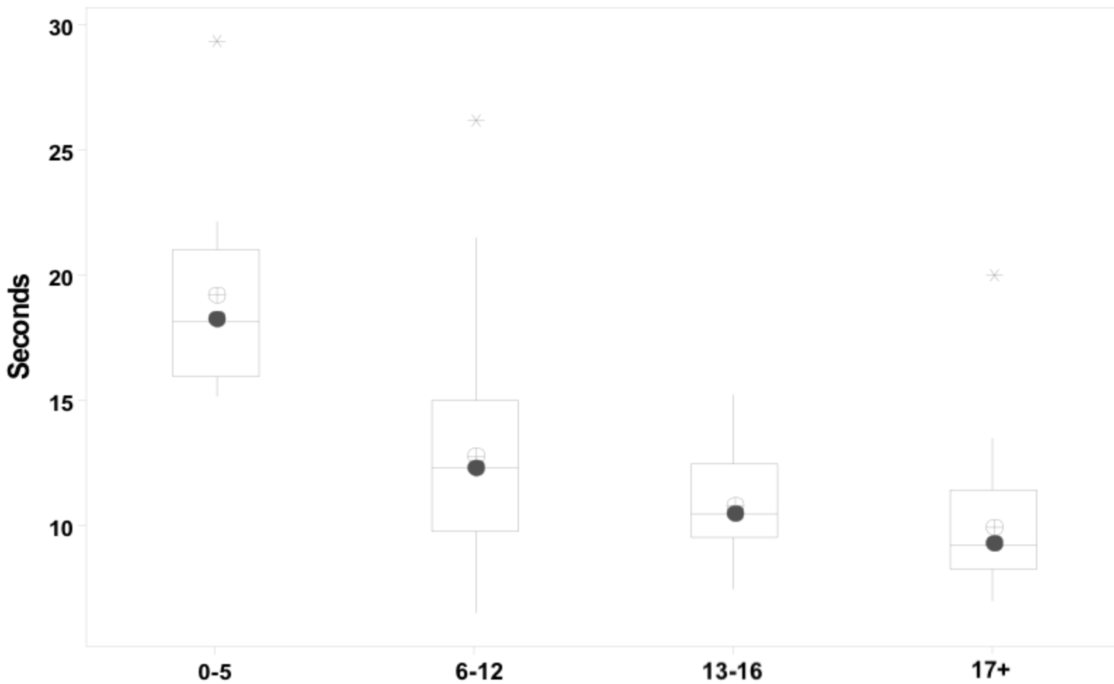


Figure 5.47. Box plot of Stroop Color Word Test Part I according to education groups

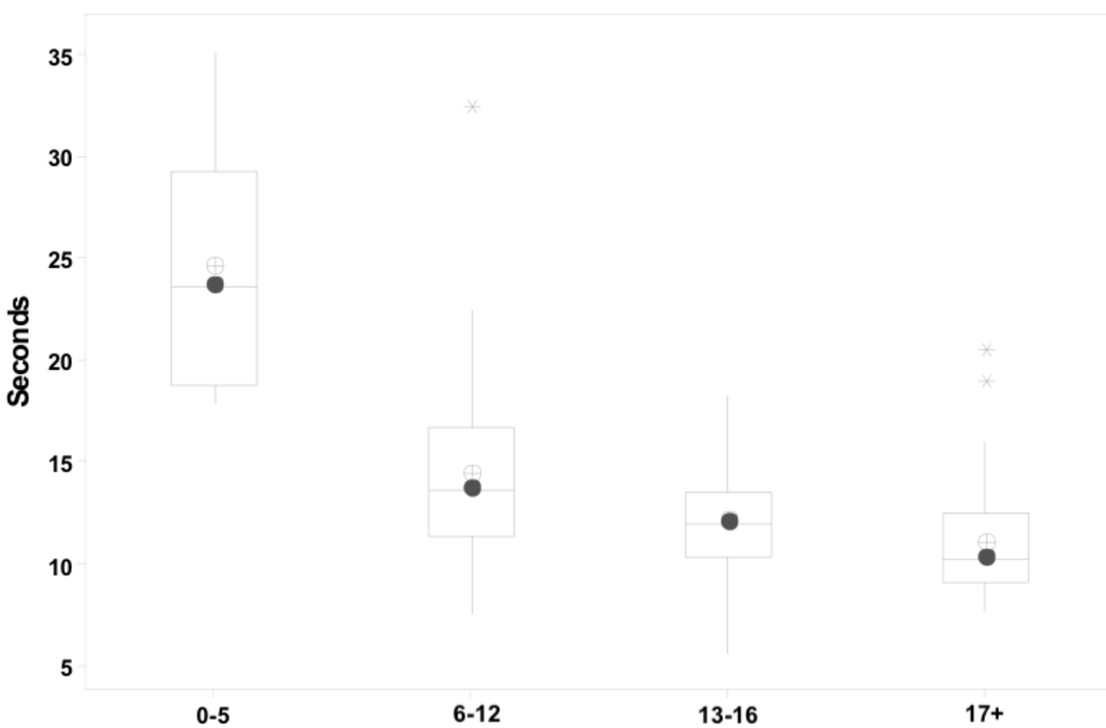


Figure 5.48. Box plot of Stroop Color Word Test Part II according to education groups

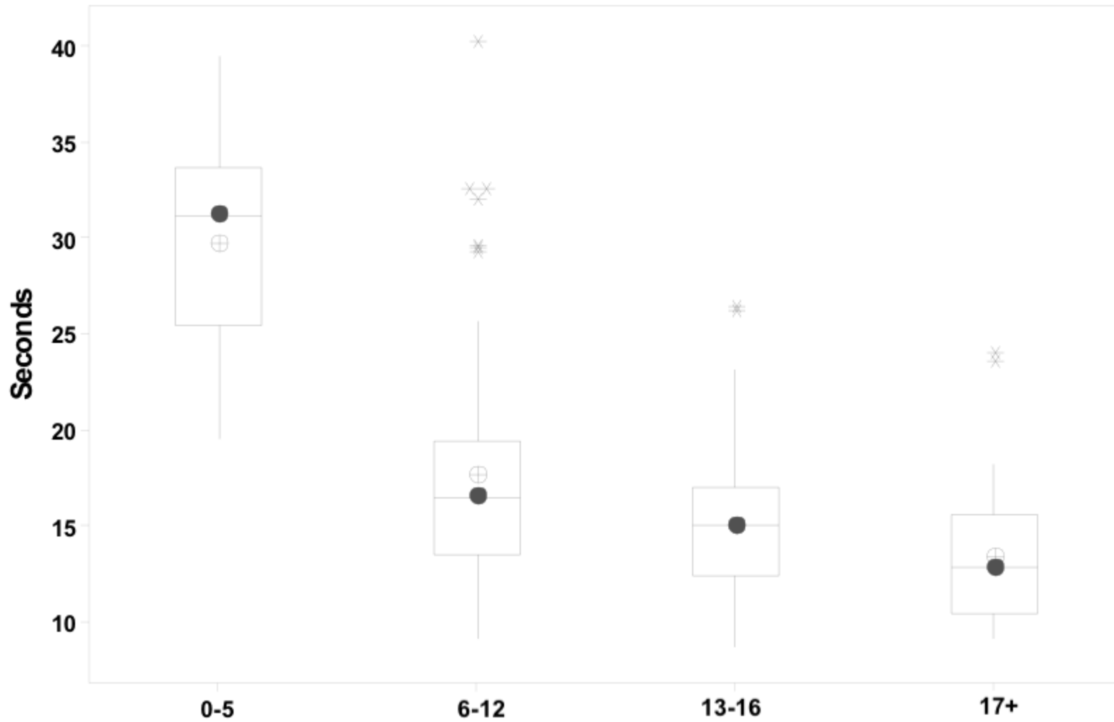


Figure 5.49. Box plot of Stroop Color Word Test Part III according to education groups

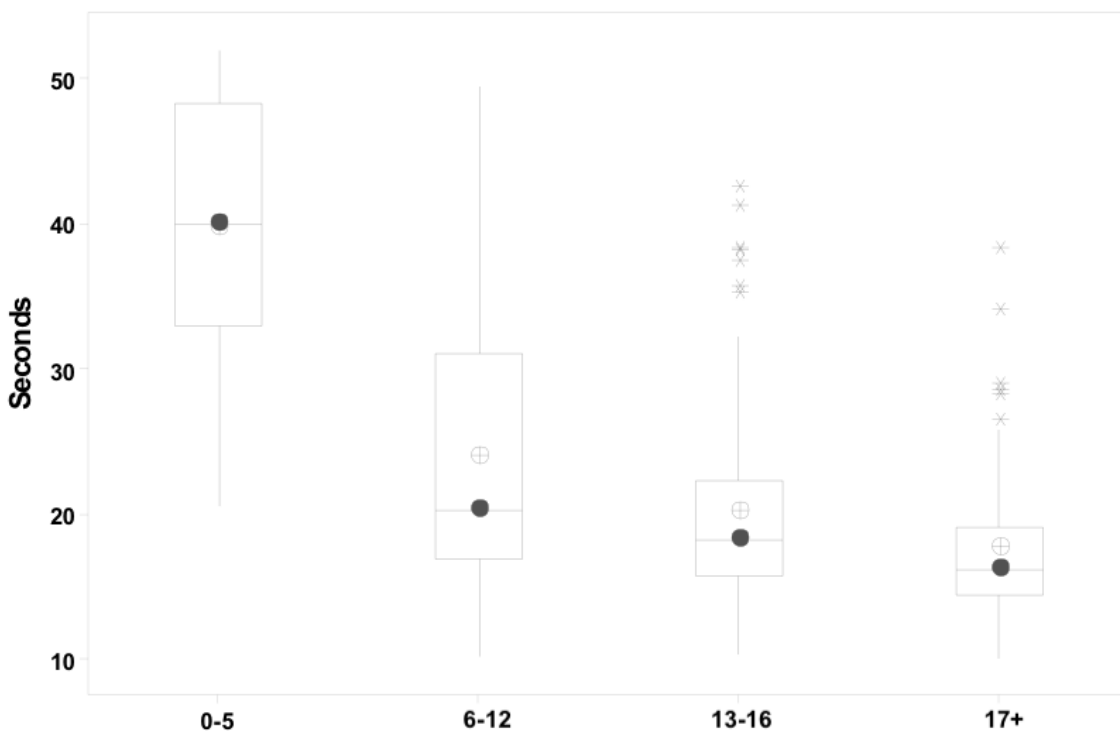


Figure 5.50. Box plot of Stroop Color Word Test Part IV according to education groups

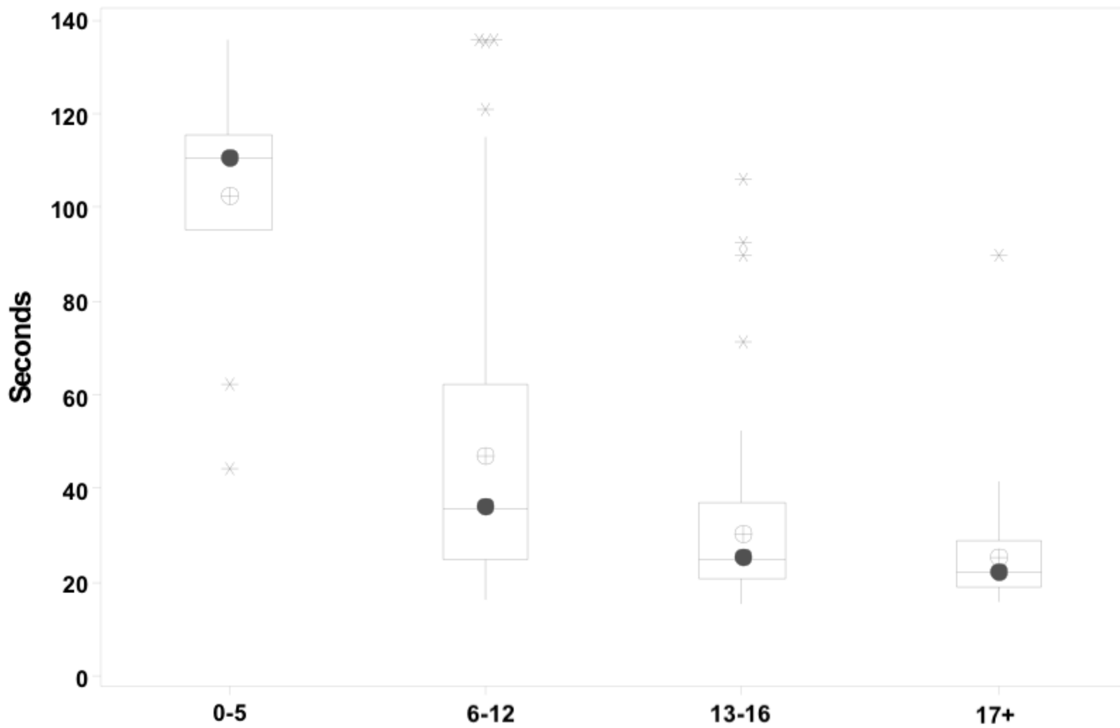


Figure 5.51. Box plot of Stroop Color Word Test Part V according to education groups

According to boxplots in Figure 5.52 and 5.53, there is a decreasing trend in digit span from high income to low income.

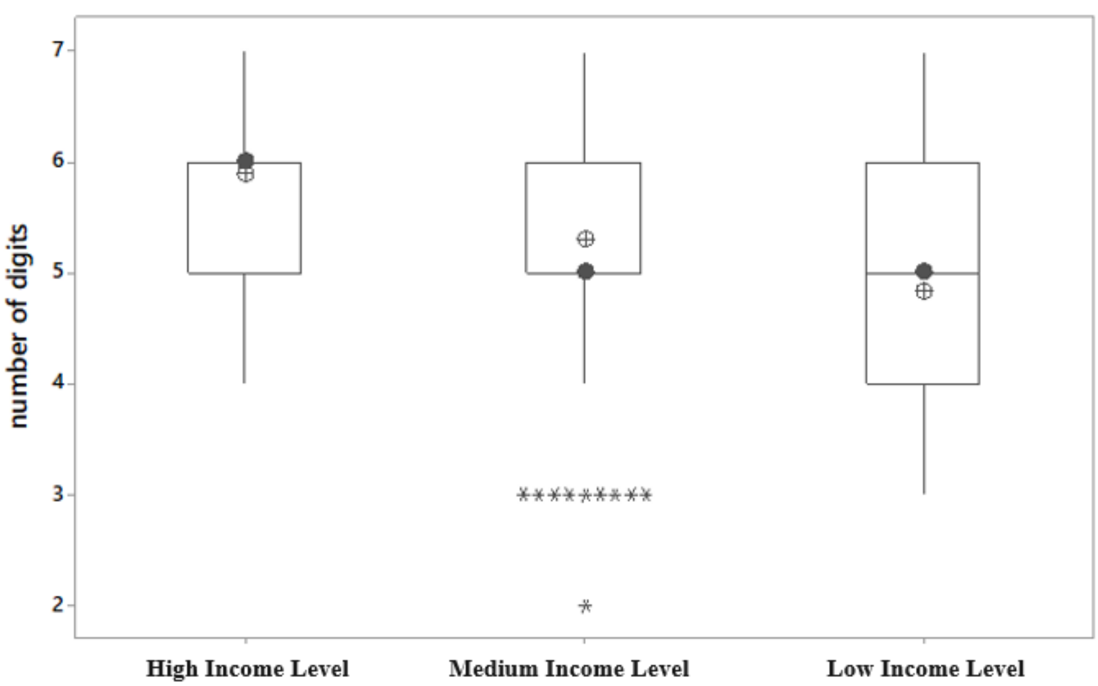


Figure 5.52. Box plot of Digit Forward Test according to income levels

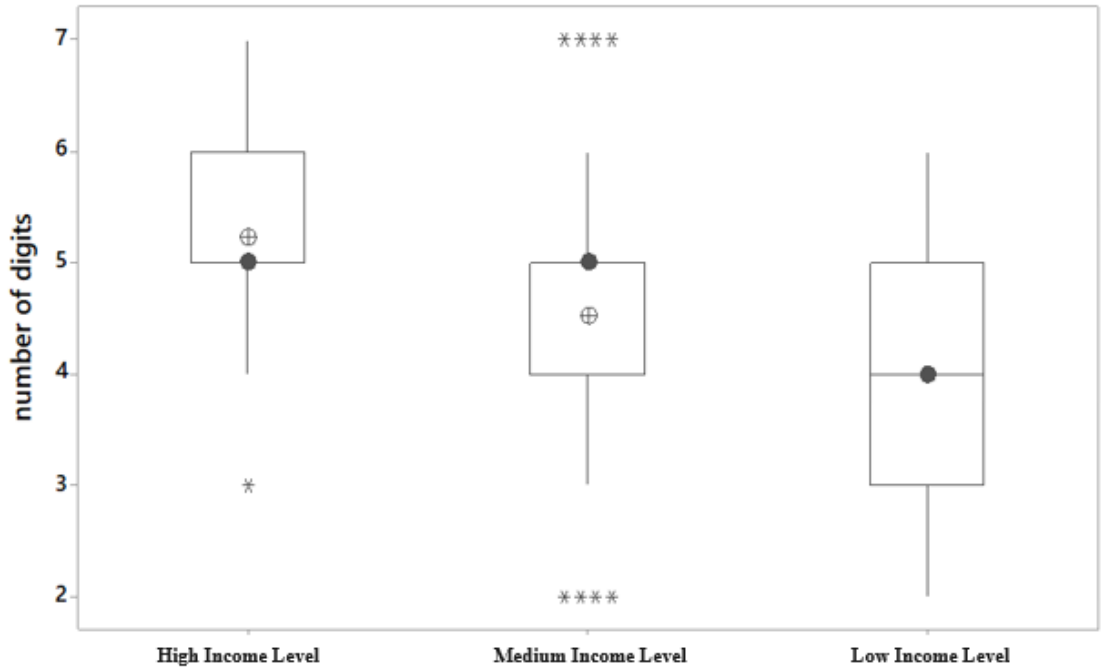


Figure 5.53. Box plot of Digit Backward Test according to income levels

According to boxplots in Figure 5.54 and 5.55, there is a decreasing trend in corsi span from high income to low income.

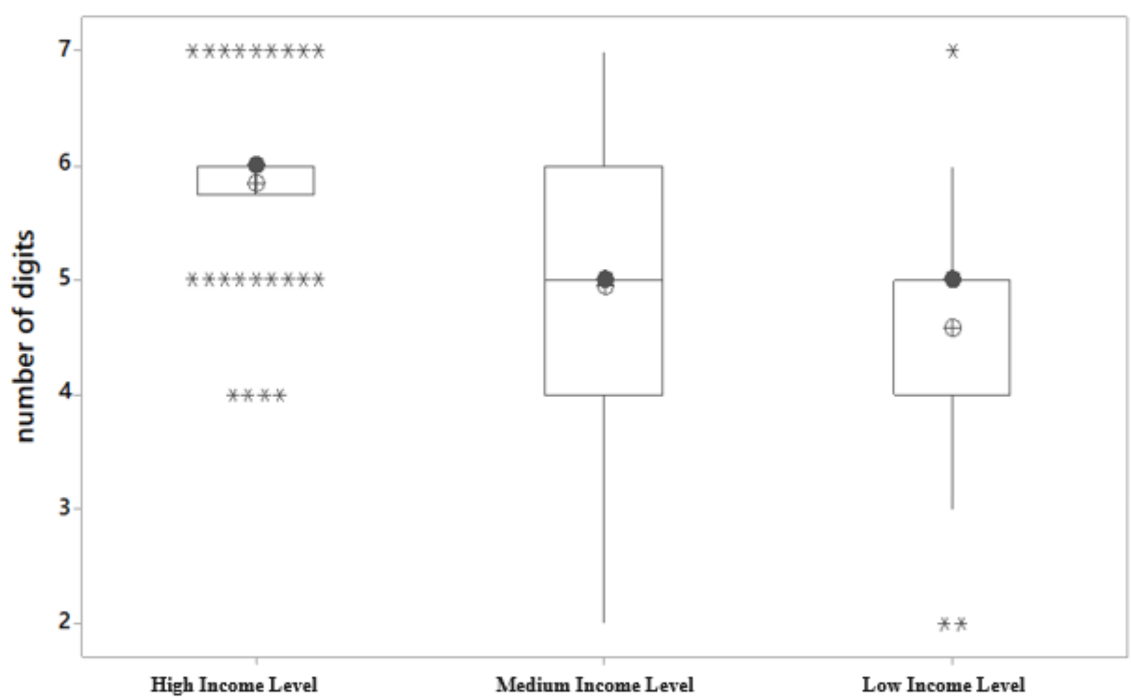


Figure 5.54. Box plot of Corsi Forward Test according to income levels

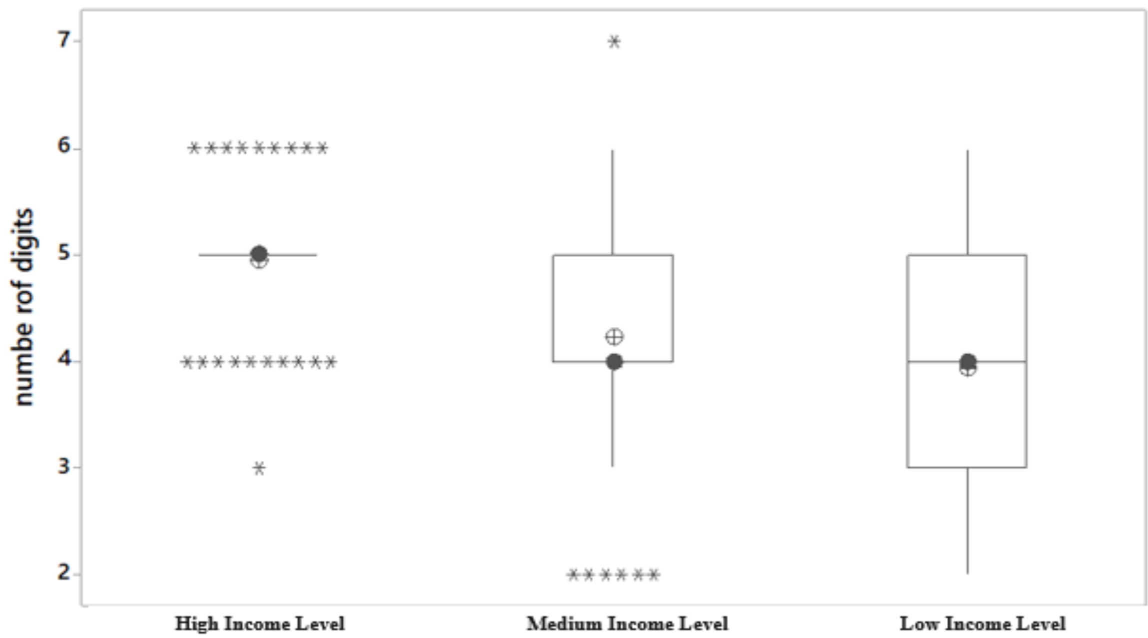


Figure 5.55. Box plot of Corsi Backward Test according to income levels

According to boxplots in Figure 5.56 and 5.57, there is no trend between income level and reaction time.

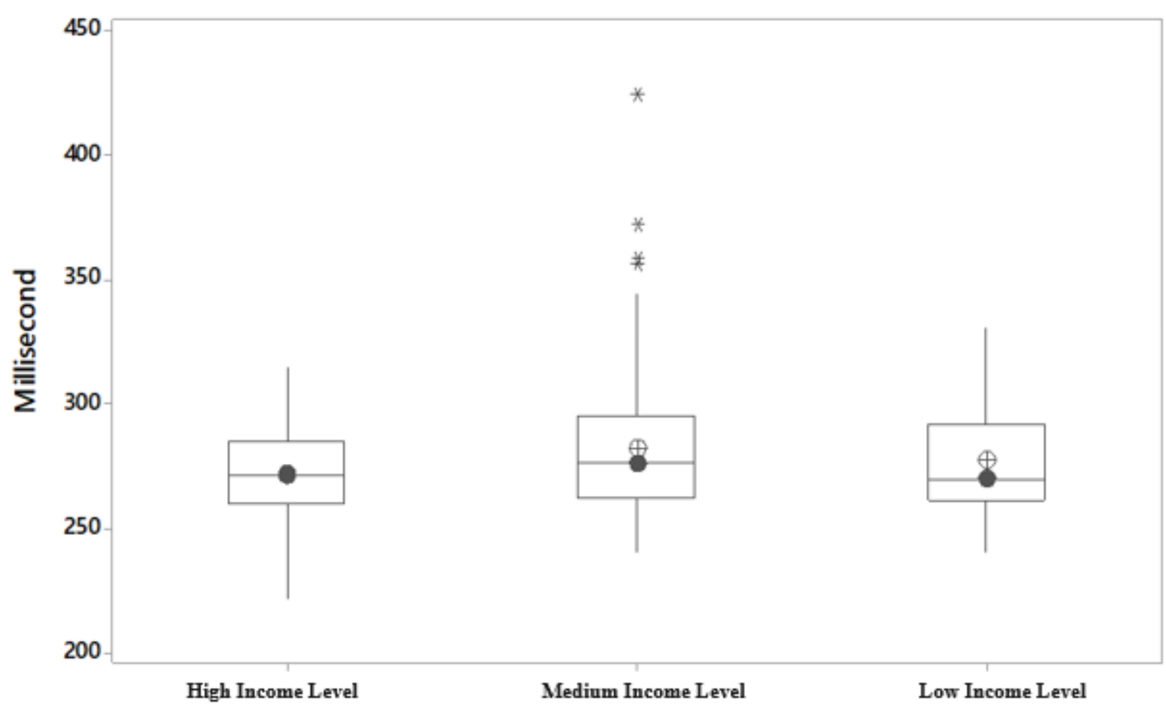


Figure 5.56. Box plot of Reaction Time (Dominant Hand) according to income levels

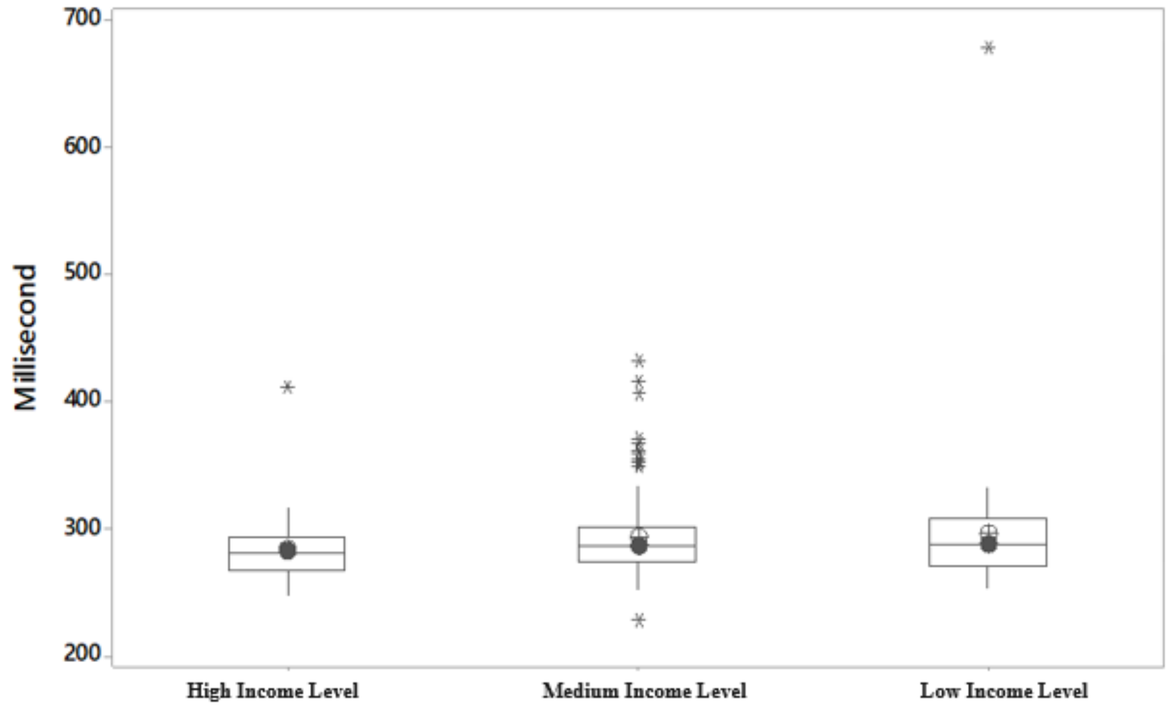


Figure 5.57. Box plot of Reaction Time (Non-Dominant Hand) according to income levels

Boxplot in Figure 5.58 shows the increase in number of correct answers with income level.

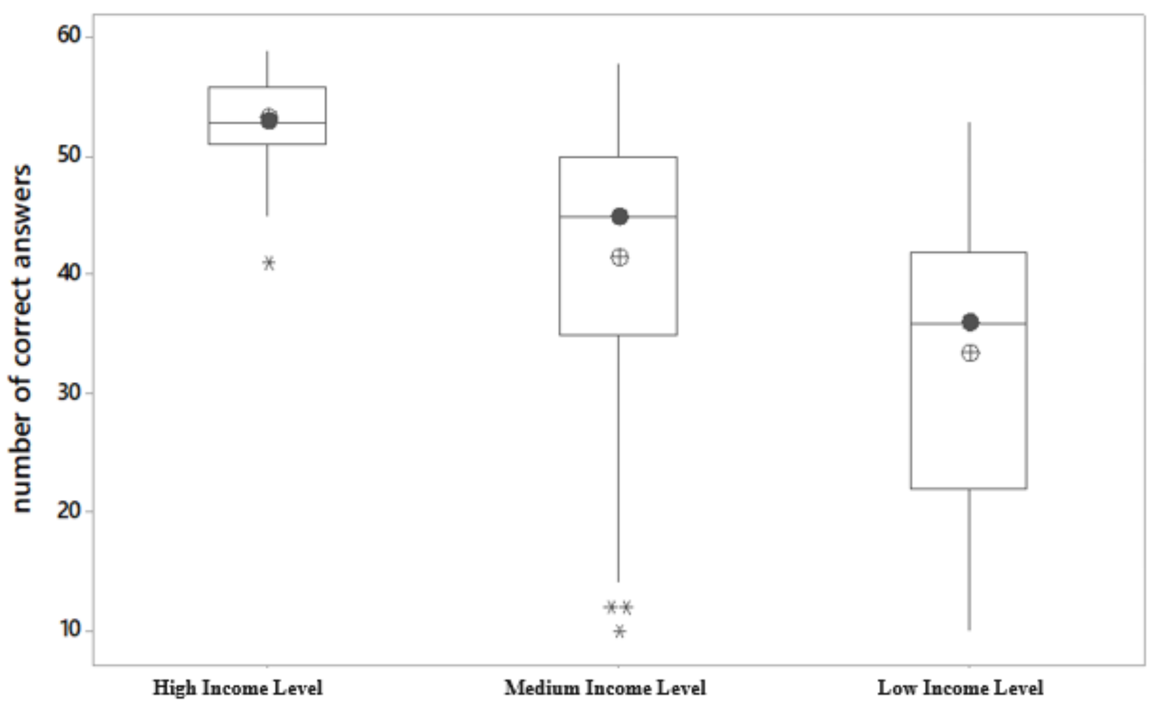


Figure 5.58. Box plot of Raven Test according to income levels

According to boxplots between Figure 5.59 -5.63, there is no trend between income level and Purdue Pegboard test results.

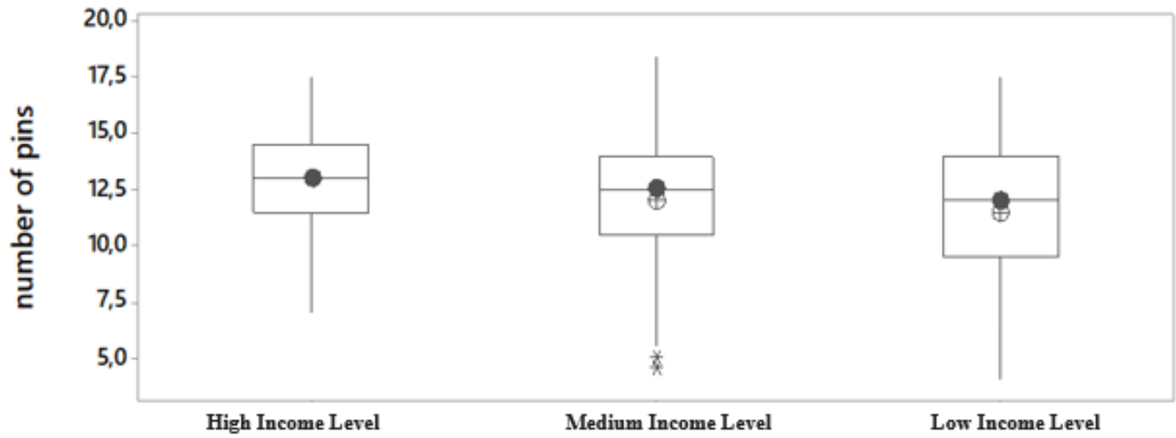


Figure 5.59. Box plot of Purdue Pegboard (Dominant Hand) according to income levels

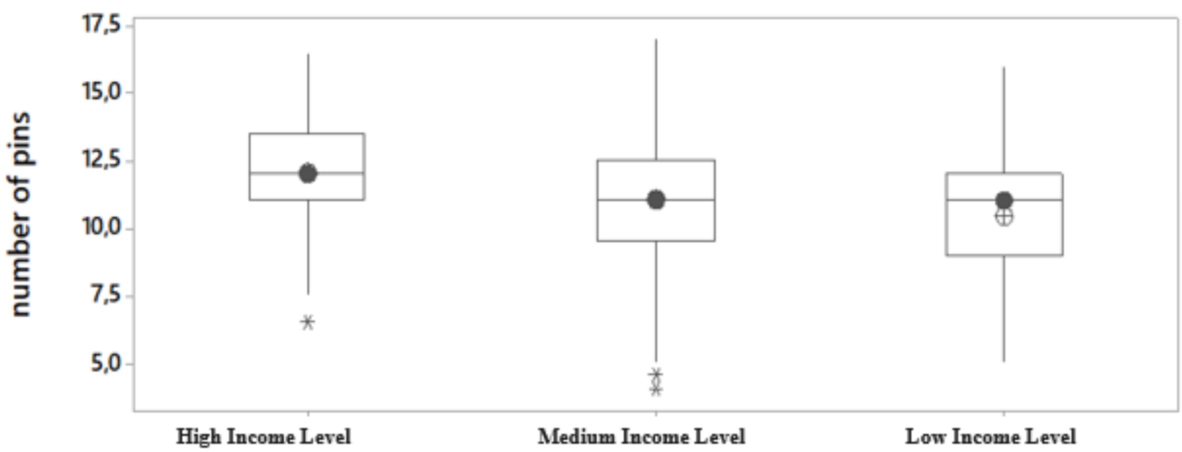


Figure 5.60. Box plot of Purdue Pegboard (Non Dominant Hand) according to income levels

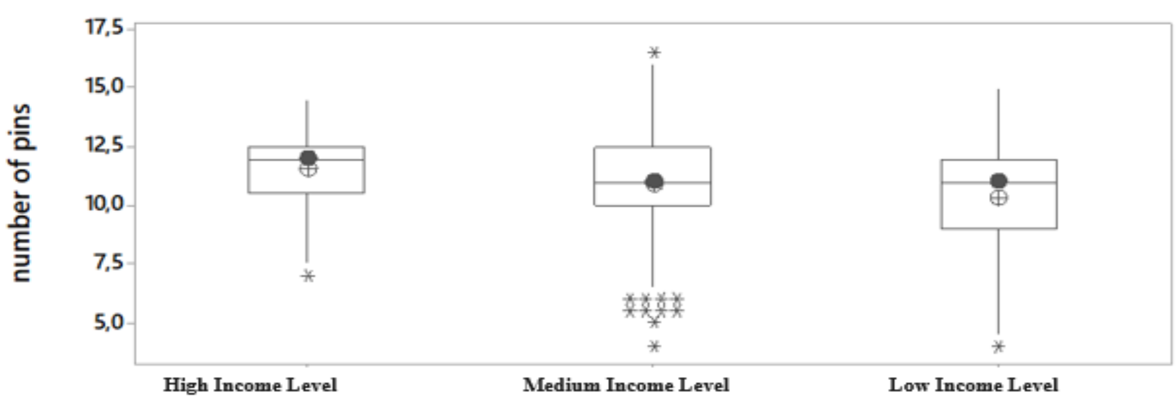


Figure 5.61. Box plot of Purdue Pegboard (Both Hand) according to income levels

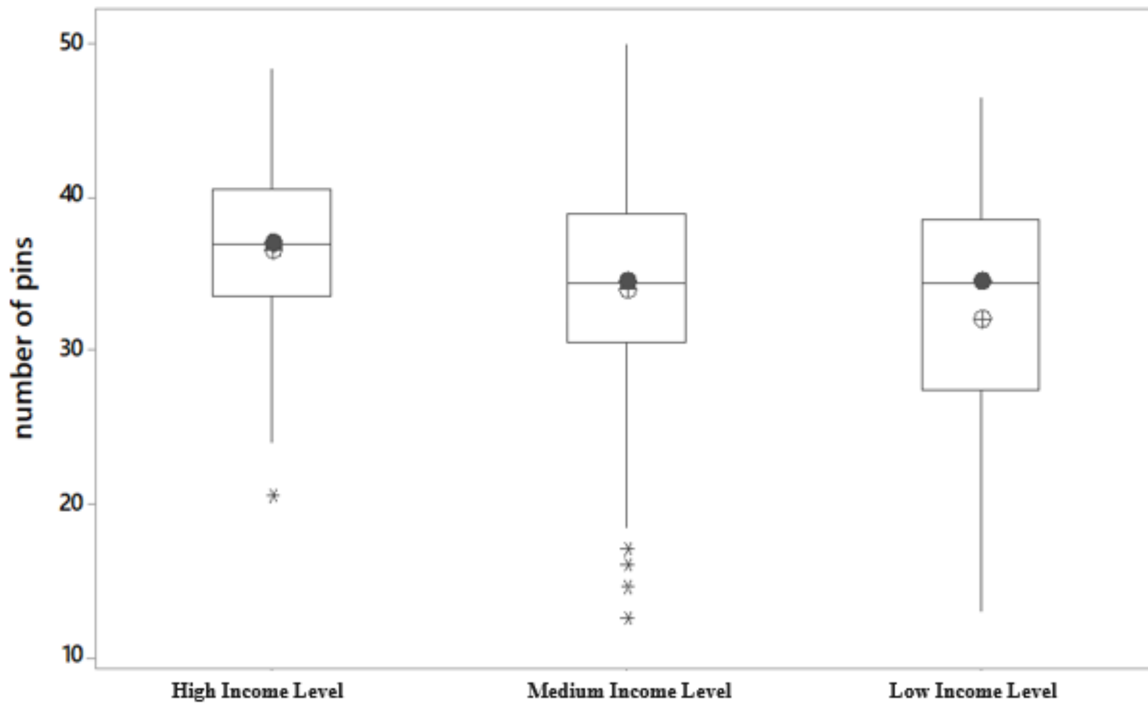


Figure 5.62. Box plot of Purdue Pegboard (Total) according to income levels

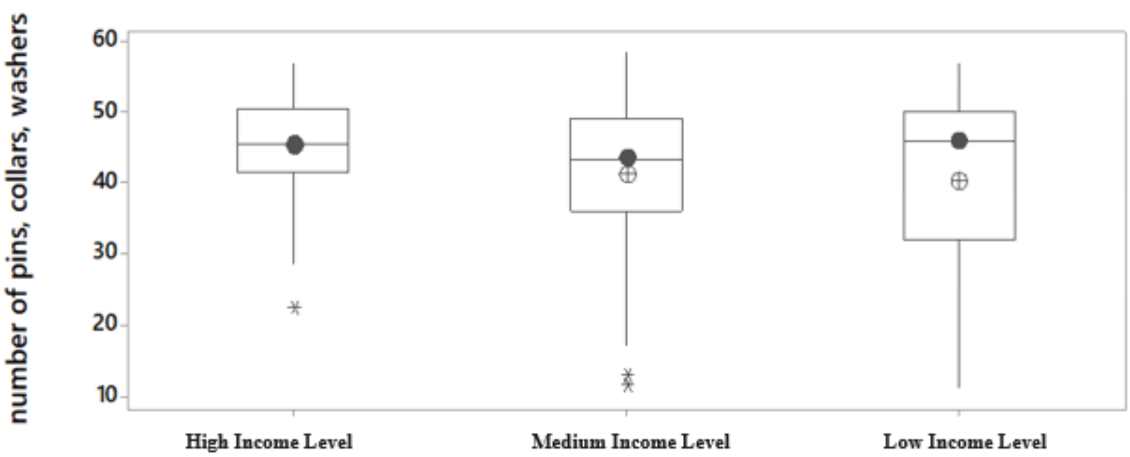


Figure 5.63. Box plot of Purdue Pegboard (Assembly) according to income levels

According to boxplots between Figure 5.64 -5.68, there is no certain trend between income level and completion time in seconds.

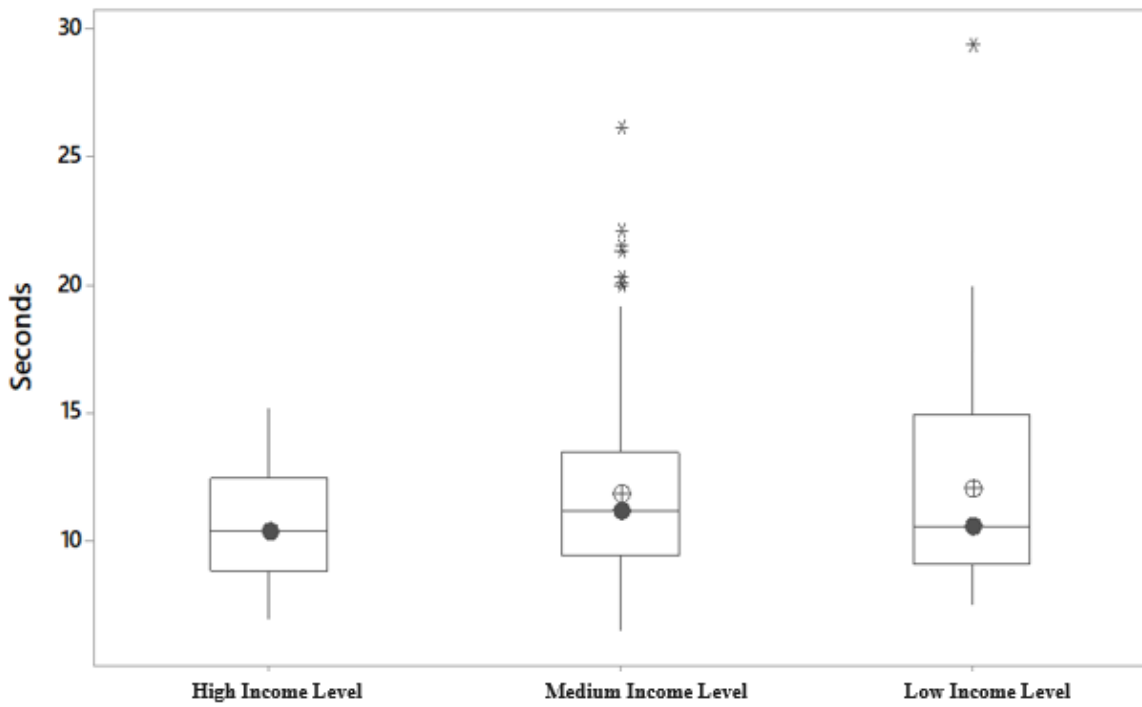


Figure 5.64. Box plot of Stroop Color Word Test Part I according to income levels

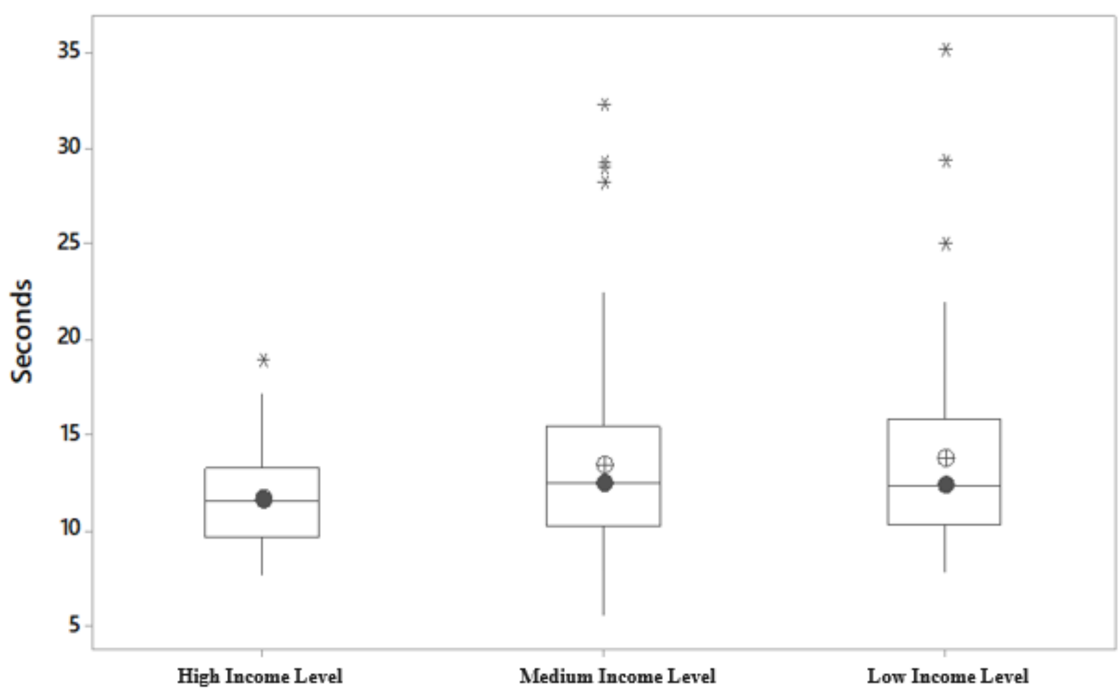


Figure 5.65. Box plot of Stroop Color Word Test Part II according to income levels

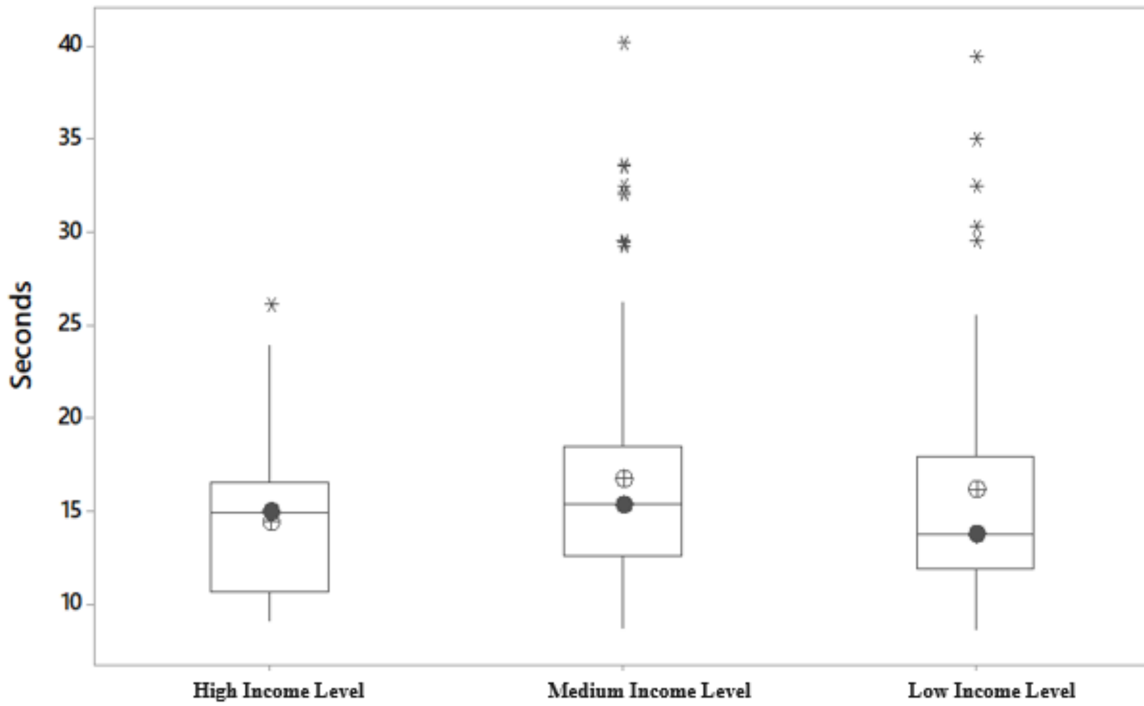


Figure 5.66. Box plot of Stroop Color Word Test Part III according to income levels

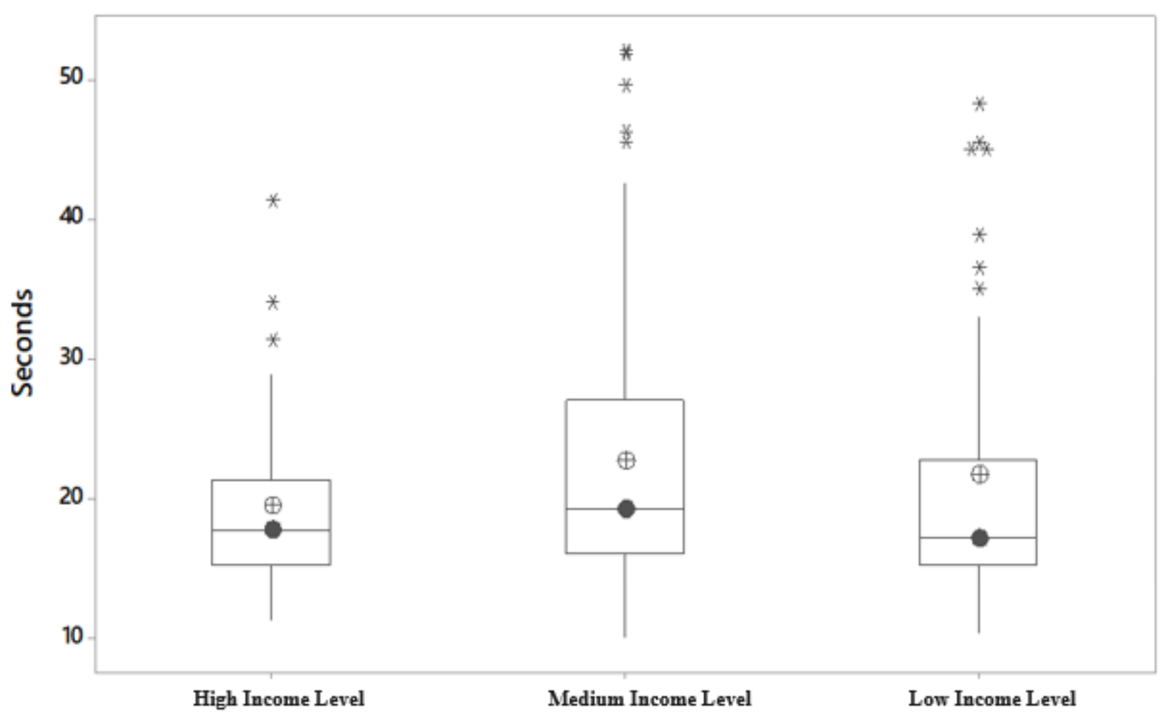


Figure 5.67. Box plot of Stroop Color Word Test Part IV according to income levels

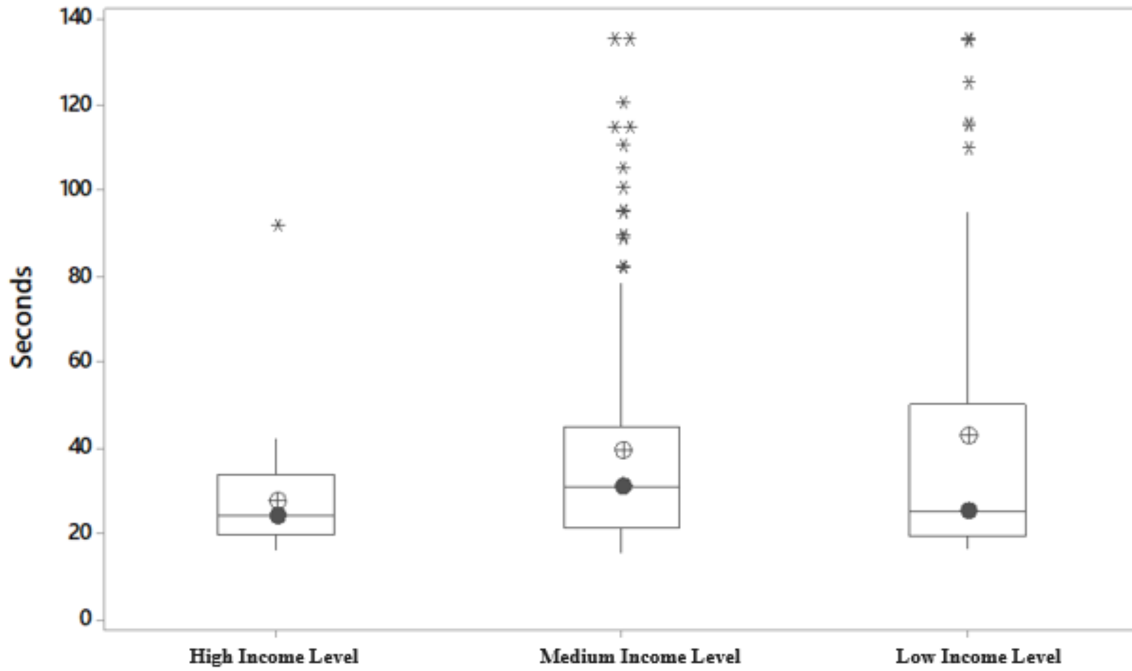


Figure 5.68. Box plot of Stroop Color Word Test Part V according to income levels

According to boxplots between 5.69-5.72, the means of single participants' digit and corsi span are higher than married ones.

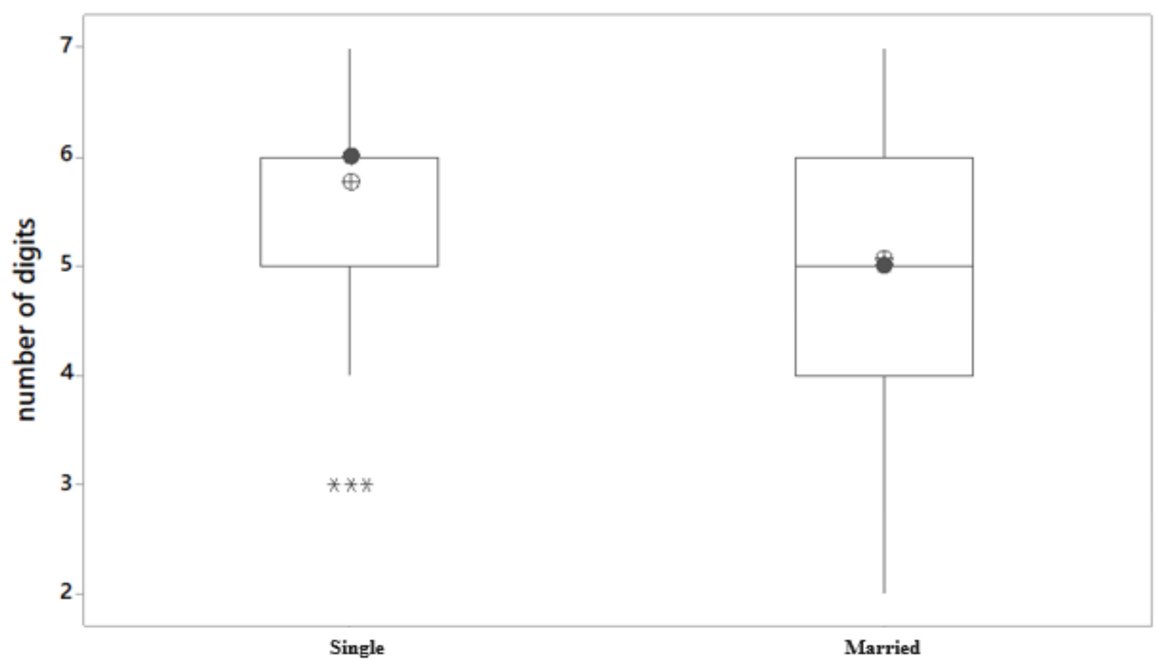


Figure 5.69. Box plot of Digit Forward Test according to marital status

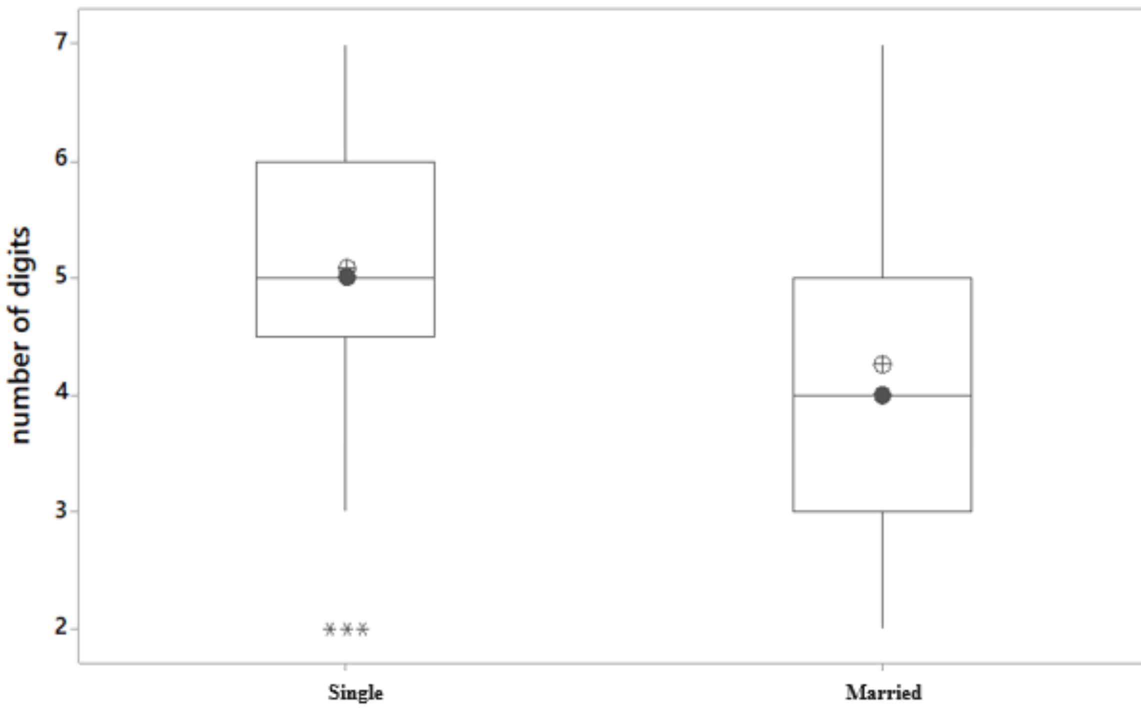


Figure 5.70. Box plot of Digit Backward Test according to marital status

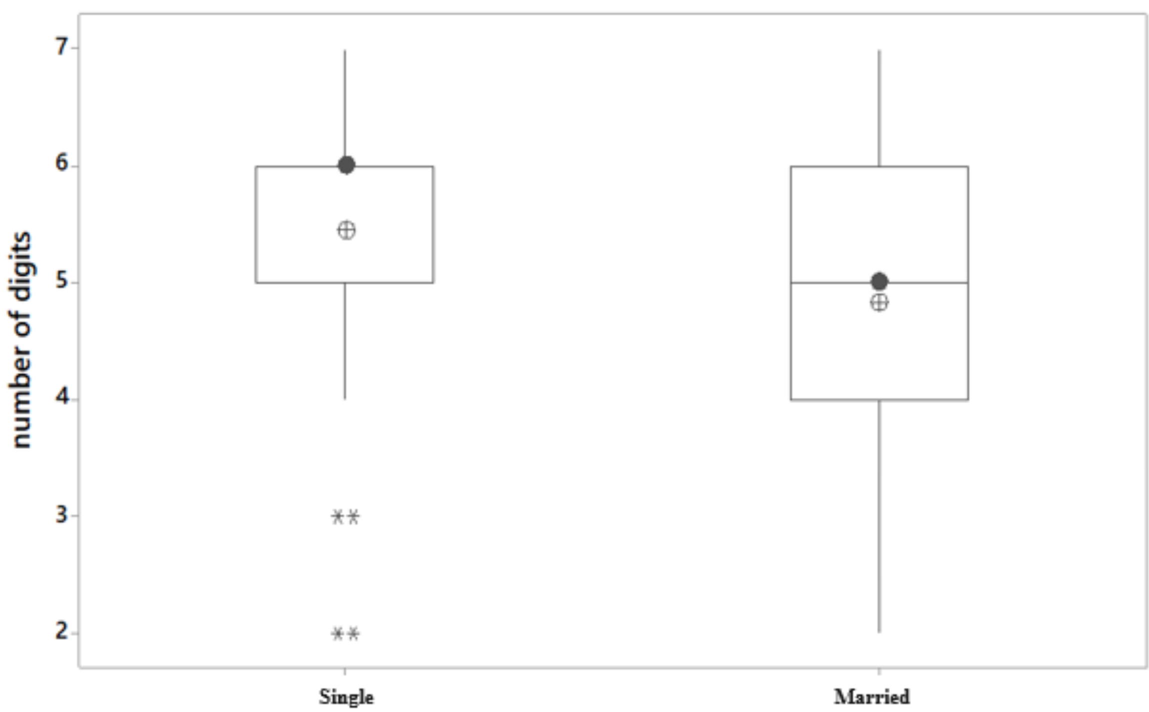


Figure 5.71. Box plot of Corsi Forward Test according to marital status

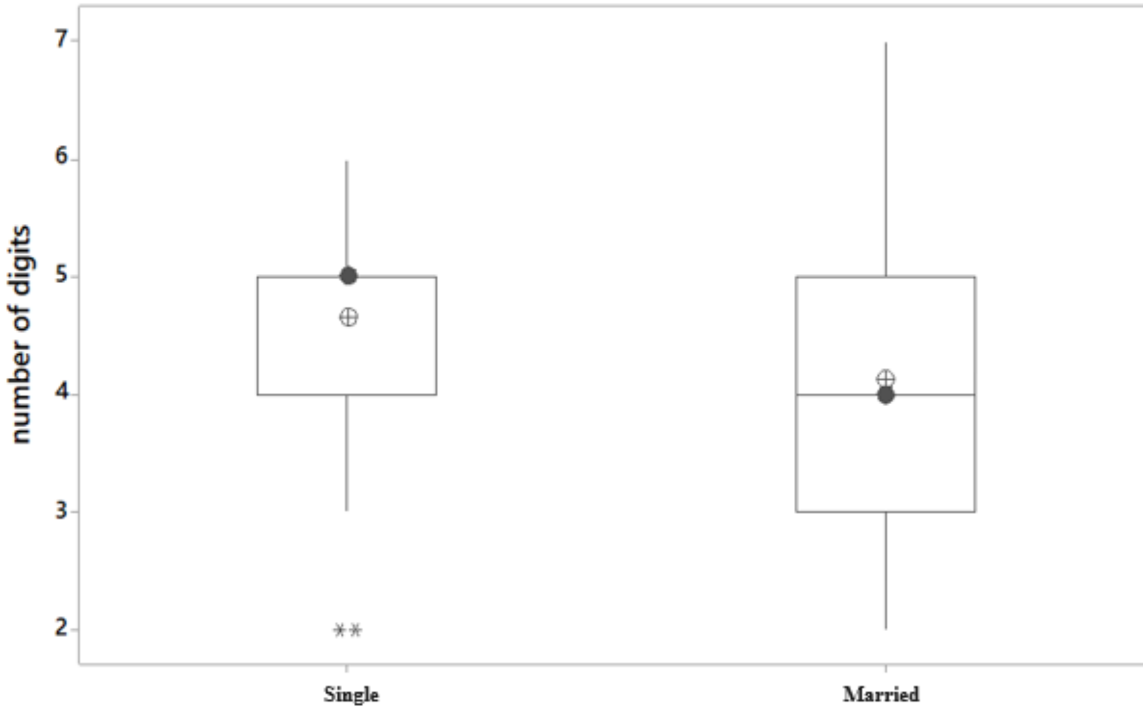


Figure 5.72. Box plot of Corsi Backward Test according to marital status

According to boxplots in Figure 5.73 and 5.74, there is no certain trend between marital status and reaction time.

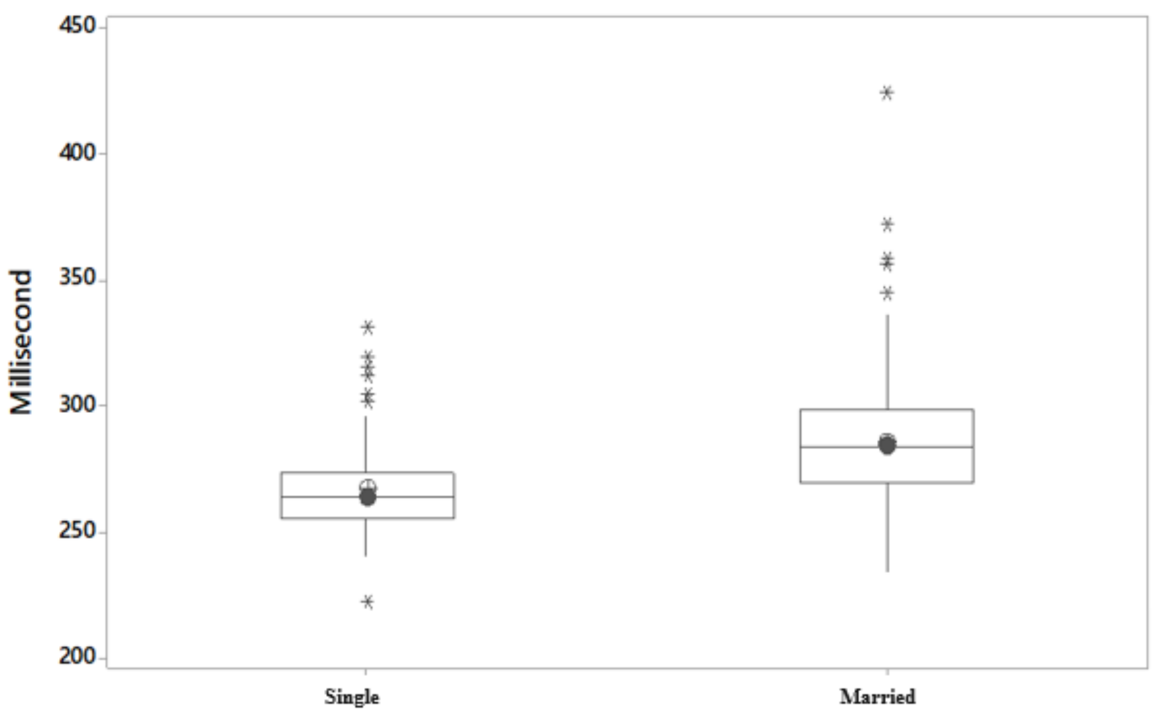


Figure 5.73. Box plot of Reaction Time (Dominant Hand) according to marital status

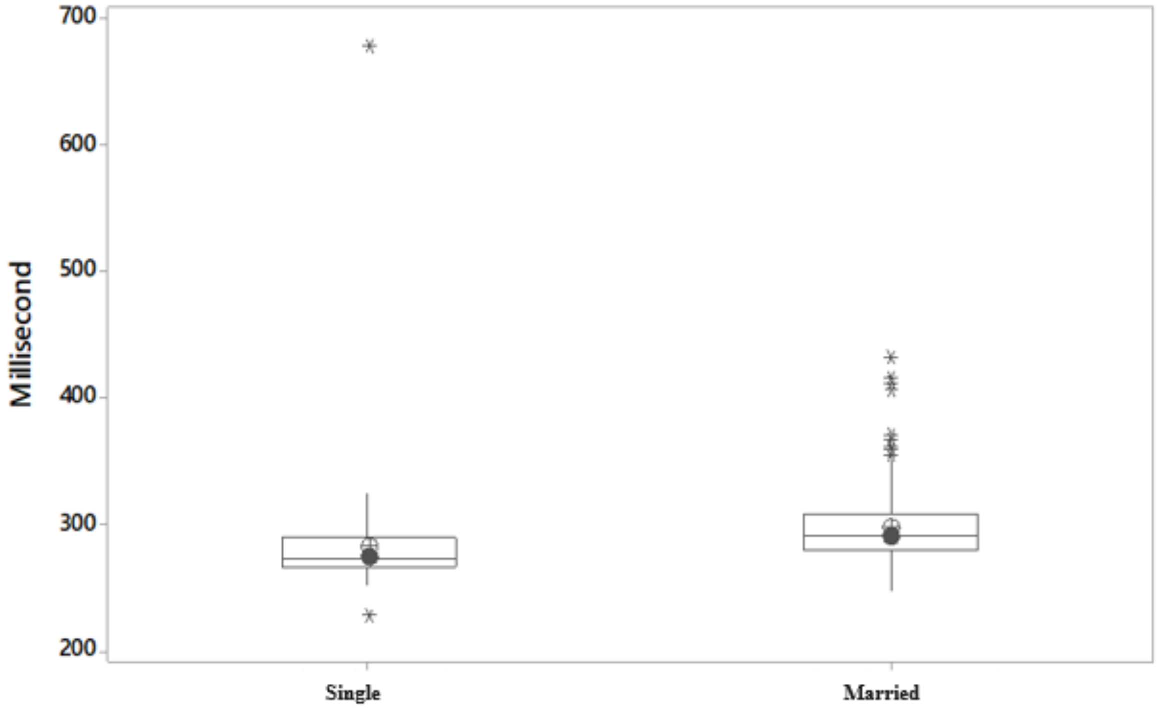


Figure 5.74. Box plot of Reaction Time (Non Dominant Hand) according to marital status

According to boxplot in Figure 5.75, the mean of single participants' correct answers is higher than married ones.

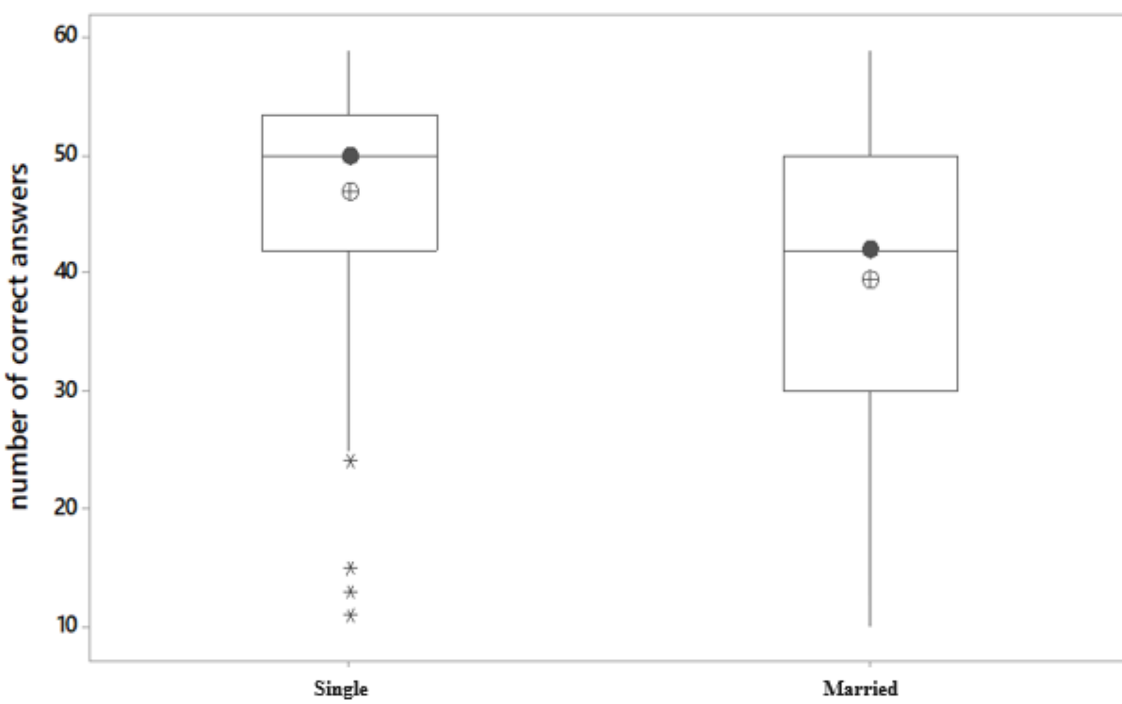


Figure 5.75. Box plot of Raven Test according to marital status

According to boxplots between 5.76-5.80, the means of single participants' Purdue Pegboars test results are higher than married ones.

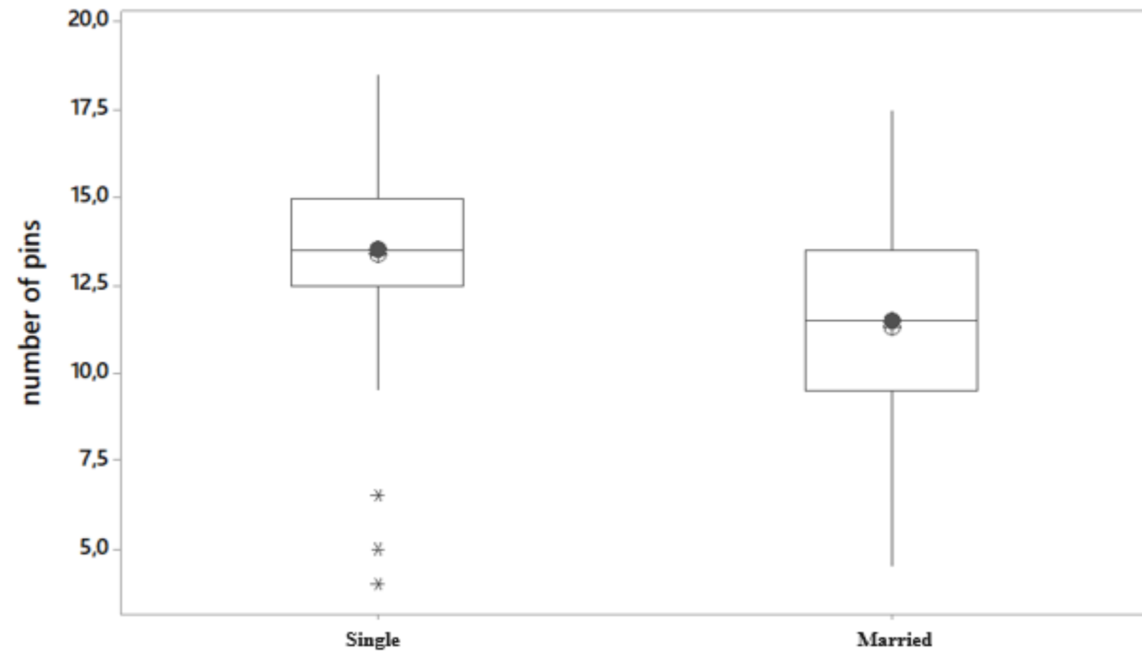


Figure 5.76. Box plot of Purdue Pegboard (Dominant Hand) according to marital status

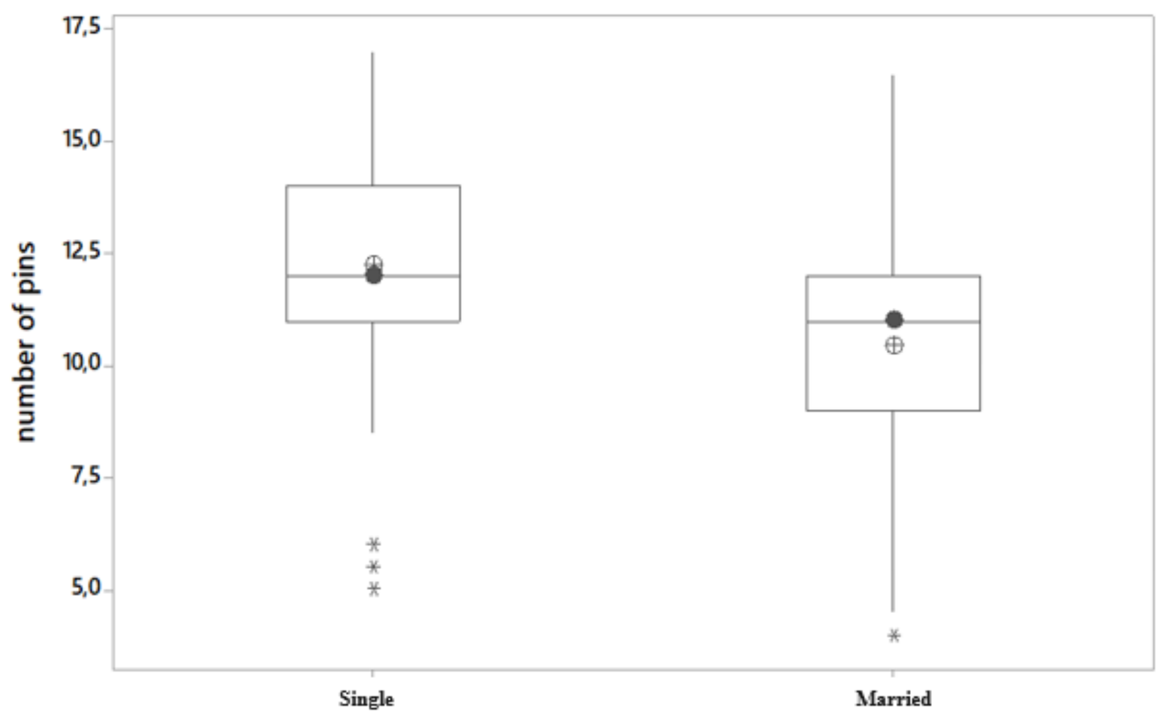


Figure 5.77. Box plot of Purdue Pegboard (Non Dominant Hand) according to marital status

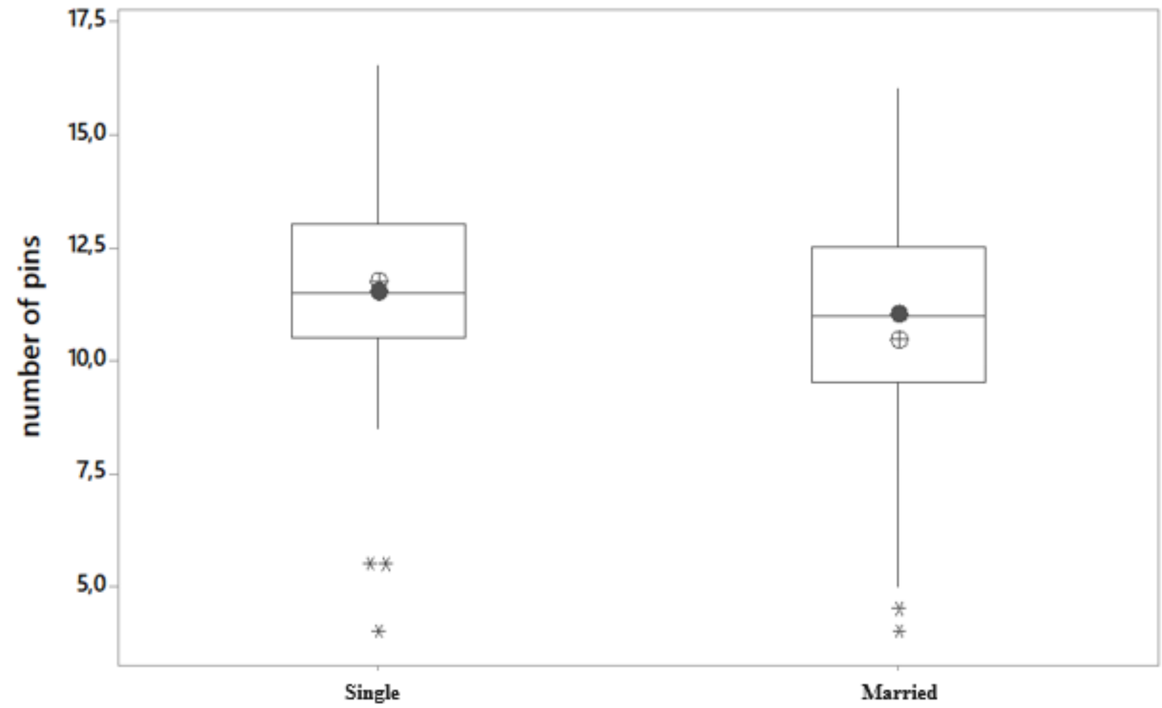


Figure 5.78. Box plot of Purdue Pegboard (Both Hand) according to marital status

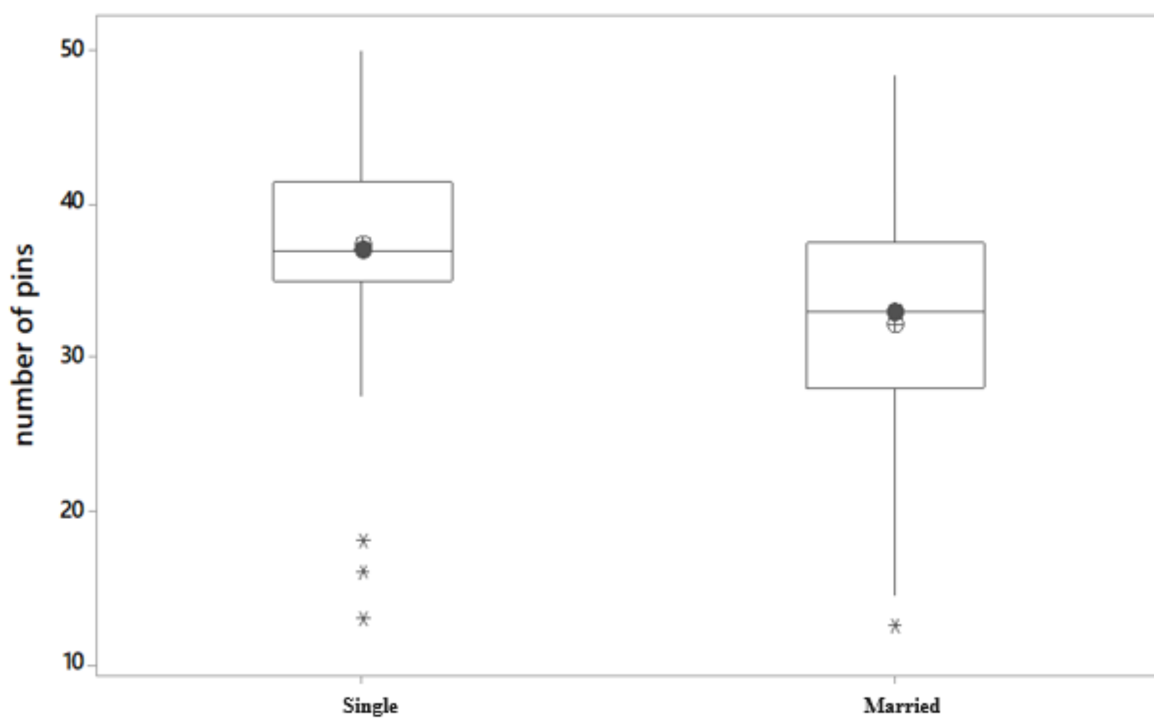


Figure 5.79. Box plot of Purdue Pegboard (Total) according to marital status

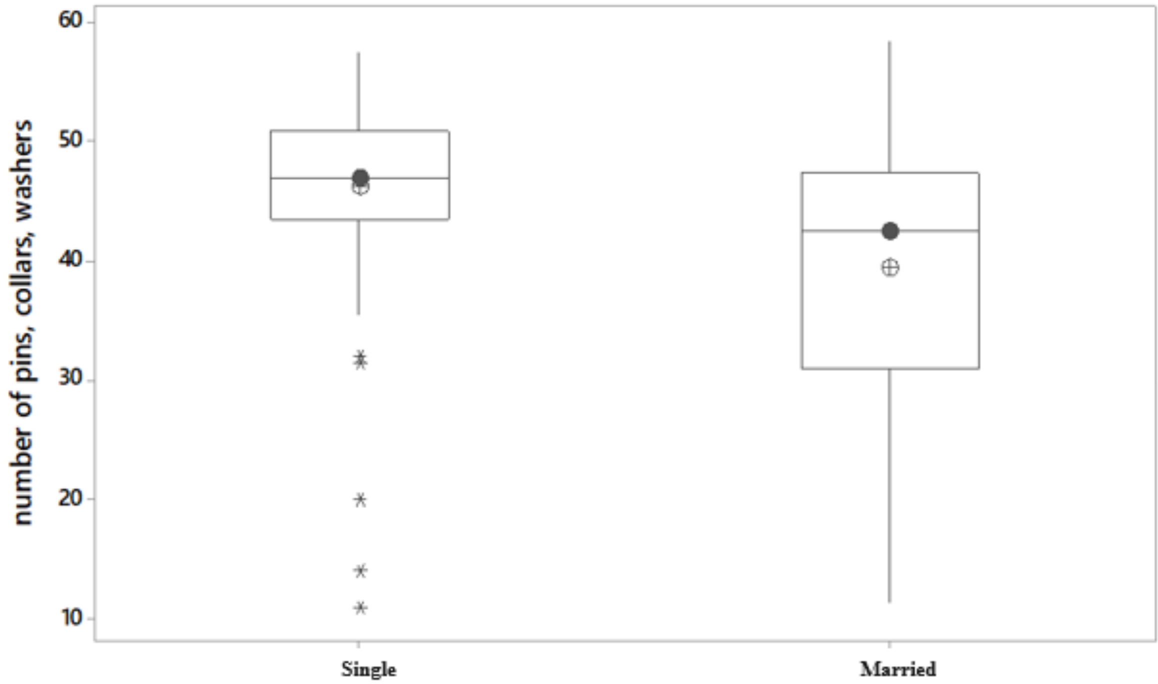


Figure 5.80. Box plot of Purdue Pegboard (Assembly) according to marital status

According to boxplots between 5.81-5.85, the means of single participants' completion time are less than married ones.

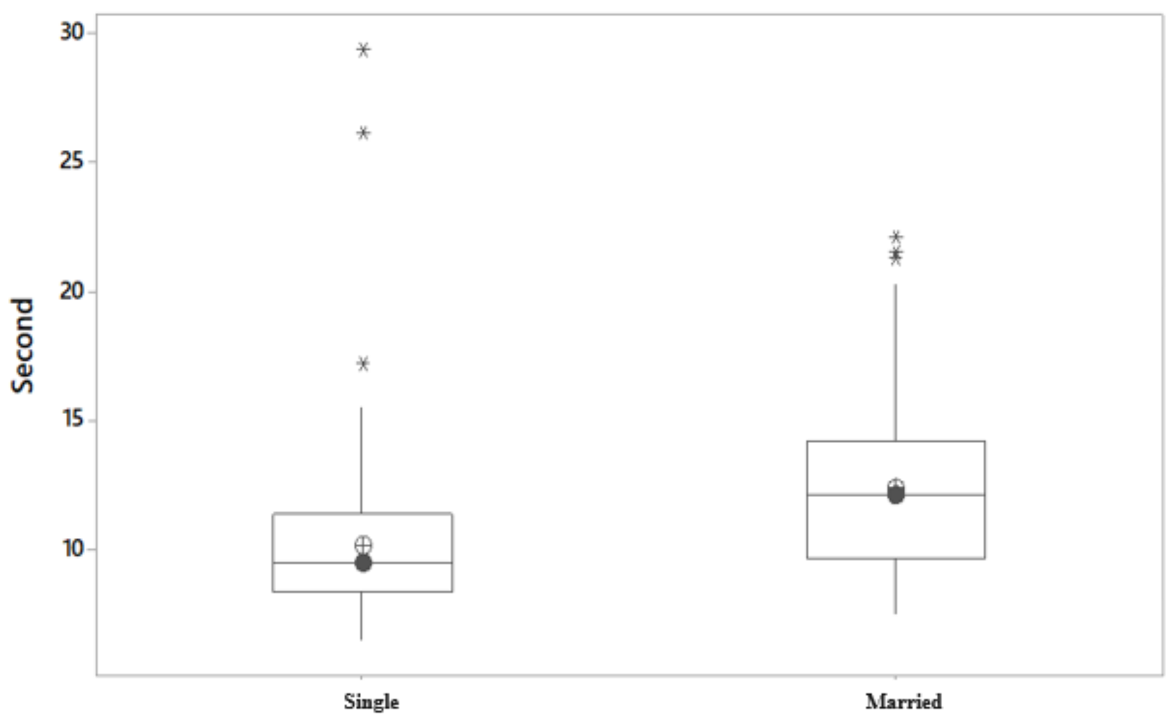


Figure 5.81. Box plot of Stroop Color Word Test Part I according to marital status

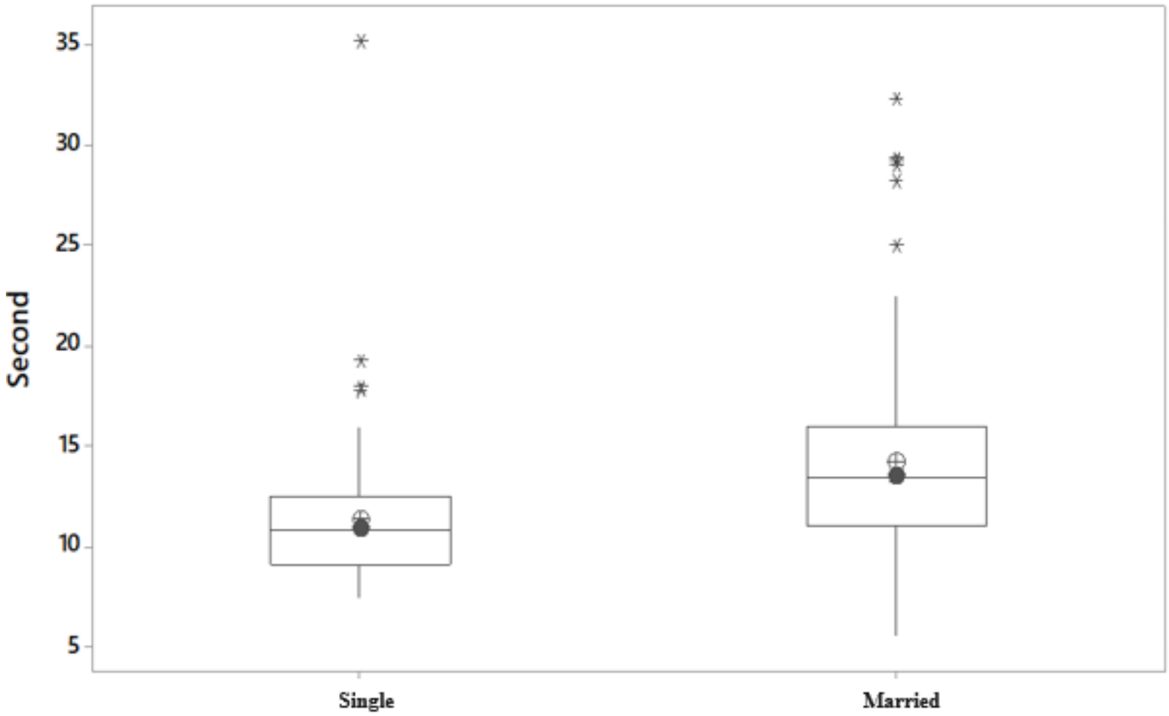


Figure 5.82. Box plot of Stroop Color Word Test Part II according to marital status

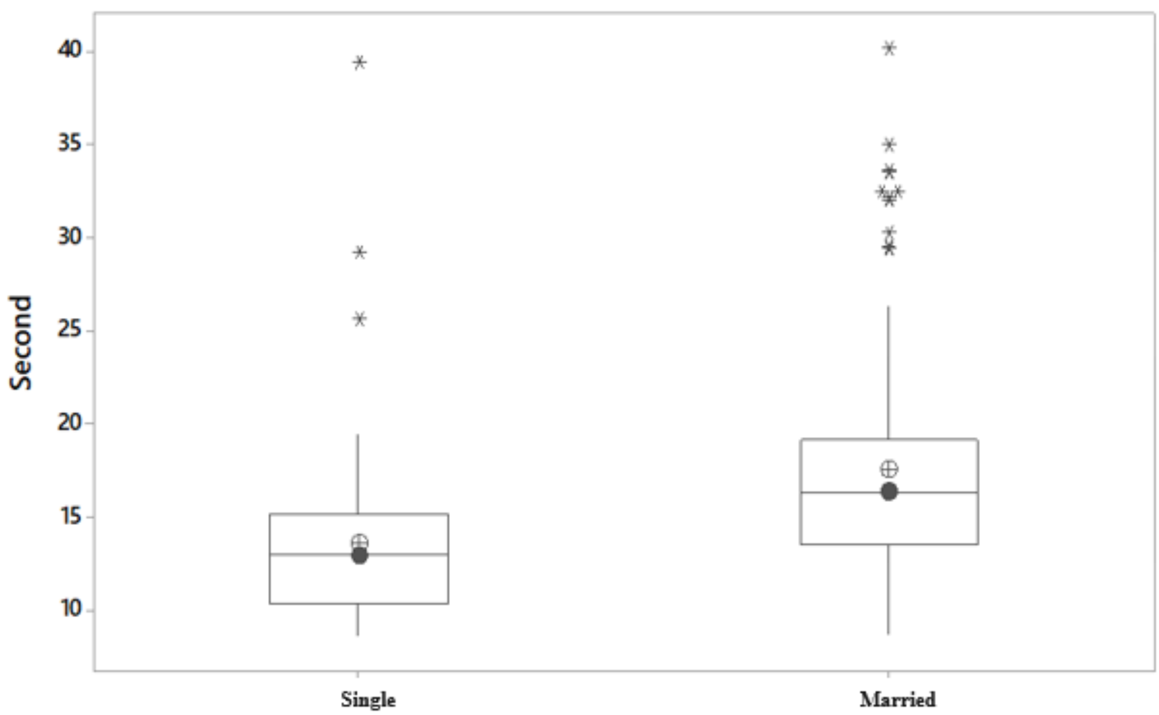


Figure 5.83. Box plot of Stroop Color Word Test Part III according to marital status

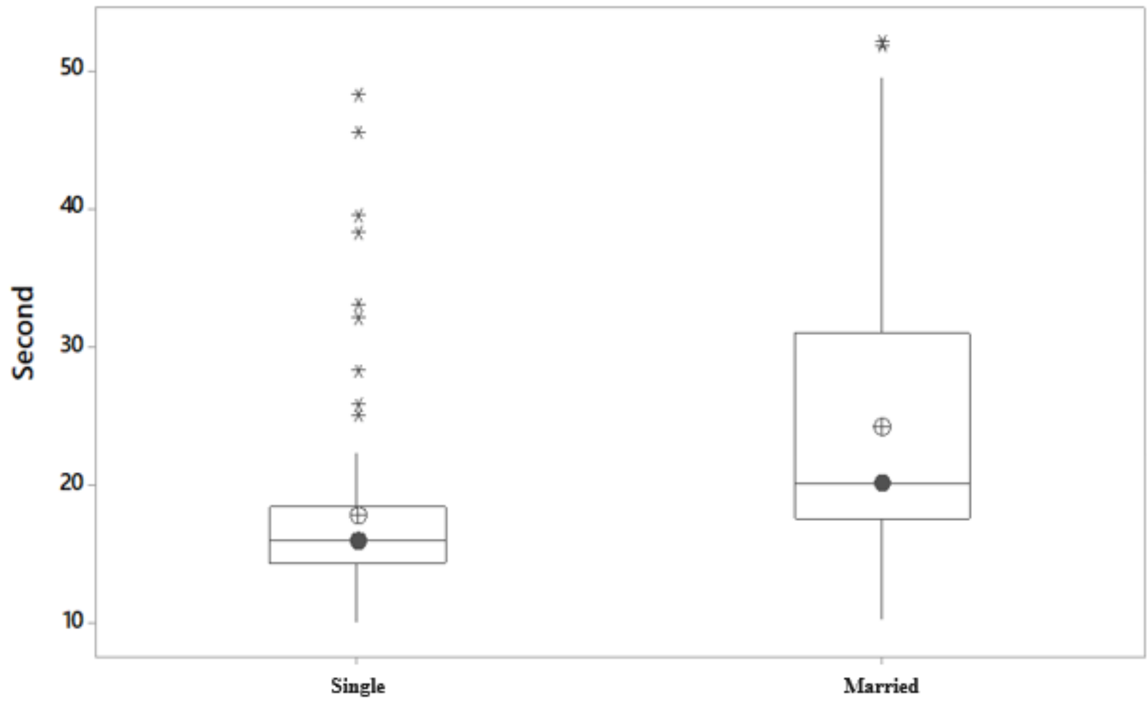


Figure 5.84. Box plot of Stroop Color Word Test Part IV according to marital status

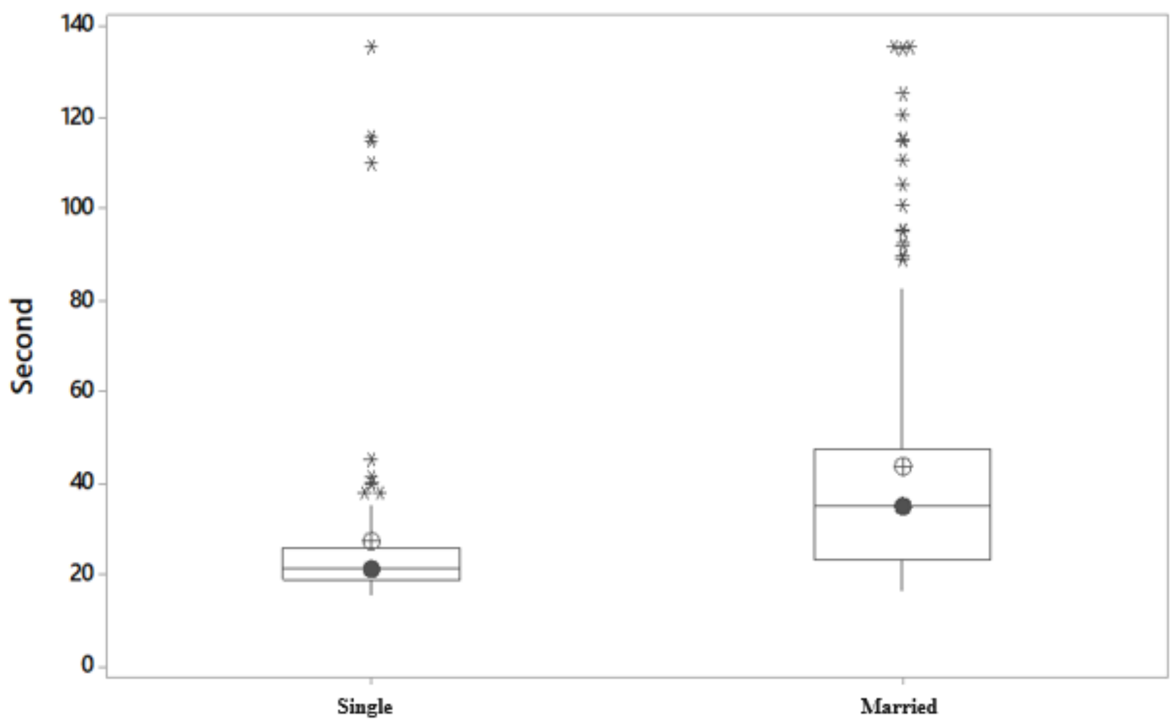


Figure 5.85. Box plot of Stroop Color Word Test Part V according to marital status

Boxplots in between Figure 5.86-5.101 show that there is no certain trend between smoking habit and test results.

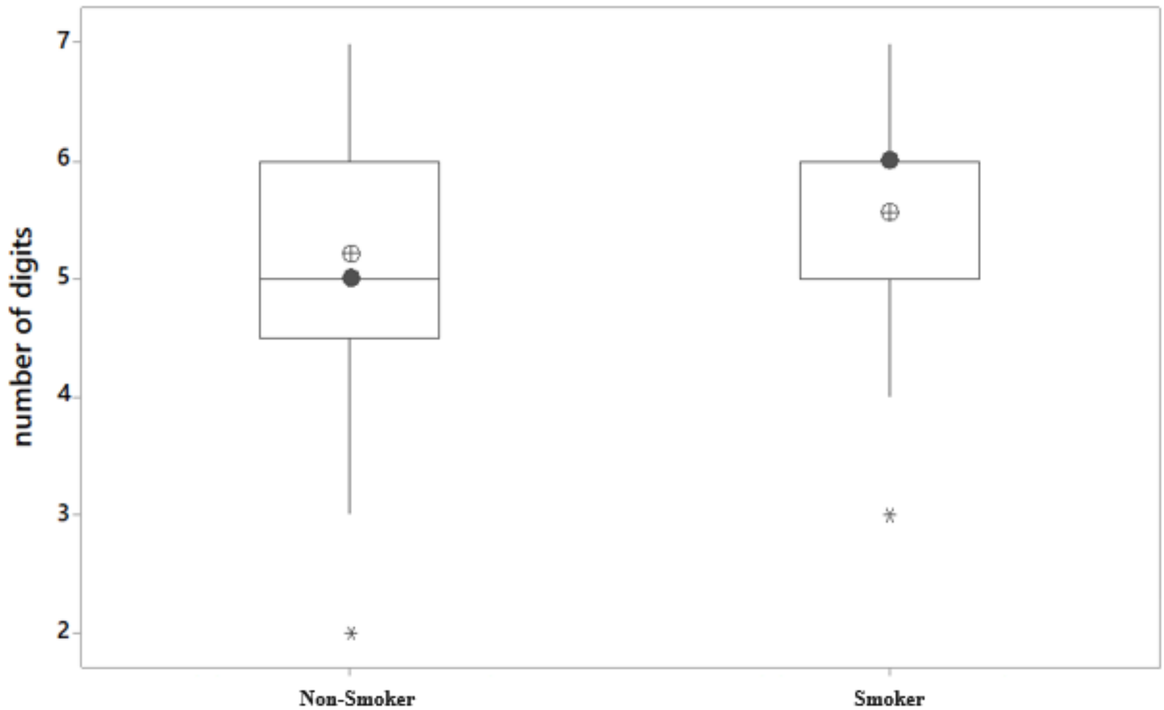


Figure 5.86. Box plot of Digit Forward Test according to smoking habit

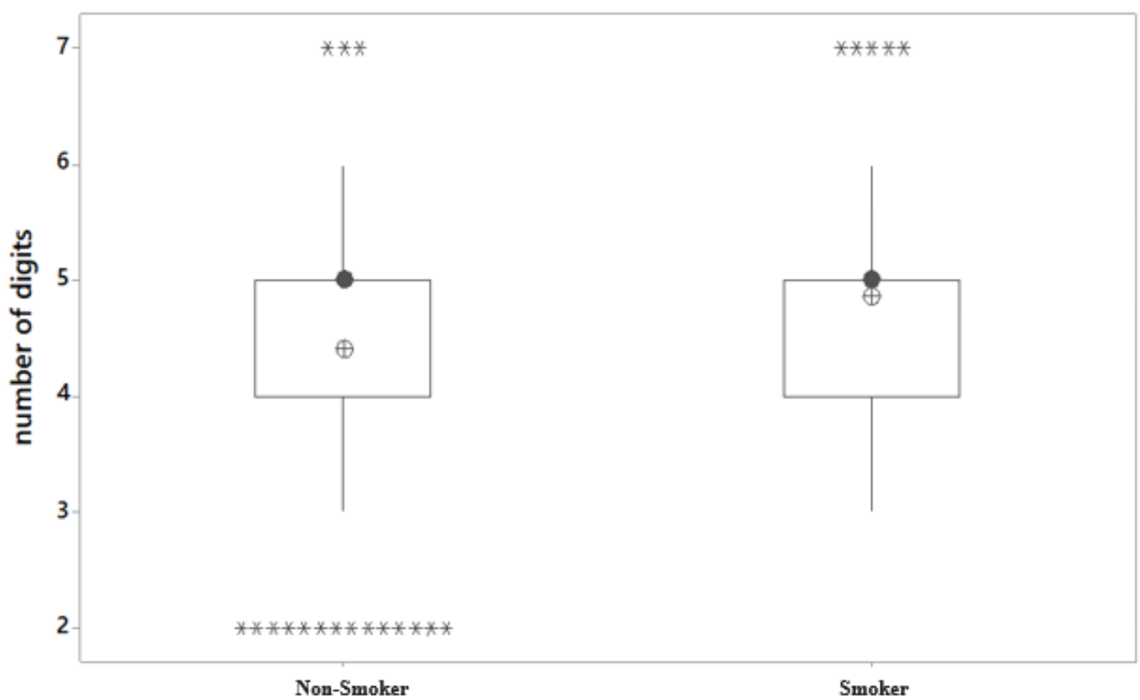


Figure 5.87. Box plot of Digit Backward Test according to smoking habit

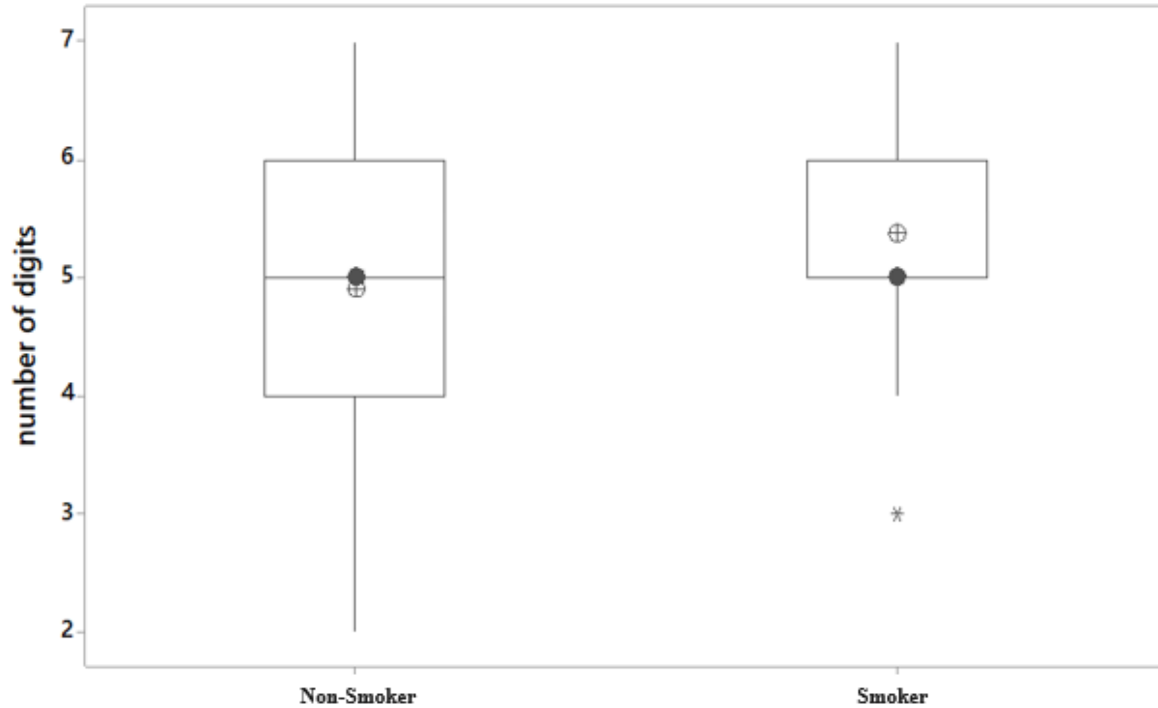


Figure 5.88. Box plot of Corsi Forward Test according to smoking habit

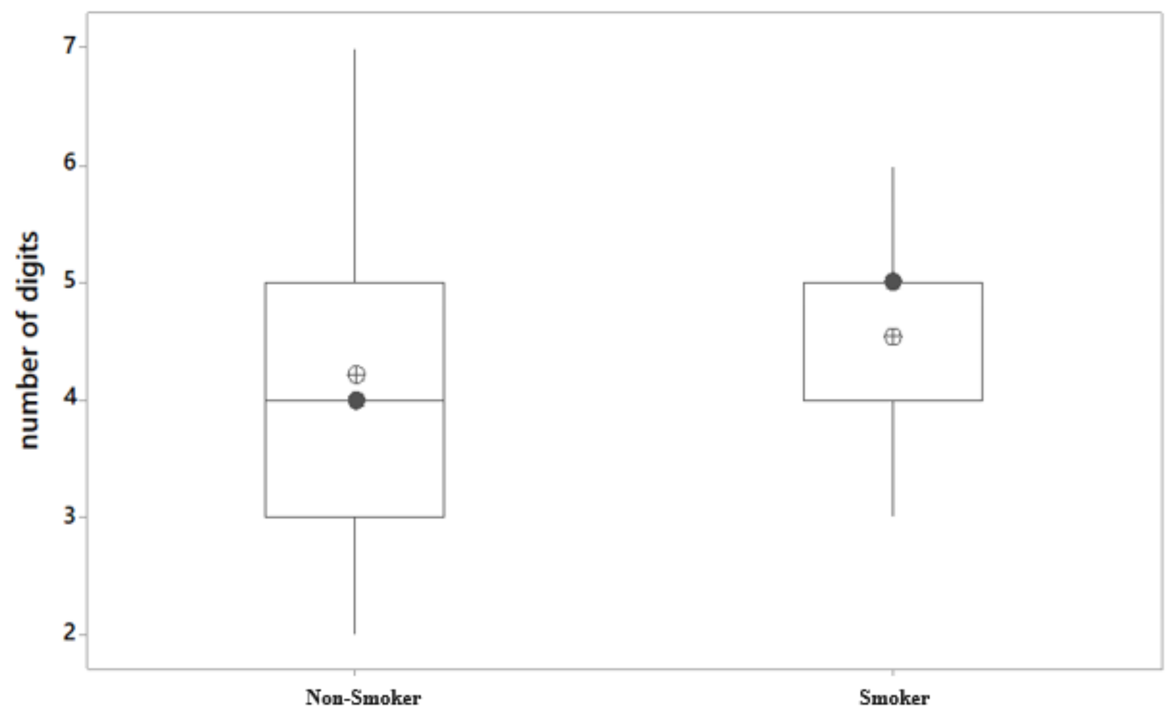


Figure 5.89. Box plot of Corsi Backward Test according to smoking habit

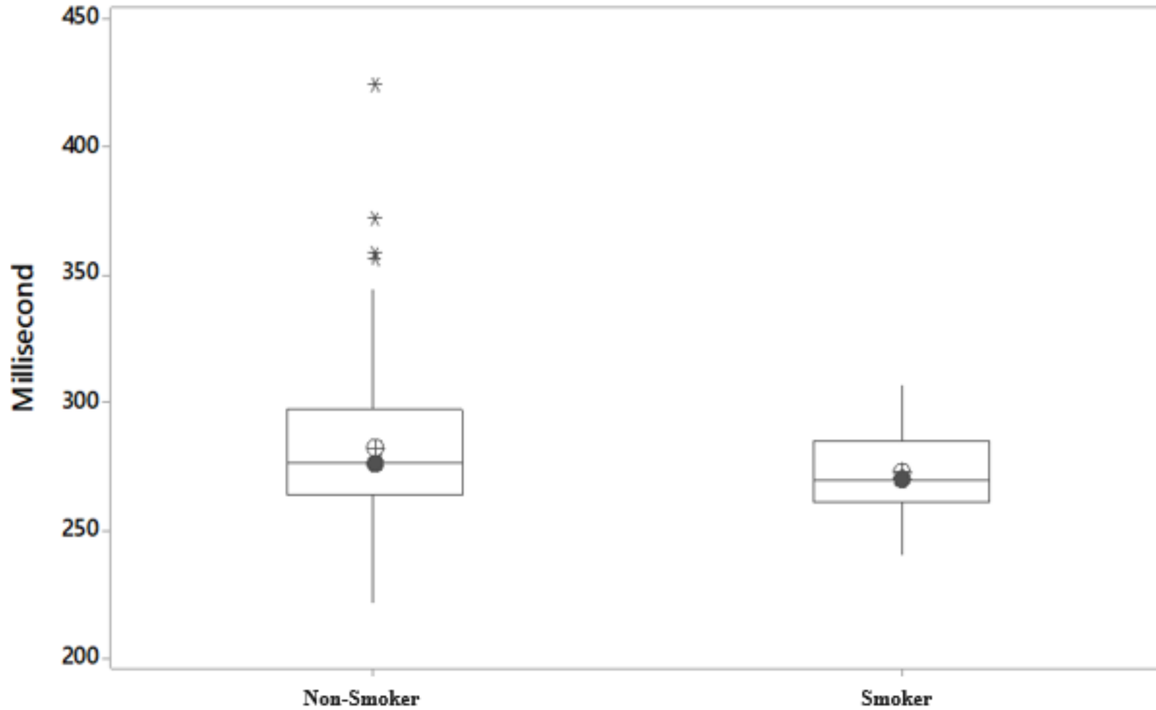


Figure 5.90. Box plot of Reaction Time (Dominant Hand) according to smoking habit

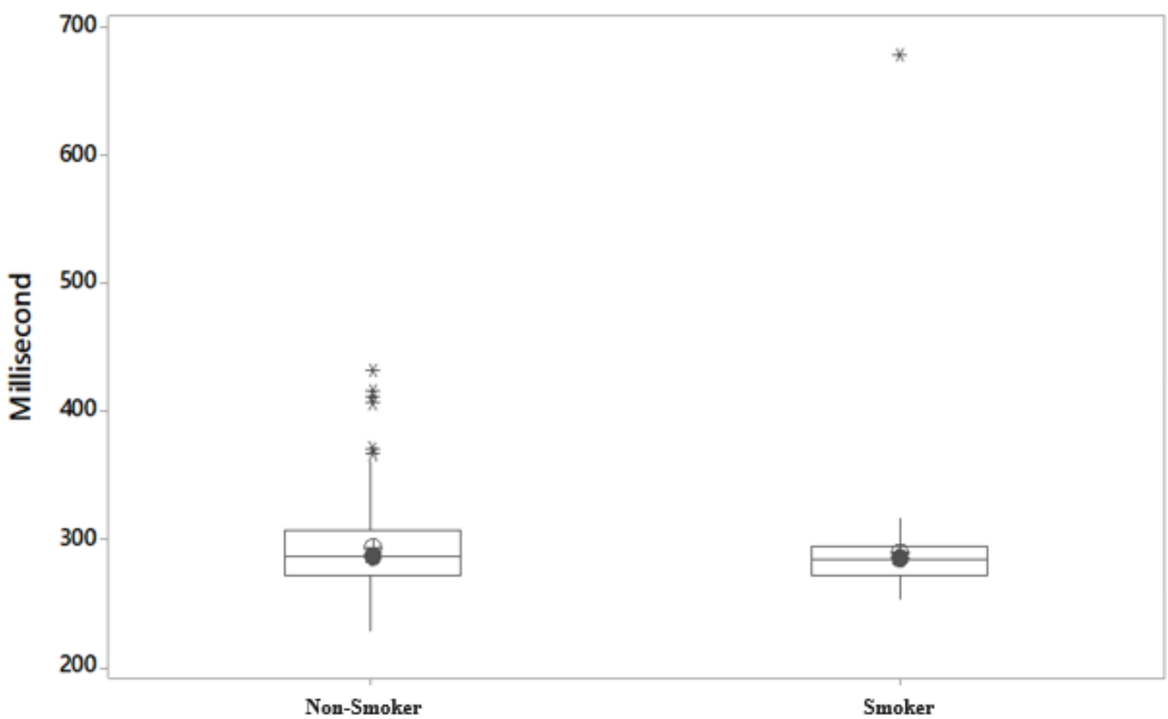


Figure 5.91. Box plot of Reaction Time (Non-Dominant Hand) according to smoking habit

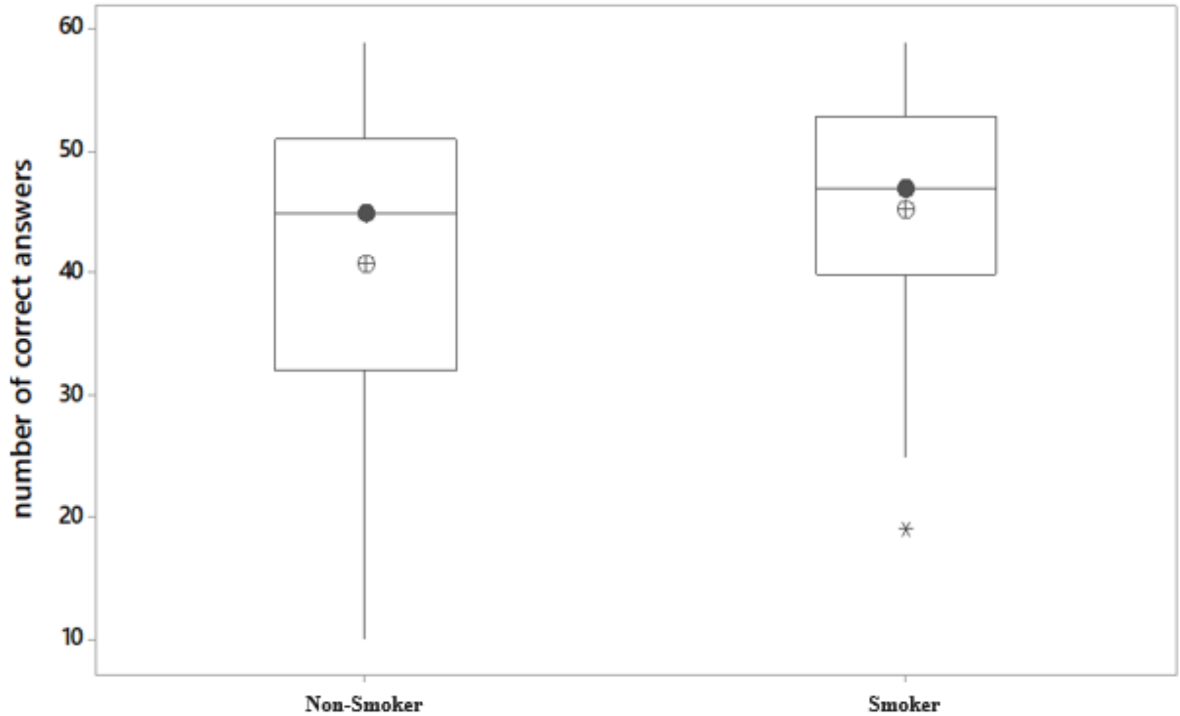


Figure 5.92. Box plot of Raven Test according to smoking habit

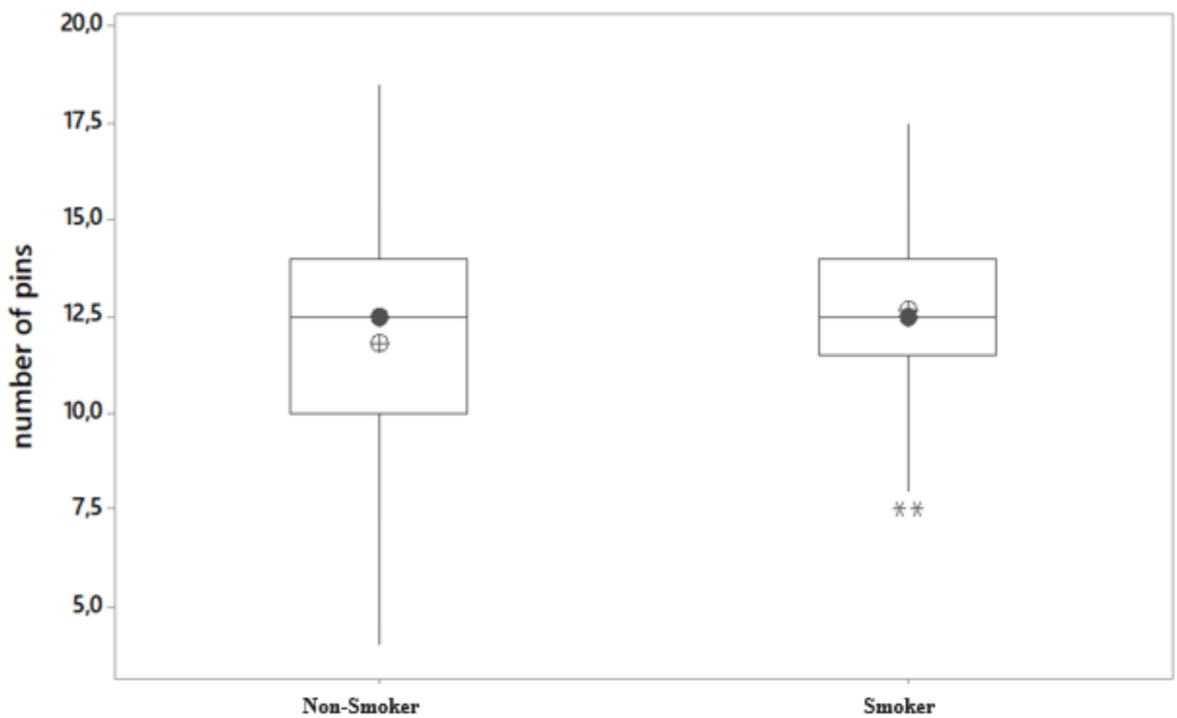


Figure 5.93. Box plot of Purdue Pegboard (Dominant Hand) according to smoking habit

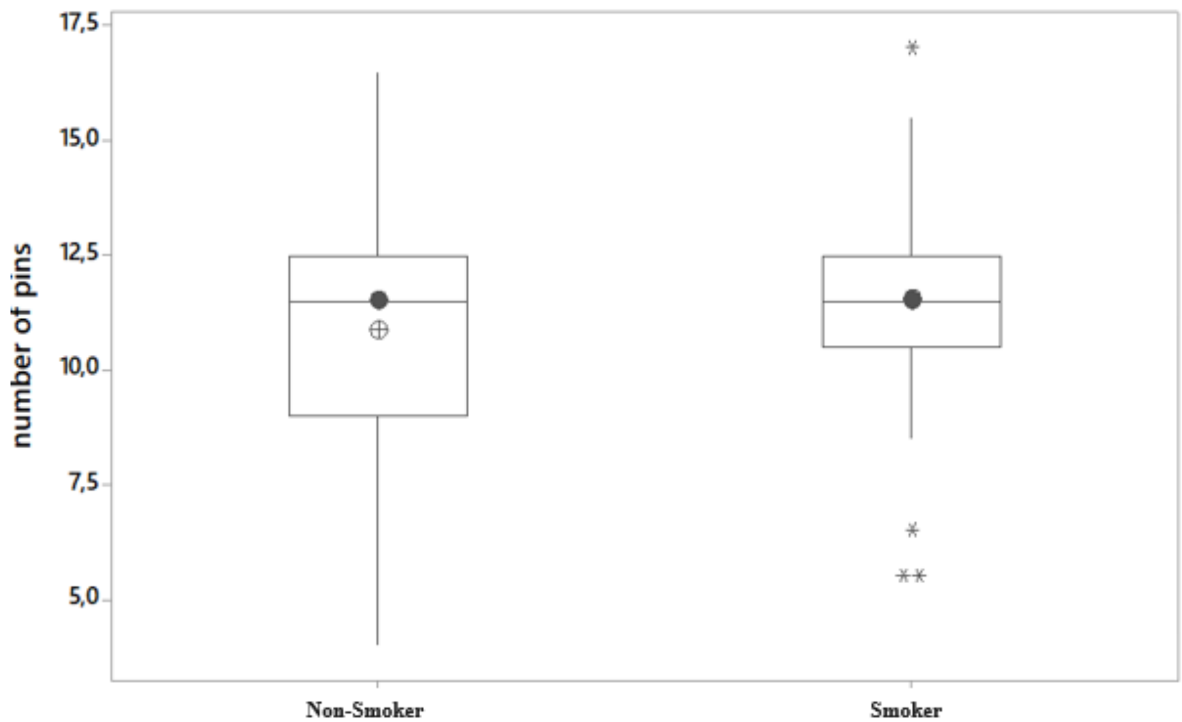


Figure 5.94. Box plot of Purdue Pegboard (Non Dominant Hand) according to smoking habit

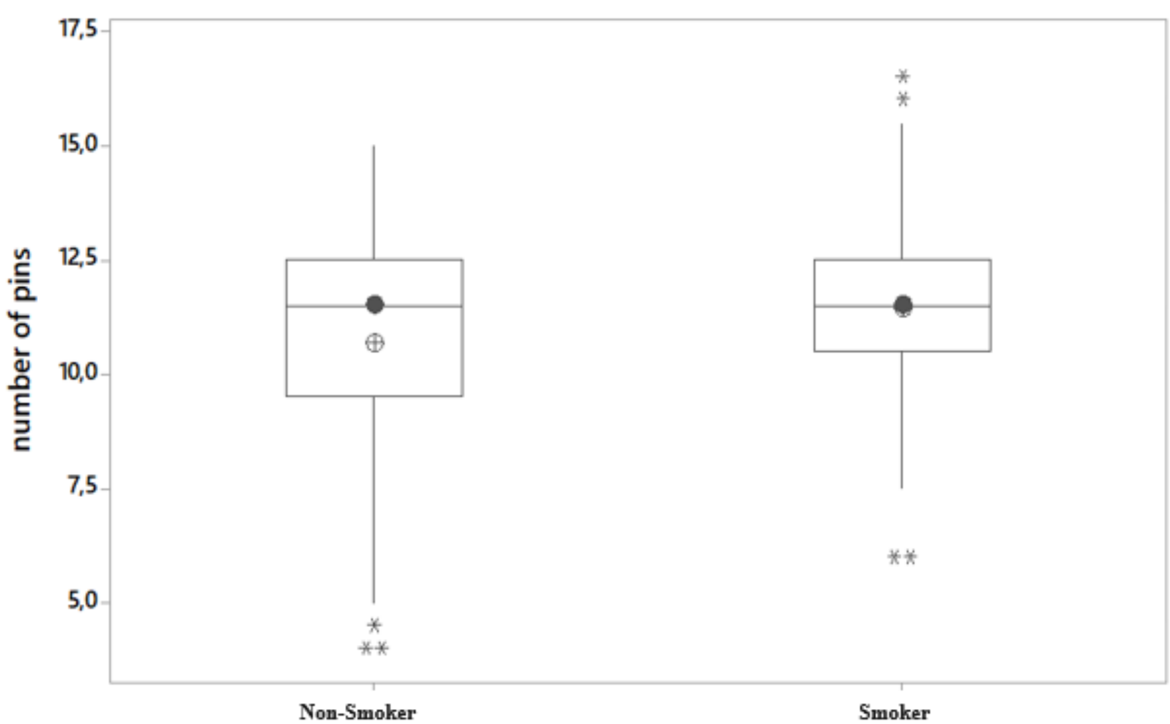


Figure 5.95. Box plot of Purdue Pegboard (Both Hand) according to smoking habit

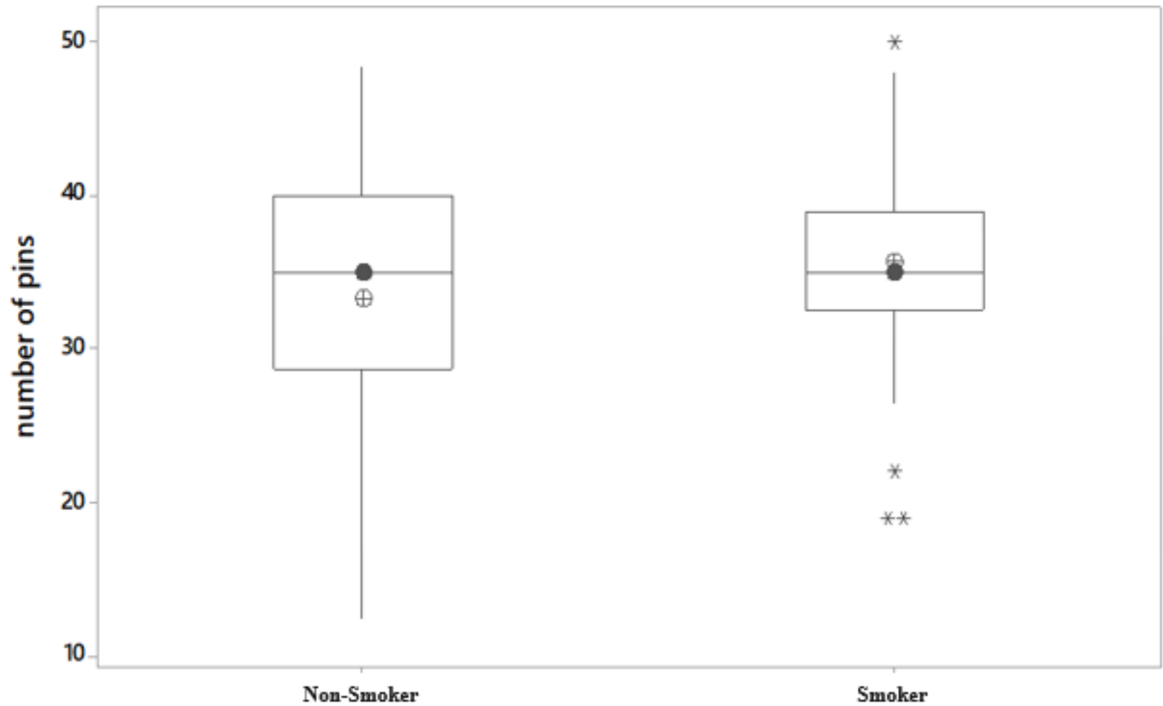


Figure 5.96. Box plot of Purdue Pegboard (Total) according to smoking habit

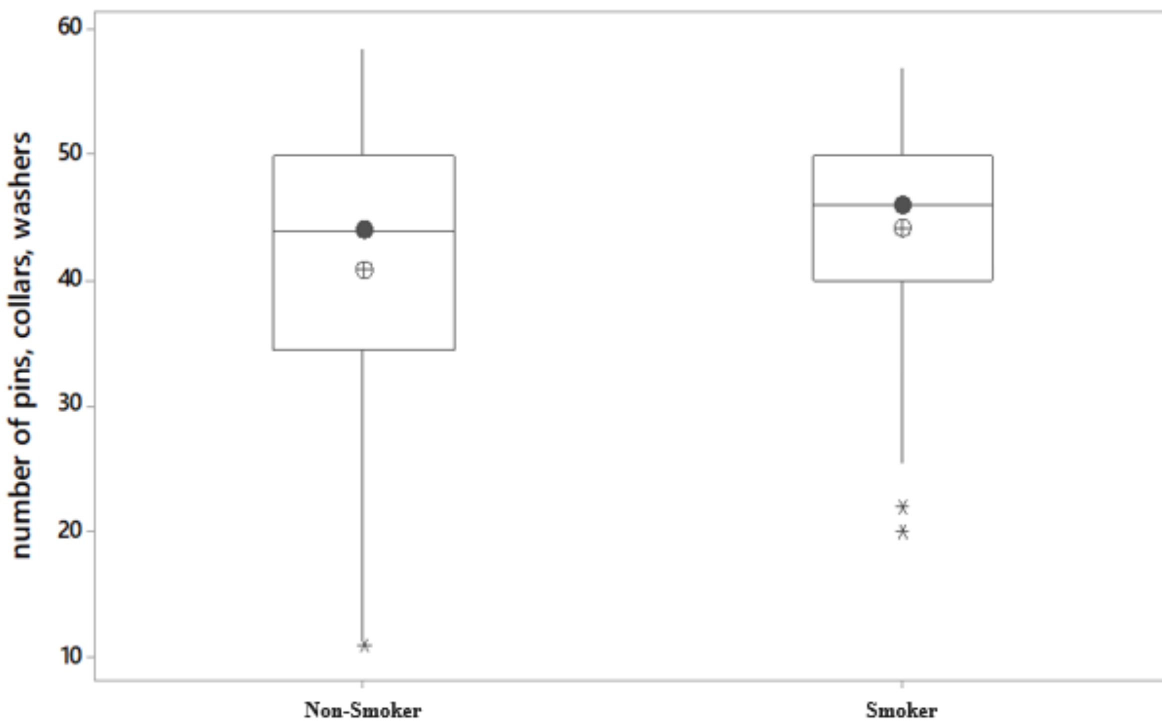


Figure 5.97. Box plot of Purdue Pegboard (Assembly) according to smoking habit

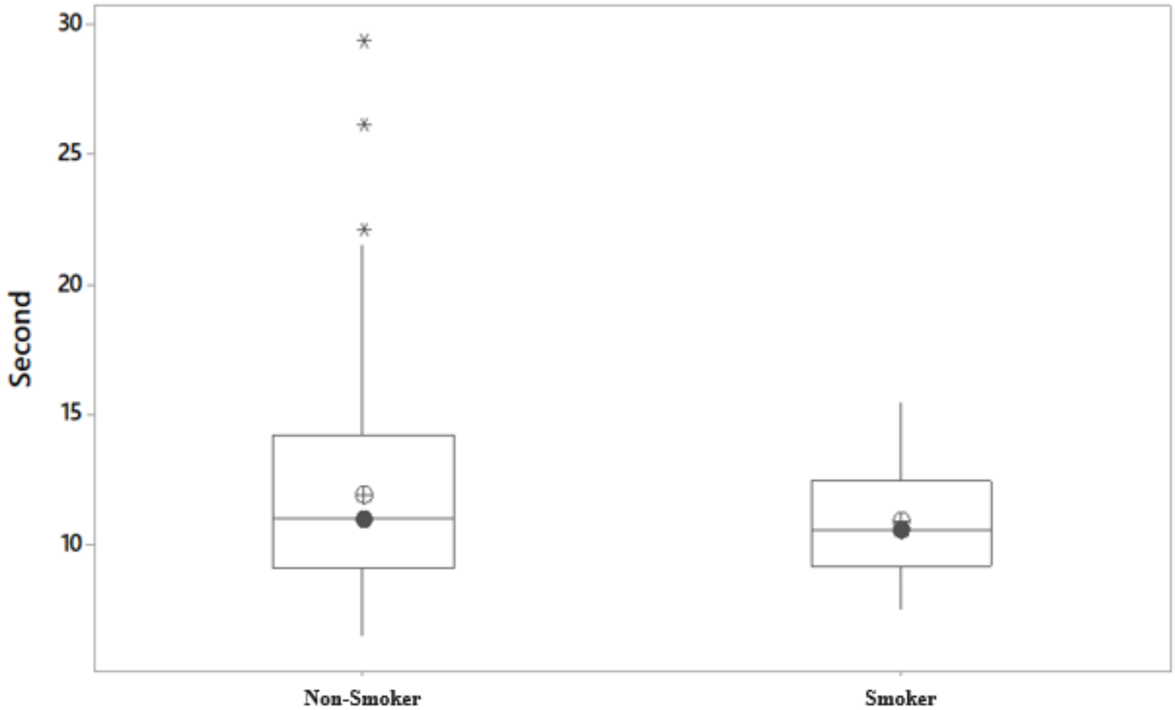


Figure 5.98. Box plot of Stroop Color Word Test Part I according to smoking habit

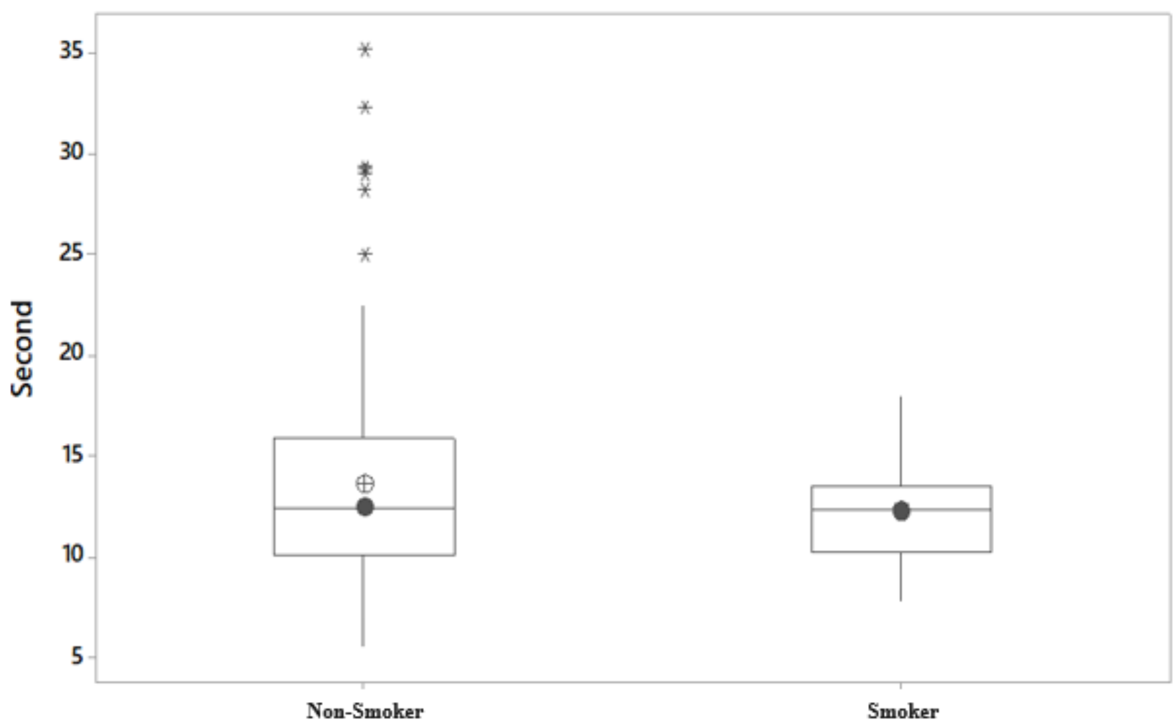


Figure 5.99. Box plot of Stroop Color Word Test Part II according to smoking habit

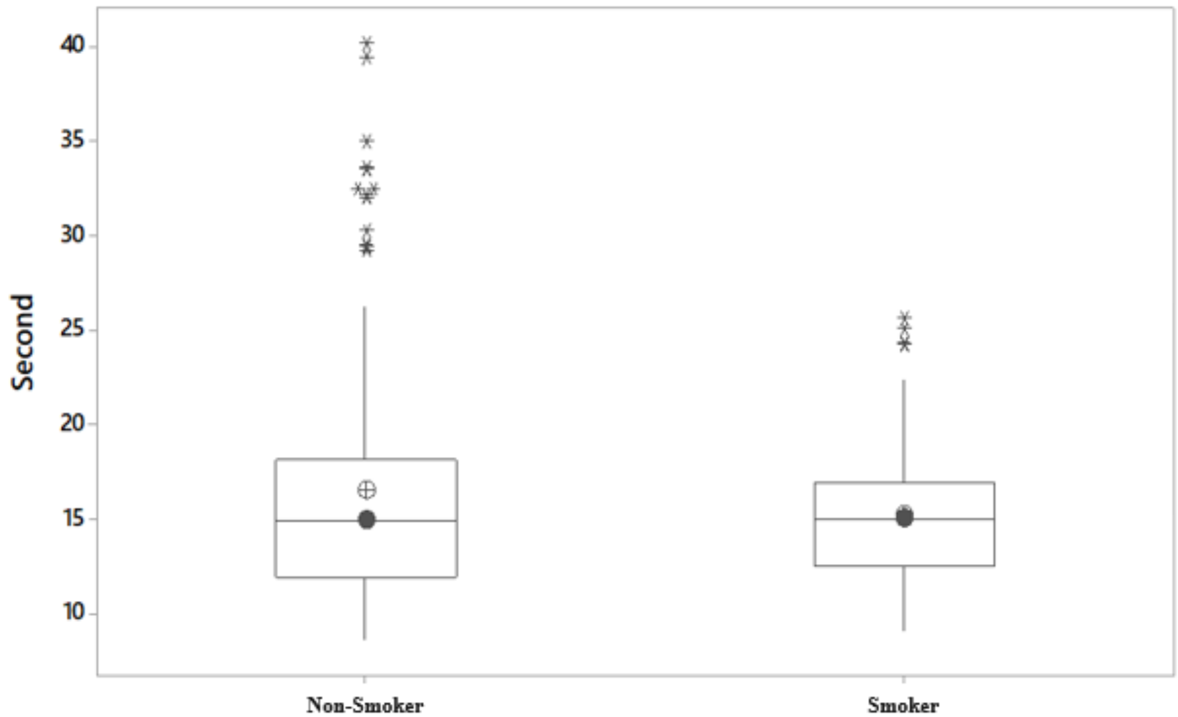


Figure 5.100. Box plot of Stroop Color Word Test Part III according to smoking habit

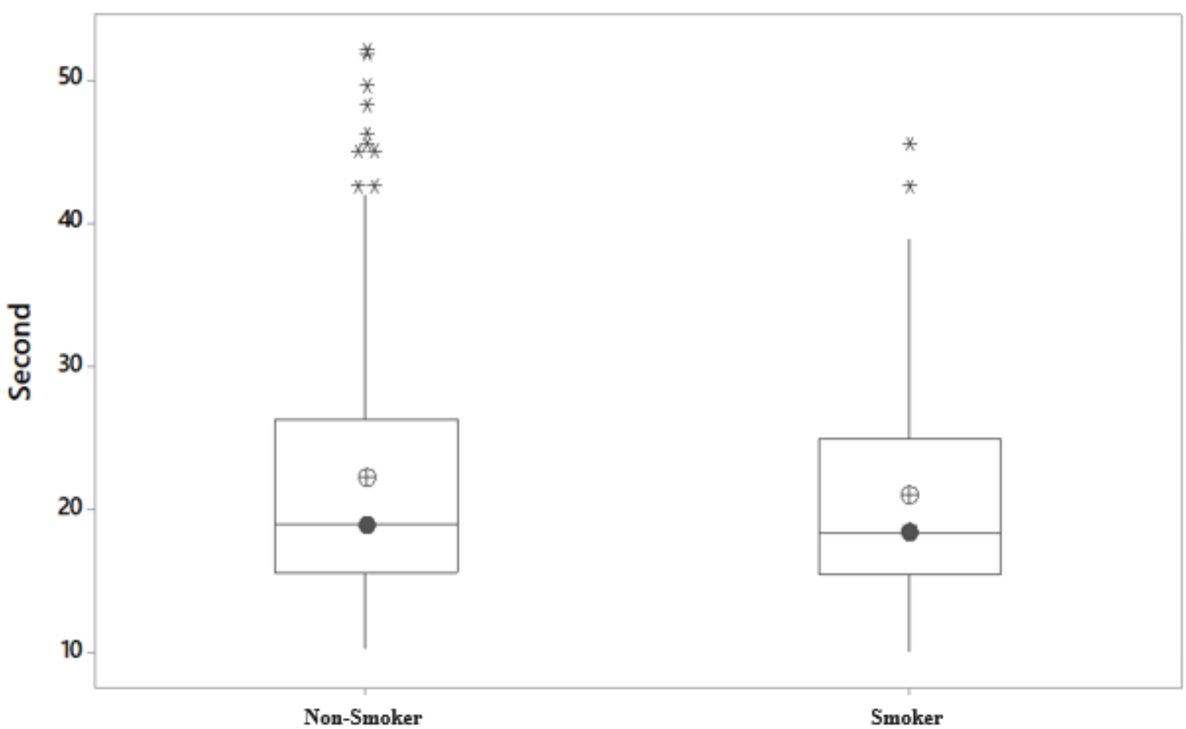


Figure 5.101. Box plot of Stroop Color Word Test Part IV according to smoking habit

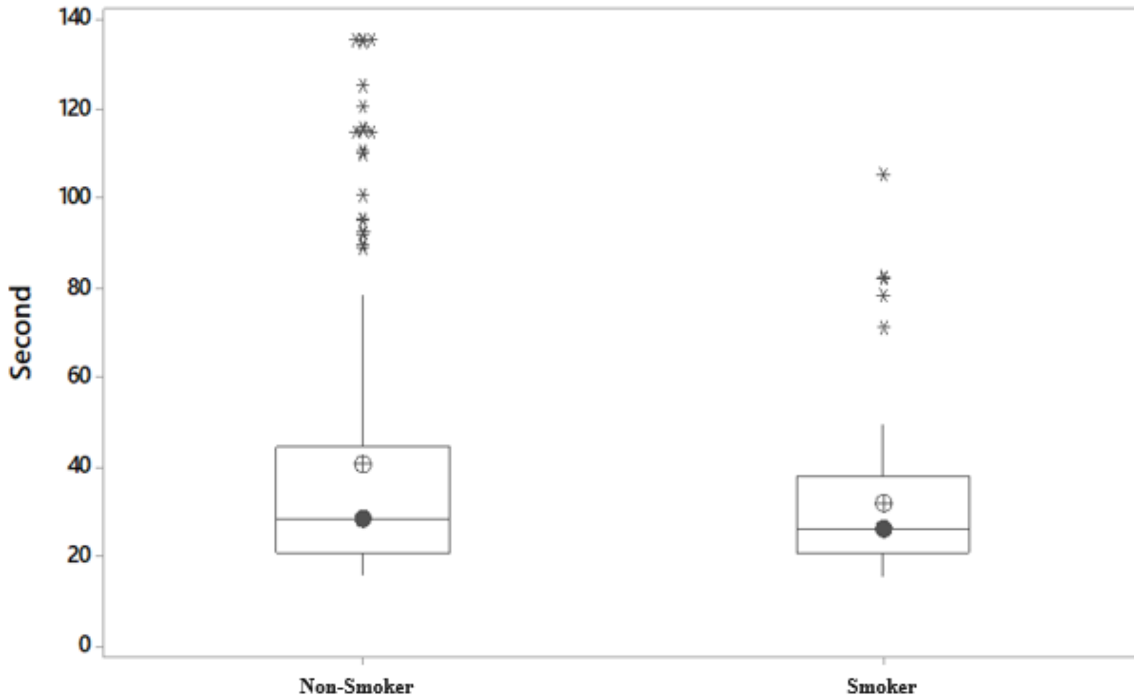


Figure 5.102. Box plot of Stroop Color Word Test Part V according to smoking habit

5.3. Inferential Statistics

5.3.1. Checking the Assumptions for Parametric Tests

For the inferential statistics, the assumptions for the parametric tests were calculated first.

(i) Normality assumption: Normal probability plots for residuals are used to check normality assumption (Appendix C). Residual plots appears a sample from a normal distribution centered at zero, if normality assumption is satisfied (Montgomery, 2005).

Normality assumption is also checked with Anderson-Darling normality test. According to Razali and Wah (2011), among all normality tests the most powerful one is Anderson-Darling test.

The hypotheses are below:

H_o: The sampled population is normally distributed
H_1: The sampled population is not normally distributed
If $p \geq 0.05$ normal; $p < 0.05$ not normal.

Table 5.9. Distribution of Response Variables

Response Variables	**Type**	**p - value**	**Distribution**
Digit Span Forward (number of digits)	Continuous	0.11	Normal
Digit Span Backward (number of digits)	Continuous	0.19	Normal
Corsi Span Forward (length of sequence)	Continuous	0.60	Normal
Corsi Span Backward (length of sequence)	Continuous	0.69	Normal
Stroop Color and Word Part 1 (time)	Continuous	0.05	Normal
Stroop Color and Word Part 2 (time)	Continuous	<0.005	Non-Normal *
Stroop Color and Word Part 3 (time)	Continuous	0.12	Normal
Stroop Color and Word Part 4 (time)	Continuous	<0.005	Non-Normal *
Stroop Color and Word Part 5 (time)	Continuous	< 0.005	Non-Normal *
Reaction Time Test Dominant Hand (time)	Continuous	< 0.005	Non-Normal *
Reaction Time Test Non-Dominant Hand (time)	Continuous	<0.005	Non-Normal *
Raven Test (number of correct answers)	Continuous	< 0.005	Non-Normal *
Purdue Pegboard Test Dominant Hand (number of pins)	Continuous	0.02	Non-Normal *
Purdue Pegboard Test Non-Dominant Hand (number of pins)	Continuous	< 0.005	Non-Normal *
Purdue Pegboard Test Both Hand (number of pins)	Continuous	0.05	Normal
Purdue Pegboard Test Total (number of pins)	Continuous	0.26	Normal
Purdue Pegboard Test Assembly (number of assembled parts)	Continuous	0.11	Normal

(* minor violation of normality according to probability plots)

ANOVA is a statistical method that relatively robust to minor violation of normality assumption. Due to minor violation of normality, Stroop Color and Word Part 2 (completion time), Stroop Color and Word Part 4 (completion time), Stroop Color and Word Part 5 (completion time), Reaction Time (time in millisecond) and Raven Test (number of correct answers) are accepted normally distributed.

(ii) Homogeneity of variance assumption: Levene (1960) test is used to check homogeneity (equal variance). Normality is not an assumption for Levene Test. That is, it can also be applied when the normality assumption is violated (Villanueva *et al.*, 2000).

The results of Levene test can be shown in Table 5.10. The graph of Levene test results are also used to evaluate whether intervals of the groups are overlapping or not.

Hypotheses are below:

Ho: The differences between some of variances are not statistically significant
H1: The differences between some of variances are statistically significant

If p-value ≤ 0.05: The differences between some of the variances are statistically significant. Then, for these results, we have checked the graph.

Table 5.10. Levene Test Results

Factor	Test	p value	Graph Result	Equal Variance Status
Age Factor	Digit Forward	0.31	Overlap	Yes
	Digit Backward	0.60	Overlap	Yes
	Corsi Forward	0.77	Overlap	Yes
	Corsi Backward	0.48	Overlap	Yes
	Reaction Time Dominant Hand	0.16	Overlap	Yes
	Reaction Time Non-Dominant Hand	0.19	Overlap	Yes
	Purdue Pegboard Dominant Hand	0.21	Overlap	Yes
	Purdue Pegboard Non-Dominant Hand	0.10	Overlap	Yes
	Purdue Pegboard BH	0.60	Overlap	Yes
	Purdue Pegboard Total	0.31	Overlap	Yes
	Purdue Pegboard Assembly	0.55	Overlap	Yes
	Raven Test	0.31	Overlap	Yes
	SCWT Part I	<0.001	Do not overlap	No
	SCWT Part II	<0.001	Do not overlap	No
	SCWT Part III	<0.001	Do not overlap	No
	SCWT Part IV	<0.001	Do not overlap	No
	SCWT Part V	<0.001	Do not overlap	No
Education Factor	Digit Forward	0.08	Overlap	Yes
	Digit Backward	0.12	Overlap	Yes
	Corsi Forward	0.19	Overlap	Yes
	Corsi Backward	0.02	Overlap	No
	Reaction Time Dominant Hand	0.29	Overlap	Yes
	Reaction Time Non-Dominant Hand	0.80	Overlap	Yes
	Purdue Pegboard Dominant Hand	0.00	Do not overlap	No
	Purdue Pegboard Non-Dominant Hand	0.00	Do not overlap	No
	Purdue Pegboard BH	0.00	Do not overlap	No
	Purdue Pegboard Total	0.00	Do not overlap	No
	Purdue Pegboard Assembly	0.00	Do not overlap	No
	Raven Test	0.00	Do not overlap	No
	SCWT Part I	0.00	Do not overlap	No
	SCWT Part II	0.00	Do not overlap	No
	SCWT Part III	0.00	Do not overlap	No
	SCWT Part IV	0.00	Do not overlap	No
	SCWT Part V	0.00	Do not overlap	No

Table 5.10. Levene Test Results (cont.)

Factor	Test	p value	Graph Result	Equal Variance Status
Income Level	Digit Forward	0.02	Overlap	Yes
	Digit Backward	0.10	Overlap	Yes
	Corsi Forward	0.02	Overlap	No
	Corsi Backward	0.00	Do not overlap	No
	Reaction Time Dominant Hand	0.18	Overlap	Yes
	Reaction Time Non-Dominant Hand	0.32	Overlap	Yes
	Purdue Pegboard Dominant Hand	0.01	Do not overlap	No
	Purdue Pegboard Non-Dominant Hand	0.06	Overlap	Yes
	Purdue Pegboard BH	0.01	Do not overlap	No
	Purdue Pegboard Total	0.02	Overlap	Yes
	Purdue Pegboard Assembly	0.00	Do not overlap	No
	Raven Test	0.00	Do not overlap	No
	SCWT Part I	0.06	Overlap	Yes
	SCWT Part II	0.03	Overlap	Yes
	SCWT Part III	0.15	Overlap	Yes
	SCWT Part IV	0.09	Overlap	Yes
	SCWT Part V	0.00	Do not overlap	No
Smoking Habit	Digit Forward	0.07	Overlap	Yes
	Digit Backward	0.01	Do not overlap	No
	Corsi Forward	0.01	Do not overlap	No
	Corsi Backward	0.00	Do not overlap	No
	Reaction Time Dominant Hand	0.00	Do not overlap	No
	Reaction Time Non-Dominant Hand	0.27	Overlap	Yes
	Purdue Pegboard Dominant Hand	0.00	Do not overlap	No
	Purdue Pegboard Non-Dominant Hand	0.00	Do not overlap	No
	Purdue Pegboard BH	0.00	Do not overlap	No
	Purdue Pegboard Total	0.00	Do not overlap	No
	Purdue Pegboard Assembly	0.00	Do not overlap	No
	Raven Test	0.00	Do not overlap	No
	SCWT Part I	0.00	Do not overlap	No
	SCWT Part II	0.00	Do not overlap	No
	SCWT Part III	0.00	Do not overlap	No
	SCWT Part IV	0.12	Overlap	Yes
	SCWT Part V	0.00	Do not overlap	No

Table 5.10. Levene Test Results (cont.)

Factor	Test	p value	Graph Result	Equal Variance Status
Marital Status	Digit Forward	0.17	Overlap	Yes
	Digit Backward	0.07	Overlap	Yes
	Corsi Forward	0.59	Overlap	Yes
	Corsi Backward	0.03	Overlap	Yes
	Reaction Time Dominant Hand	0.01	Overlap	Yes
	Reaction Time Non-Dominant Hand	0.50	Overlap	Yes
	Purdue Pegboard Dominant Hand	0.02	Overlap	Yes
	Purdue Pegboard Non-Dominant Hand	0.06	Overlap	Yes
	Purdue Pegboard BH	0.01	Overlap	Yes
	Purdue Pegboard Total	0.01	Overlap	Yes
	Purdue Pegboard Assembly	0.00	Do not overlap	No
	Raven Test	0.00	Do not overlap	No
	SCWT Part I	0.06	Overlap	Yes
	SCWT Part II	0.01	Overlap	Yes
	SCWT Part III	0.01	Overlap	Yes
	SCWT Part IV	0.00	Do not overlap	No
	SCWT Part V	0.00	Overlap	Yes

For factors that have unequal variance, Welch's ANOVA and Games-Howell (for post-hoc) tests are applied beside parametric ANOVA and Tukey tests. Results have been compared. Since we get the similar results for parametric ANOVA and Welch's ANOVA, Tukey and Games Howell, we continue with parametric ANOVA and Tukey test.

5.3.2. Correlation Analysis

Pearson correlation analysis is used for continuous variables which are age and education, to measure correlation between test performance and continuous variables. In addition to Pearson correlation, Spearman correlation coefficient is used for income factor which is ordinal variable due to provide categorization of participants to 3 groups which are low, medium and high income.

Table 5.11 shows the results of correlation analysis. According to the results, there is negative correlation between age and Digit Span, Corsi Span and Purdue Pegboard test results. Then, it can be summarized as when age increases, short term memory and motor functions are being weak. In this study, education and Digit Span, Corsi Span and Purdue Pegboard test results are positively correlated and Reaction Time (lower is better), Stroop Color Test results are negatively correlated. In summary, education has positive effect on test results. In the case of increasement of education, memory function, motor functions and decision making processes is improved as well. When we look at income factor and its relation with the result variables, it can be easily seen that there is weak positive relationship with Digit Span, Corsi Span and Purdue Pegboard test results. There is weak negative relationship with Reaction Time and Stroop Color test results.

Table 5.11. Correlation Matrix

r (correlation coefficient) **P- Value**	**Age**	**Education**	**Income Level**
Digit Forward	-0.71	0.64	0.32
	<0.001	<0.001	<0.001
Digit Backward	-0.69	0.64	0.33
	<0.001	<0.001	<0.001
Corsi Forward	-0.64	0.66	0.38
	<0.001	<0.001	<0.001
Corsi Backward	-0.64	0.62	0.33
	<0.001	<0.001	<0.001
Reaction Time Dominant Hand	0.71	-0.42	-0.04
	<0.001	<0.001	<0.001
Reaction Time Non-Dominant Hand	0.45	-0.26	-0.09
	<0.001	<0.001	<0.001
Purdue Pegboard Dominant Hand	-0.80	0.48	0.14
	<0.001	<0.001	0.02
Purdue Pegboard Non-Dominant Hand	-0.78	0.48	0.19
	<0.001	<0.001	<0.001
Purdue Pegboard Both Hand	-0.76	0.46	0.14
	<0.001	<0.001	0.008
Purdue Pegboard Total	-0.81	0.49	0.16
	<0.001	<0.001	0.003
Purdue Pegboard Assembly	-0.84	0.55	0.08
	<0.001	<0.001	0.01
Raven Test	-0.69	0.83	0.59
	<0.001	<0.001	<0.001
Stroop Color and Word Test Part I	0.77	-0.55	-0.12
	<0.001	<0.001	0.05
Stroop Color and Word Test Part II	0.75	-0.56	-0.12
	<0.001	<0.001	0.05
Stroop Color and Word Test Part III	0.74	-0.53	-0.05
	<0.001	<0.001	0.44
Stroop Color and Word Test Part IV	0.71	-0.47	-0.03
	<0.001	<0.001	0.61
Stroop Color and Word Test Part V	0.81	-0.59	-0.18
	<0.001	<0.001	<0.001

The Pearson's Product Moment Correlation Coefficient is used to measure the correlation between two interval or ratio variables. In this study, there are 3 independent bipartite variables which are hand preference (Right Handed/Left Handed), marital status (Single/Married) and smoking habit (Smoker /Non-Smoker).

Since the Phi Coefficient (r_{pbi}) is used for calculating the correlation between two dichotomous variables and Point biserial method computes correlation when one variable is interval/ratio and the second is dichotomous, we use Point Biseral correlation calculation for these 3 variables (Yount, 2006). It this study, independent variables are dichotomous and result variables are interval, following formula is used to calculate The Phi Coefficient ($r\varphi$).

$$r_{pbi} = (Mp - Mq)/ St * (p*q)^{1/2} \tag{5.1}$$

r_{pbi} = point-biserial correlation coefficient

M_p = mean for categorical group 1 (i.e., those coded as 1s)

M_q = mean for categorical group 2 (i.e., those coded as 0s)

S_t = standard deviation

p = proportion of subjects that in group 1 (i.e., those coded as 1s)

q = proportion of subjects that in group 2 (i.e., those coded as 0s)

Table 5.12 shows the results of Point Biseral Correlation of these varibles.

Table 5.12. Point Biseral Correlation Matrix

Point biseral r value	**Marital Status**	**Smoking Habit**	**Hand Preference**
Digit Forward	0.32 (p<0.001)	0.16 (p<0.001)	-0.03 (p<0.001)
Digit Backward	-0.34 (p<0.001)	0.18 (p<0.001)	-0.03 (p<0.001)
Corsi Forward	-0.27 (p<0.001)	0.19 (p<0.001)	-0.04 (p<0.001)
Corsi Backward	-0.26 (p<0.001)	0.15 (p<0.001)	-0.04 (p<0.001)
Reaction Time Dominant Hand	0.37 (p=0.01)	-0.18 (p<0.001)	0.004 (p<0.001)
Reaction Time Non-Dominant Hand	0.19 (p=0.01)	-0.04 (p=0.02)	-0.09 (p=0.01)
Raven Test	-0.29 (p<0.001)	0.17 (p<0.001)	-0.002 (p<0.001)
Purdue Pegboard Dominant Hand	-0.35 (p<0.001)	0.14 (p<0.001)	-0.06 (p<0.001)
Purdue Pegboard Non-Dominant Hand	-0.33 (p<0.001)	0.12 (p<0.001)	0.08 (p<0.001)
Purdue Pegboard Both Hand	-0.25 (p<0.001)	0.14 (p=0.01)	-0.01 (p<0.001)
Purdue Pegboard Total	-0.32 (p<0.001)	0.14 (p=0.03)	-0.002 (p<0.001)
Purdue Pegboard Assembly	-0.31 (p<0.001)	0.15 (p<0.001)	0.01 (p<0.001)
Stroop Color-Word Test Part I	0.31 (p<0.001)	-0.14 (p<0.001)	0.11 (p<0.001)
Stroop Color-Word Test Part II	0.32 (p<0.001)	-0.15 (p<0.001)	0.05 (p<0.001)
Stroop Color-Word Test Part III	0.34 (p<0.001)	-0.11 (p<0.001)	0.02 (p<0.001)
Stroop Color-Word Test Part IV	0.35 (p<0.001)	-0.06 (p<0.001)	-0.005 (p<0.001)
Stroop Color-Word Test Part V	0.30 (p<0.001)	-0.15 (p<0.001)	0.01 (p<0.001)

According to the Point Biseral Correlation results, there is a weak negative relationship between marital status and Digit Span, Corsi Span, Raven and Purdue Pegboard test results. Hand dominance and smoking habit are also not strongly correlated with the result variables.

Pearson correlations among the response variables were also estimated (Table 5.13). The results are summarized below:

- There is a strong positive correlation between Digit Span and Corsi Span responses.

- There is also strong positive correlation between Raven and Digit and Corsi Span responses.

- There is a negative correlation between reaction time and other test responses, except Stroop Color Word Test. That is, Stroop Color Word Test and Reaction Time Test Results are correlated positively. So, people with long reaction time has long completion time results for Stroop Color Word Test .

- Results of test parts (for example Digit Forward and Backward) are correlated positively with each other. Another example, people who plug high number of pin at the dominant hand part (higher performance) of the Purdue Pegboard Test has also high Purdue Pegboard Assembly results (high performance).

- It can be said that there is a positive relationship between motor functions and memory ability since Digit Span, Corsi Span and Purdue Pegboard test results are correlated positively.

- In summary: The higher the performance in one test, the higher performance in all other tests.

Note: One should notice that lower Stroop Color Word and Reaction Times test results indicate high performances. For all the other tests, the higher scores are indication of higher performances. For this reason, negative correlations between Stroop Color Word, Reaction Time test and the other test results indicate high performances in both tests.

Table 5.13. Pearson Correlation between test results

Pearson rho / p value	Digit Forward	Digit Backward	Corsi Forward	Corsi Backward	Reaction Time DH	Reaction Time NDH	Raven	Purdue Pegboard DH	Purdue Pegboard NDH	Purdue Pegboard BH	Purdue Pegboard TR	Purdue Pegboard Assembly	Stroop 1	Stroop 2	Stroop 3	Stroop 4
Digit B.	0.70															
	<0.001															
Corsi F.	0.73	0.71														
	<0.001	<0.001														
Corsi B.	0.69	0.69	0.70													
	<0.001	<0.001	<0.001													
Reaction DH	-0.60	-0.55	-0.47	-0.51												
	<0.001	<0.001	<0.001	<0.001												
Reaction NDH	-0.59	-0.57	-0.51	-0.53	0.80											
	<0.001	<0.001	<0.001	<0.001	<0.001											
Raven	0.75	0.73	0.77	0.73	-0.52	-0.53										
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001										
Purdue DH	0.63	0.61	0.61	0.57	-0.66	-0.64	0.61									
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001									
Purdue NDH	0.62	0.57	0.64	0.60	-0.60	-0.62	0.61	0.87								
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001								
Purdue BH	0.57	0.54	0.58	0.59	-0.54	-0.56	0.55	0.84	0.88							
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001							
Purdue TR	0.62	0.59	0.63	0.61	-0.62	-0.63	0.61	0.95	0.96	0.94						
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001						
Purdue Assembly	0.60	0.59	0.53	0.58	-0.74	-0.75	0.59	0.80	0.77	0.73	0.80					
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001					
Stroop 1	-0.62	-0.58	-0.53	-0.53	0.66	0.63	-0.55	-0.63	-0.56	-0.47	-0.58	-0.64				
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
Stroop 2	-0.61	-0.59	-0.51	-0.51	0.65	0.62	-0.54	-0.61	-0.54	-0.46	-0.56	-0.65	0.94			
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001			
Stroop 3	-0.56	-0.55	-0.49	-0.49	0.64	0.62	-0.49	-0.53	-0.48	-0.39	-0.48	-0.61	0.85	0.89		
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
Stroop 4	-0.53	-0.51	-0.49	-0.46	0.62	0.62	-0.46	-0.50	-0.45	-0.35	-0.45	-0.59	0.80	0.83	0.89	
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Stroop 5	-0.64	-0.61	-0.57	-0.58	0.67	0.68	-0.58	-0.58	-0.51	-0.43	-0.52	-0.65	0.81	0.82	0.85	0.89
	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

5.3.4. Factor Effects

ANOVA is used to measure differences in means between different groups to detect factor effect.

5.3.5. ANOVA Assumptions

There are three assumptions for ANOVA. Normality and homogeneity of variance assumptions are checked before in Section 5.2.6. In addition to them, independence assumption is checked before applying parametric ANOVA.

Independence assumption indicates that there is no high correlation between independent variables and error terms (Montogomery, 2005).

The residual plots in time sequence of data collection can be used to check independence assumption. Positive or negative tendency in time indicates positive or negative correlation which doesn't satisfy independence assumption (Montgomery, 2005). The plots of the residuals versus observation order show that there is no correlation between residuals (Appendix C).

According to Montogomery (2005) in order to provide independence, proper randomization is an important step. Because of this reason, participants are conducted tests in a random order.

5.3.6. ANOVA Results

First of all, ANOVA is applied by including all factors. Then, ANOVA is applied again after ignoring the factors that have no effect on the test results. Final ANOVA results are presented in tables 5.15 – 5.31.

Table 5.14. ANOVA results for Digit Span Forward Test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	81.29	16.26	37.70	<0.001
Education Group	3	10.21	3.40	7.89	<0.001
Income Level	2	4.40	2.19	5.10	0.01
Error	241	103.94	0.43		
Lack-of-Fit	29	21.61	0.74	1.92	0.01
Pure Error	212	82.34	0.39		
Total	251	297.32			

Table 5.15. ANOVA results for Digit Span Backward Test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	87.79	17.56	36.19	<0.001
Education Group	3	10.66	3.55	7.32	<0.001
Income Level	2	6.18	3.09	6.37	<0.001
Error	241	116.93	0.48		
Lack-of-Fit	29	10.90	0.37	0.75	0.81
Pure Error	212	106.03	0.50		
Total	251	336.22			

Table 5.16. ANOVA results for Corsi Span Forward Test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	56.17	11.23	20.99	<0.001
Education Group	3	40.36	13.45	25.14	<0.001
Error	243	130.03	0.53		
Lack-of-Fit	11	9.17	0.83	1.60	0.10
Pure Error	232	120.86	0.52		
Total	251	322.10			

Table 5.17. ANOVA results for Corsi Span Backward Test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	48.05	9.61	20.67	<0.001
Education Group	3	23.59	7.86	16.92	<0.001
Error	243	112.98	0.46		
Lack-of-Fit	11	3.56	0.32	0.69	0.75
Pure Error	232	109.41	0.47		
Total	251	252.60			

Table 5.18. ANOVA results for Raven Test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	7224.0	1444.80	66.29	<0.001
Education Group	3	3604.4	1201.48	55.13	<0.001
Income Level	2	1371.8	685.92	31.47	<0.001
Error	241	5252.4	21.79		
Lack-of-Fit	29	906.5	31.26	1.52	0.05
Pure Error	212	4345.9	20.50		
Total	251	38861.6			

Table 5.19. ANOVA results for Stroop Color Word Test Part I

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	848.64	169.73	43.35	<0.001
Education Group	3	160.78	53.59	13.69	<0.001
Error	243	951.48	3.92		
Lack-of-Fit	11	90.73	8.25	2.22	0.01
Pure Error	232	860.75	3.71		
Total	251	2838.93			

Table 5.20. ANOVA test for Stroop Color Word Test Part II

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	1173.2	234.64	37.32	<0.001
Education Group	3	453.0	150.98	24.02	<0.001
Error	243	1527.8	6.29		
Lack-of-Fit	11	137.8	12.53	2.09	0.02
Pure Error	232	1389.9	5.99		
Total	251	4774.2			

Table 5.21. ANOVA results for Stroop Color Word Test Part III

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	2122.3	424.45	33.36	<0.001
Education Group	3	583.6	194.52	15.29	<0.001
Error	243	3092.0	12.72		
Lack-of-Fit	11	244.5	22.23	1.81	0.05
Pure Error	232	2847.4	12.27		
Total	251	8197.9			

Table 5.22. ANOVA results for Stroop Color Word Test Part IV

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	5718.3	1143.65	30.23	<0.001
Education Group	3	729.0	243.00	6.42	<0.001
Error	243	9193.7	37.83		
Lack-of-Fit	11	1246.4	113.31	3.31	0.00
Pure Error	232	7947.3	34.26		
Total	251	20390.9			

Table 5.23. ANOVA results for Stroop Color Word Test Part V

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	72524	14504.7	104.55	<0.001
Education Group	3	5637	1878.9	13.54	<0.001
Error	243	33713	138.7		
Lack-of-Fit	11	2766	251.4	1.88	0.04
Pure Error	232	30948	133.4		
Total	251	177836			

Table 5.24. ANOVA results for Purdue Pegboard Dominant Hand

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	1432.6	286.52	109.41	<0.001
Error	246	644.2	2.62		
Total	251	2076.8			

Table 5.25. ANOVA results for Purdue Pegboard Non Dominant Hand

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	1168.6	233.71	98.65	<0.001
Error	246	582.8	2.37		
Total	251	1751.4			

Table 5.26. ANOVA results for Purdue Pegboard Both Hand

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	993.0	198.61	93.89	<0.001
Error	246	520.4	2.12		
Total	251	1513.4			

Table 5.27. ANOVA test results for Purdue Pegboard Total Result

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	10352.3	2070.46	124.38	<0.001
Error	246	4061.6	16.65		
Total	251	14413.9			

Table 5.28. ANOVA test results for Purdue Pegboard Assembly Result

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	12855.0	2571.00	100.99	<0.001
Education Group	3	475.0	158.33	6.22	<0.001
Error	243	6186.5	25.46		
Lack-of-Fit	11	320.1	29.10	1.15	0.32
Pure Error	232	5866.4	25.29		
Total	251	28623.4			

Table 5.29. ANOVA test results for Reaction Time Dominant Hand

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	80038	16007.6	55.17	<0.001
Error	246	71374	290.1		
Total	251	151412			

Table 5.30. ANOVA test results for Reaction Time Non Dominant Hand

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age Group	5	79079	15816	15.18	<0.001
Error	246	256384	1042		
Total	251	335462			

The ANOVA results could be interpreted as follows;

- Age group has a significant effect on all test results.
- Education group significantly affects memory and attention based test results which are Digit Span, Corsi Span and Stroop Color Word tests.
- Education group also was found significant for Purdue Pegboard Assembly test result.
- Stroop Color Word Test all parts are affected by age and education factors. The other factors have no significant effect on its parts.

- Income level has a significant effect on two versions (forward and backward) of Digit Span test.

- Marital status factor was not found significant for any of the test results.

- There is not a significant effect of smoking habit on all test results.

- Purdue Pegboard Dominant Hand, Purdue Pegboard Non-Dominant Hand, Purdue Pegboard Both Hand, Purdue Pegboard Total and Reaction Time (Dominant and Non Dominant) Hand Results are affected by only age group factor.

5.3.7. Post-hoc Analysis (Pairwise Comparisions)

Tukey tests are used to compare group means. Tukey test is applied to results for p-value ≤ 0.05 which indicates that the differences between some of the means are statistically significant.

From Tukey test results, grouping information tables are used to determine if the mean difference between any pair of groups is statistically significant or not. According to grouping information table if groups do not have same letter, they are statistically different (Montgomery, 2005).

Table 5.31, 5.32 and 5.33 show the differences between means, t- values and p- values for each group. Letter grouping information tables also can be seen in Appendix D.

Table 5.31. Tukey's test results for age group differences

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	P-Value
Digit Forward	(31-40) - (18-30)	-0.26	0.15	-1.75	0.49
	(41-50) - (18-30)	-0.37	0.15	-2.54	0.11
	(51-60) - (18-30)	-1.06	0.15	-7.19	<0.001
	(61-70) - (18-30)	-1.20	0.21	-5.67	<0.001
	(71-93) - (18-30)	-2.52	0.16	-15.38	<0.001
	(41-50) – (31-40)	-0.11	0.15	-0.77	0.972
	(51-60) - (31-40)	-0.80	0.15	-5.40	<0.001
	(61-70) - (31-40)	-0.95	0.21	-4.45	<0.001
	(71-93) - (31-40)	-2.26	0.17	-13.74	<0.001
	(51-60) - (41-50)	-0.69	0.15	-4.66	<0.001
	(61-70) - (41-50)	-0.83	0.21	-3.92	<0.001
	(71-93) - (41-50)	-2.15	0.16	-13.10	<0.001
	(61-70) - (51-60)	-0.15	0.21	-0.68	0.98
	(71-93) - (51-60)	-1.46	0.16	-8.88	<0.001
	(71-93) - (61-70)	-1.32	0.22	-5.87	<0.001
Digit Backward	(31-40) - (18-30)	0.08	0.16	0.53	0.995
	(41-50) - (18-30)	-0.16	0.16	-1.00	0.917
	(51-60) - (18-30)	-0.82	0.16	-5.19	<0.001
	(61-70) - (18-30)	-1.47	0.23	-6.49	<0.001
	(71-93) - (18-30)	-2.45	0.18	-14.01	<0.001
	(41-50) – (31-40)	-0.24	0.16	-1.53	0.647
	(51-60) - (31-40)	-0.90	0.16	-5.70	<0.001
	(61-70) - (31-40)	-1.55	0.23	-6.84	<0.001
	(71-93) - (31-40)	-2.53	0.18	-14.43	<0.001
	(51-60) - (41-50)	-0.66	0.16	-4.20	<0.001
	(61-70) - (41-50)	-1.31	0.23	-5.80	<0.001
	(71-93) - (41-50)	-2.29	0.16	-13.11	<0.001
	(61-70) - (51-60)	-0.65	0.23	-2.88	<0.001
	(71-93) - (51-60)	-1.63	0.18	-9.30	<0.001
	(71-93) - (61-70)	-0.98	0.24	-4.10	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Corsi Forward	(31-40) - (18-30)	-0.11	0.17	-0.65	0.99
	(41-50) - (18-30)	-0.25	0.16	-1.55	0.63
	(51-60) - (18-30)	-0.49	0.16	-2.94	0.04
	(61-70) - (18-30)	-1.19	0.24	-4.99	<0.001
	(71-93) - (18-30)	-2.39	0.18	-12.98	<0.001
	(41-50) – (31-40)	-0.15	0.17	-0.89	0.95
	(51-60) - (31-40)	-0.38	0.16	-2.28	0.20
	(61-70) - (31-40)	-1.08	0.23	-4.53	<0.001
	(71-93) - (31-40)	-2.29	0.19	-12.35	<0.001
	(51-60) - (41-50)	-0.23	0.17	-1.40	0.73
	(61-70) - (41-50)	-0.94	0.24	-3.92	0.001
	(71-93) - (41-50)	-2.14	0.18	-11.60	<0.001
	(61-70) - (51-60)	-0.70	0.24	-2.94	0.04
	(71-93) - (51-60)	-1.90	0.18	-10.30	<0.001
	(71-93) - (61-70)	-1.20	0.25	-4.76	<0.001
Corsi Backward	(31-40) - (18-30)	-0.04	0.14	-0.29	1.000
	(41-50) - (18-30)	-0.16	0.15	-1.06	0.89
	(51-60) - (18-30)	-0.64	0.14	-4.34	<0.001
	(61-70) - (18-30)	-0.95	0.21	-4.44	<0.001
	(71-93) - (18-30)	-2.06	0.17	-12.48	<0.001
	(41-50) – (31-40)	-0.11	0.15	-0.76	0.97
	(51-60) - (31-40)	-0.60	0.15	-4.03	0.001
	(61-70) - (31-40)	-0.91	0.21	-4.23	<0.001
	(71-93) - (31-40)	-2.01	0.17	-12.17	<0.001
	(51-60) - (41-50)	-0.49	0.15	-3.28	0.01
	(61-70) - (41-50)	-0.79	0.21	-3.71	0.003
	(71-93) - (41-50)	-1.90	0.16	-11.53	<0.001
	(61-70) - (51-60)	-0.30	0.21	-1.43	0.71
	(71-93) - (51-60)	-1.41	0.17	-8.55	<0.001
	(71-93) - (61-70)	-1.11	0.23	-4.92	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Reaction Time Dominant Hand	(31-40) - (18-30)	5.37	3.39	1.58	0.61
	(41-50) - (18-30)	17.70	3.37	5.25	<0.001
	(51-60) - (18-30)	22.81	3.39	6.73	<0.001
	(61-70) - (18-30)	49.14	4.88	10.07	<0.001
	(71-93) - (18-30)	51.99	3.77	13.79	<0.001
	(41-50) – (31-40)	12.33	3.39	3.64	0.004
	(51-60) - (31-40)	17.44	3.41	5.12	<0.001
	(61-70) - (31-40)	43.77	4.89	8.95	<0.001
	(71-93) - (31-40)	46.62	3.79	12.31	<0.001
	(51-60) - (41-50)	5.12	3.39	1.51	0.66
	(61-70) - (41-50)	31.44	4.88	6.44	<0.001
	(71-93) - (41-50)	34.30	3.77	9.09	<0.001
	(61-70) - (51-60)	26.33	4.89	5.38	<0.001
	(71-93) - (51-60)	29.18	3.79	7.71	<0.001
	(71-93) - (61-70)	2.85	5.16	0.55	0.99
Reaction Time Non Dominant Hand	(31-40) - (18-30)	16.68	6.42	2.60	0.09
	(41-50) - (18-30)	16.04	6.39	2.51	0.12
	(51-60) - (18-30)	26.24	6.42	4.08	<0.001
	(61-70) - (18-30)	50.80	9.25	5.49	<0.001
	(71-93) - (18-30)	55.01	7.15	7.70	<0.001
	(41-50) – (31-40)	-0.64	6.42	-0.10	1.00
	(51-60) - (31-40)	9.56	6.46	1.48	0.67
	(61-70) - (31-40)	34.12	9.27	3.68	0.003
	(71-93) - (31-40)	38.33	7.18	5.34	<0.001
	(51-60) - (41-50)	10.20	6.42	1.59	0.61
	(61-70) - (41-50)	34.76	9.25	3.76	0.002
	(71-93) - (41-50)	38.97	7.15	5.45	<0.001
	(61-70) - (51-60)	24.56	9.27	2.65	0.08
	(71-93) - (51-60)	28.77	7.18	4.01	<0.001
	(71-93) - (61-70)	4.21	9.79	0.43	0.99

Table 5.31. Tukey's test results for age group differences (cont.)

Test	**Age Group Difference**	**Difference of Means**	**SE of Difference**	**T-Value**	**Adj. P-Value**
Raven	(31-40) - (18-30)	-1.15	1.63	-0.70	0.98
	(41-50) - (18-30)	-1.22	1.62	-0.75	0.97
	(51-60) - (18-30)	-6.73	1.63	-4.14	<0.001
	(61-70) - (18-30)	-12.12	2.34	-5.18	<0.001
	(71-93) - (18-30)	-28.80	1.81	-15.92	<0.001
	(41-50) – (31-40)	-0.07	1.63	-0.04	1.00
	(51-60) - (31-40)	-5.58	1.63	-3.41	0.008
	(61-70) - (31-40)	-10.98	2.35	-4.68	<0.001
	(71-93) - (31-40)	-27.66	1.82	-15.23	<0.001
	(51-60) - (41-50)	-5.51	1.63	-3.39	0.01
	(61-70) - (41-50)	-10.91	2.34	-4.66	<0.001
	(71-93) - (41-50)	-27.59	1.81	-15.25	<0.001
	(61-70) - (51-60)	-5.40	2.35	-2.30	0.194
	(71-93) - (51-60)	-22.08	1.82	-12.15	<0.001
	(71-93) - (61-70)	-16.68	2.48	-6.73	0.000
Purdue Pegboard Dominant Hand	(31-40) - (18-30)	-0.68	0.32	-2.12	0.27
	(41-50) - (18-30)	-1.81	0.32	-5.66	<0.001
	(51-60) - (18-30)	-2.49	0.32	-7.74	<0.001
	(61-70) - (18-30)	-4.40	0.46	-9.49	<0.001
	(71-93) - (18-30)	-7.58	0.36	-21.15	<0.001
	(41-50) – (31-40)	-1.13	0.32	-3.51	0.01
	(51-60) - (31-40)	-1.81	0.32	-5.59	<0.001
	(61-70) - (31-40)	-3.72	0.47	-8.00	<0.001
	(71-93) - (31-40)	-6.89	0.36	-19.17	<0.001
	(51-60) - (41-50)	-0.68	0.32	-2.11	0.28
	(61-70) - (41-50)	-2.59	0.46	-5.58	<0.001
	(71-93) - (41-50)	-5.77	0.36	-16.09	<0.001
	(61-70) - (51-60)	-1.91	0.46	-4.11	0.001
	(71-93) - (51-60)	-5.09	0.36	-14.14	<0.001
	(71-93) - (61-70)	-3.18	0.49	-6.47	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Purdue Pegboard Non Dominant Hand	(31-40) - (18-30)	-0.69	0.31	-2.28	0.20
	(41-50) - (18-30)	-1.39	0.31	-4.57	<0.001
	(51-60) - (18-30)	-1.84	0.31	-6.00	<0.001
	(61-70) - (18-30)	-4.10	0.44	-9.30	<0.001
	(71-93) - (18-30)	-6.82	0.34	-20.01	<0.001
	(41-50) – (31-40)	-0.69	0.31	-2.26	0.21
	(51-60) - (31-40)	-1.14	0.31	-3.70	0.003
	(61-70) - (31-40)	-3.40	0.44	-7.70	<0.001
	(71-93) - (31-40)	-6.12	0.34	-17.89	<0.001
	(51-60) - (41-50)	-0.45	0.31	-1.46	0.69
	(61-70) - (41-50)	-2.71	0.44	-6.14	<0.001
	(71-93) - (41-50)	-5.43	0.34	-15.92	<0.001
	(61-70) - (51-60)	-2.26	0.44	-5.12	<0.001
	(71-93) - (51-60)	-4.98	0.34	-14.55	<0.001
	(71-93) - (61-70)	-2.72	0.47	-5.82	<0.001
Purdue Pegboard Both Hand	(31-40) - (18-30)	-0.26	0.29	-0.90	0.95
	(41-50) - (18-30)	-0.83	0.29	-2.89	0.04
	(51-60) - (18-30)	-1.31	0.29	-4.53	<0.001
	(61-70) - (18-30)	-3.08	0.41	-7.39	<0.001
	(71-93) - (18-30)	-6.16	0.32	-19.12	<0.001
	(41-50) – (31-40)	-0.57	0.29	-1.98	0.36
	(51-60) - (31-40)	-1.05	0.29	-3.61	0.004
	(61-70) - (31-40)	-2.82	0.42	-6.74	<0.001
	(71-93) - (31-40)	-5.89	0.32	-18.23	<0.001
	(51-60) - (41-50)	-0.48	0.29	-1.65	0.56
	(61-70) - (41-50)	-2.24	0.42	-5.39	<0.001
	(71-93) - (41-50)	-5.32	0.32	-16.53	<0.001
	(61-70) - (51-60)	-1.77	0.42	-4.23	<0.001
	(71-93) - (51-60)	-4.84	0.32	-14.99	<0.001
	(71-93) - (61-70)	-3.08	0.44	-6.98	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	**Age Group Difference**	**Difference of Means**	**SE of Difference**	**T-Value**	**Adj. P-Value**
Purdue Pegboard Total	(31-40) - (18-30)	-1.64	0.83	-1.98	0.35
	(41-50) - (18-30)	-4.04	0.83	-4.89	<0.001
	(51-60) - (18-30)	-5.64	0.83	-6.79	<0.001
	(61-70) - (18-30)	-11.58	1.20	-9.68	<0.001
	(71-93) - (18-30)	-20.55	0.92	-22.24	<0.001
	(41-50) – (31-40)	-2.39	0.83	-2.88	0.05
	(51-60) - (31-40)	-4.00	0.84	-4.79	<0.001
	(61-70) - (31-40)	-9.94	1.20	-8.29	<0.001
	(71-93) - (31-40)	-18.91	0.93	-20.38	<0.001
	(51-60) - (41-50)	-1.60	0.83	-1.93	0.38
	(61-70) - (41-50)	-7.54	1.20	-6.31	<0.001
	(71-93) - (41-50)	-16.51	0.92	-17.87	<0.001
	(61-70) - (51-60)	-5.94	1.20	-4.95	<0.001
	(71-93) - (51-60)	-14.91	0.93	-16.07	<0.001
	(71-93) - (61-70)	-8.97	1.27	-7.09	<0.001
Purdue Pegboard Assembly	(31-40) - (18-30)	-2.78	1.04	-2.69	0.08
	(41-50) - (18-30)	-5.08	1.03	-4.93	<0.001
	(51-60) - (18-30)	-8.56	1.04	-8.27	<0.001
	(61-70) - (18-30)	-17.55	1.49	-11.77	<0.001
	(71-93) - (18-30)	-29.32	1.15	-25.45	<0.001
	(41-50) – (31-40)	-2.29	1.04	-2.21	0.23
	(51-60) - (31-40)	-5.78	1.04	-5.55	<0.001
	(61-70) - (31-40)	-14.76	1.49	-9.88	<0.001
	(71-93) - (31-40)	-26.54	1.16	-22.94	<0.001
	(51-60) - (41-50)	-3.49	1.04	-3.37	0.01
	(61-70) - (41-50)	-12.47	1.49	-8.36	<0.001
	(71-93) - (41-50)	-24.25	1.15	-21.04	<0.001
	(61-70) - (51-60)	-8.98	1.49	-6.01	<0.001
	(71-93) - (51-60)	-20.76	1.16	-17.95	<0.001
	(71-93) - (61-70)	-11.78	1.58	-7.47	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Stroop Color Word Part I	(31-40) - (18-30)	0.86	0.42	2.03	0.33
	(41-50) - (18-30)	1.86	0.42	4.42	<0.001
	(51-60) - (18-30)	2.87	0.42	6.79	<0.001
	(61-70) - (18-30)	4.49	0.61	7.38	<0.001
	(71-93) - (18-30)	8.39	0.47	17.83	<0.001
	(41-50) – (31-40)	1.00	0.42	2.37	0.17
	(51-60) - (31-40)	2.02	0.42	4.74	<0.001
	(61-70) - (31-40)	3.64	0.61	5.95	<0.001
	(71-93) - (31-40)	7.54	0.47	15.95	<0.001
	(51-60) - (41-50)	1.01	0.42	2.39	0.16
	(61-70) - (41-50)	2.63	0.61	4.32	<0.001
	(71-93) - (41-50)	6.54	0.47	13.88	<0.001
	(61-70) - (51-60)	1.62	0.61	2.65	0.08
	(71-93) - (51-60)	5.52	0.47	11.69	<0.001
	(71-93) - (61-70)	3.90	0.65	6.05	<0.001
Stroop Color Word Part II	(31-40) - (18-30)	1.01	0.56	1.79	0.47
	(41-50) - (18-30)	1.92	0.56	3.41	0.01
	(51-60) - (18-30)	3.46	0.57	6.13	<0.001
	(61-70) - (18-30)	5.26	0.81	6.47	<0.001
	(71-93) - (18-30)	10.64	0.63	16.94	<0.001
	(41-50) – (31-40)	0.90	0.57	1.60	0.59
	(51-60) - (31-40)	2.45	0.57	4.32	<0.001
	(61-70) - (31-40)	4.25	0.82	5.21	<0.001
	(71-93) - (31-40)	9.63	0.63	15.26	<0.001
	(51-60) - (41-50)	1.55	0.57	2.74	0.07
	(61-70) - (41-50)	3.35	0.81	4.11	0.001
	(71-93) - (41-50)	8.73	0.63	13.89	<0.001
	(61-70) - (51-60)	1.79	0.81	2.21	0.23
	(71-93) - (51-60)	7.18	0.63	11.38	<0.001
	(71-93) - (61-70)	5.38	0.86	6.25	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Stroop Color Word Part III	(31-40) - (18-30)	1.22	0.77	1.59	0.60
	(41-50) - (18-30)	2.86	0.77	3.73	0.003
	(51-60) - (18-30)	4.85	0.77	6.30	<0.001
	(61-70) - (18-30)	7.74	1.11	6.98	<0.001
	(71-93) - (18-30)	13.39	0.86	15.64	<0.001
	(41-50) – (31-40)	1.63	0.77	2.12	0.27
	(51-60) - (31-40)	3.62	0.77	4.69	<0.001
	(61-70) - (31-40)	6.51	1.11	5.86	<0.001
	(71-93) - (31-40)	12.16	0.86	14.16	<0.001
	(51-60) - (41-50)	1.99	0.77	2.59	0.10
	(61-70) - (41-50)	4.88	1.11	4.40	<0.001
	(71-93) - (41-50)	10.53	0.86	12.31	<0.001
	(61-70) - (51-60)	2.89	1.11	2.60	0.09
	(71-93) - (51-60)	8.54	0.86	9.94	<0.001
	(71-93) - (61-70)	5.65	1.17	4.82	<0.001
Stroop Color Word Part IV	(31-40) - (18-30)	2.43	1.26	1.92	0.39
	(41-50) - (18-30)	4.58	1.26	3.64	0.004
	(51-60) - (18-30)	7.90	1.26	6.25	<0.001
	(61-70) - (18-30)	11.64	1.82	6.40	<0.001
	(71-93) - (18-30)	20.62	1.41	14.66	<0.001
	(41-50) – (31-40)	2.15	1.26	1.70	0.53
	(51-60) - (31-40)	5.47	1.27	4.30	<0.001
	(61-70) - (31-40)	9.21	1.82	5.05	<0.001
	(71-93) - (31-40)	18.19	1.41	12.88	<0.001
	(51-60) - (41-50)	3.32	1.26	2.63	0.09
	(61-70) - (41-50)	7.07	1.82	3.88	0.001
	(71-93) - (41-50)	16.04	1.41	11.41	<0.001
	(61-70) - (51-60)	3.75	1.82	2.05	0.31
	(71-93) - (51-60)	12.72	1.41	9.01	<0.001
	(71-93) - (61-70)	8.97	1.93	4.66	<0.001

Table 5.31. Tukey's test results for age group differences (cont.)

Test	Age Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Stroop Color Word Part V	(31-40) - (18-30)	4.47	2.52	1.77	0.48
	(41-50) - (18-30)	7.47	2.50	2.98	0.03
	(51-60) - (18-30)	13.91	2.52	5.52	<0.001
	(61-70) - (18-30)	26.18	3.62	7.22	<0.001
	(71-93) - (18-30)	73.74	2.80	26.33	<0.001
	(41-50) – (31-40)	3.00	2.52	1.19	0.84
	(51-60) - (31-40)	9.44	2.53	3.73	0.003
	(61-70) - (31-40)	21.71	3.63	5.98	<0.001
	(71-93) - (31-40)	69.27	2.81	24.64	<0.001
	(51-60) - (41-50)	6.43	2.52	2.56	0.11
	(61-70) - (41-50)	18.71	3.62	5.16	<0.001
	(71-93) - (41-50)	66.27	2.80	23.66	<0.001
	(61-70) - (51-60)	12.27	3.63	3.38	0.01
	(71-93) - (51-60)	59.83	2.81	21.28	<0.001
	(71-93) - (61-70)	47.56	3.83	12.40	<0.001

Table 5.32. Tukey's Test results for education group differences

Test	Education Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Digit Forward	(6-12) – (0-5)	1.29	0.27	4.86	<0.001
	(13-16) – (0-5)	2.22	0.26	8.40	<0.001
	(17+) – (0-5)	2.60	0.27	9.51	<0.001
	(13-16) – (6-12)	0.92	0.13	7.11	<0.001
	(17+) – (6-12)	1.30	0.15	8.83	<0.001
	(17+) – (13-16)	0.38	0.14	2.69	0.04
Digit Backward	(6-12) – (0-5)	1.64	0.28	5.84	<0.001
	(13-16) – (0-5)	2.49	0.28	8.94	<0.001
	(17+) – (0-5)	3.02	0.29	10.49	<0.001
	(13-16) – (6-12)	0.84	0.14	6.19	<0.001
	(17+) – (6-12)	1.38	0.15	8.88	<0.001
	(17+) – (13-16)	0.53	0.15	3.58	0.002

Table 5.32. Tukey's Test results for education group differences (cont.)

Test	Education Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Corsi Forward	(6-12) – (0-5)	1.50	0.27	5.61	<0.001
	(13-16) – (0-5)	2.44	0.27	9.20	<0.001
	(17+) – (0-5)	2.95	0.27	10.77	<0.001
	(13-16) – (6-12)	0.93	0.13	7.19	<0.001
	(17+) – (6-12)	1.45	0.15	9.80	<0.001
	(17+) – (13-16)	0.51	0.14	3.62	0.002
Corsi Backward	(6-12) – (0-5)	1.19	0.25	4.79	<0.001
	(13-16) – (0-5)	1.99	0.25	8.09	<0.001
	(17+) – (0-5)	2.38	0.25	9.35	<0.001
	(13-16) – (6-12)	0.79	0.12	6.61	<0.001
	(17+) – (6-12)	1.19	0.14	8.66	<0.001
	(17+) – (13-16)	0.39	0.13	2.97	0.02
Raven	(6-12) – (0-5)	17.70	2.24	7.90	<0.001
	(13-16) – (0-5)	31.68	2.21	14.31	<0.001
	(17+) – (0-5)	38.52	2.29	16.82	<0.001
	(13-16) – (6-12)	13.98	1.09	12.88	<0.001
	(17+) – (6-12)	20.82	1.23	16.88	<0.001
	(17+) – (13-16)	6.84	1.18	5.77	<0.001
Purdue Pegboard Assembly	(6-12) – (0-5)	18.32	2.71	6.76	<0.001
	(13-16) – (0-5)	25.48	2.68	9.51	<0.001
	(17+) – (0-5)	27.02	2.77	9.75	<0.001
	(13-16) – (6-12)	7.15	1.31	5.45	<0.001
	(17+) – (6-12)	8.69	1.49	5.82	<0.001
	(17+) – (13-16)	1.54	1.43	1.07	0.71
Stroop Color Word Part I	(6-12) – (0-5)	-6.44	0.83	-7.74	<0.001
	(13-16) – (0-5)	-8.40	0.82	-10.21	<0.001
	(17+) – (0-5)	-9.30	0.85	-10.92	<0.001
	(13-16) – (6-12)	-1.96	0.40	-4.86	<0.001
	(17+) – (6-12)	-2.85	0.46	-6.22	<0.001
	(17+) – (13-16)	-0.89	0.44	-2.02	0.18
Stroop Color Word Part II	(6-12) – (0-5)	-10.17	1.02	-9.97	<0.001
	(13-16) – (0-5)	-12.46	1.01	-12.35	<0.001
	(17+) – (0-5)	-13.56	1.04	-13.00	<0.001
	(13-16) – (6-12)	-2.286	0.49	-4.62	<0.001
	(17+) – (6-12)	-3.389	0.56	-6.03	<0.001
	(17+) – (13-16)	-1.102	0.54	-2.04	0.17

Table 5.32. Tukey's Test results for education group differences (cont.)

Test	Education Group Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Stroop Color Word Part III	(6-12) – (0-5)	-12.06	1.42	-8.50	<0.001
	(13-16) – (0-5)	-14.75	1.40	-10.53	<0.001
	(17+) – (0-5)	-16.31	1.45	-11.25	<0.001
	(13-16) – (6-12)	-2,697	0.68	-3.93	0.001
	(17+) – (6-12)	-4.251	0.78	-5.44	<0.001
	(17+) – (13-16)	-1.554	0.75	-2.07	0.162
Stroop Color Word Part IV	(6-12) – (0-5)	-15.87	2.40	-6.62	<0.001
	(13-16) – (0-5)	-19.59	2.37	-8.26	<0.001
	(17+) – (0-5)	-22.03	2.45	-8.98	<0.001
	(13-16) – (6-12)	-3.72	1.16	-3.20	0.01
	(17+) – (6-12)	-6.16	1.32	-4.66	<0.001
	(17+) – (13-16)	-2.44	1.27	-1.92	0.22
Stroop Color Word Part V	(6-12) – (0-5)	-55.29	6.40	-8.64	<0.001
	(13-16) – (0-5)	-71.88	6.33	-11.36	<0.001
	(17+) – (0-5)	-77.03	6.55	-11.77	<0.001
	(13-16) – (6-12)	-16.59	3.10	-5.35	<0.001
	(17+) – (6-12)	-21.74	3.53	-6.17	<0.001
	(17+) – (13-16)	-5.15	3.39	-1.52	0.43

Table 5.33. Tukey's Test results for income group differences

Test	Income Level Difference	Difference of Means	SE of Difference	T-Value	Adj. P-Value
Digit Forward	Medium - Low	0.46	0.16	2.83	0.01
	High - Low	1.05	0.19	5.31	<0.001
	High - Medium	0.59	0.16	3.56	0.001
Digit Backward	Medium - Low	0.52	0.17	3.00	0.008
	High - Low	1.22	0.21	5.86	0.00
	High - Medium	0.71	0.17	4.05	0.00
Raven	Medium - Low	8.02	1.68	4.77	<0.001
	High - Low	19..86	2.03	9.79	<0.001
	High - Medium	11.84	1.69	7.00	<0.001

Results of Tukey tests could be interpreted as follows;

- There is not an effect of age factor until the age of 50 on Digit Span, Corsi Span and Raven test results. After the age of 50, there is negative effect of age factor on the results. That is ability of memory decreases gradually after 50 (the participants older than 50 has smaller digit span).

- For the Purdue Pegboard test results, age factor has a negative effect after the age of 40. That is the participants older than 40 have lower performance than younger ones. After 40, the performance decrease gradually in each age group.

- Age factor has negative effect on all parts of Stroop Color Word and Reaction Time tests. When the age of the participant increases, their test performance decreases. That is older age participants have longer completion time than younger ones for Stroop Color Word test. After the age of 40, reaction time performance of dominant hand decreases. Afer the age of 50, reaction time performance of non-dominant hand decreases.Stroop Color Word Test performance starts decreasing after the age of 40.

- Education factor has a positive effect on Digit Span test, Corsi Span test, Raven, Purdue Pegboard Assembly and all parts of Stroop Color Word test. When education year of the participant increases, test performance increases as well. That is the high educated participants have longer digit and corsi span and shorter completion time on Stroop Color Test.

- There is positive relationship between income level and Digit Span Forward, Digit Span Backward and Raven results. High income group has the biggest mean amoung all. That is participants have high income level also have longest digit span and more correct answers on Raven Test.

- There is not a significant effect of smoking habit on all test results.

- There is not a significant effect of marital status on all test results.

5.3.8. T-test for Reaction Time and Purdue Pegboard Tests

Dominant/Non-Dominant hand effect is investigated for Reaction Time and Purdue Pegboard Test results by applying paired t-tests. First of all, F-Test is used to test the null hypothesis whether the variances of two populations are equal or not. At the results if F< F critical, t test Two Sample Assuming Equal Variances is applied, but if F > F critical, t test Two Sample Assuming Unequal Variances is applied. Results of F-Test can be seen at Table 5.34.

Table 5.34. F test results

Test Name	**F Critical**	**F**	**P value**
Purdue Pegboard Test	1.23	1.18	0.09
Reaction Time Test	1.23	1.00	0.49

Then, a two-sample t-test for equal variances is used to determine whether two sample means are different.

Therefore, the hypotheses for the t-test are:

H_0: $\mu_1 - \mu_2 = 0$

H_1: $\mu_1 - \mu_2 \neq 0$

Results for each test can be seen from Table 5.35. According to all test results, dominant/non-dominant hand was found as a significant factor for both Reaction Time and Purdue Pegboard test results.

Table 5.35. Paired t test results

Test	**T-value**	**T critical**	**p value**	**Result**
Purdue Pegboard Test	13.54	1.96	<0.001	Reject H_0
Reaction Time Test	-6.55	1.96	<0.001	Reject H_0

People show better performance while they are using their dominant hand for both tests.

5.4. Regression

5.4.1. Regression Assumptions

There are five assumptions for Regression. Normality and homogeneity of variance assumptions are checked before in Section 5.2.6. In addition to them, linearity, multicollinearity and autocorrelation are checked before applying Regression. Details of assumptions and methods which are used to check these assumptions for data can be found below.

(i) Linearity: Linearity is the first assumption of linear regression. This means that response variable (Y) is assumed to be linear function of the parameters *(β_1, β_2, β_3... β_p),* but not necessarily a linear function of the independent variables (X_1, X_2, X_3... X_p). Standard multiple regression can only accurately estimate that there must be linear relationship between the dependent and independent variables. if the relationships are linear in nature. But in reality, some types of non-linear relationships can be modeled within a linear regression framework (Montgomery, 2005). This assumption is checked by preparing scatter plots (Stevens, 2009). Scatter plots can be seen in Appendix E. These scatter plots are for determining the status of term in regression model. That is; the exponent of independent variable; X, X^2, X^3 etc.

(ii) Multicollinearity: Multicollinearity must be checked to determine whether there are redundant variables in the regression model or not (Keith, 2006). It is checked by looking variance inflation factor (VIF) that should be smaller than 10 (Keith, 2006).

(iii) Autocorrelation: Since correlation has an effect on the estimation of coefficients for the regression model, correlation between the errors is not desired (Montgomery, 2005). In order to check autocorrelation assumption, Durbin-Watson statistic is applied. The Durbin- Watson statistic takes value between 0 and 4. If there is no correlation, value will be 2. Values 0 indicate positive correlation while values towards 4 indicate negative correlation. As an assumption, in the regression model, it is desired to be between 1.5 and 2.5 (Montogomery, 2005). This assumption is fullfilled

5.4.2. The Developed Models

Stepwise regression is used to develop models. All independent variables in the model are checked each step until the variables not in the model have p-values that are greater than the specified alpha-to-enter value and when all variables in the model have p-values that are less than or equal to the specified alpha-to-remove value (Montgomery, 2005).

Based on the stepwise regression analyses, the following models were developed.

Model 1

NoD= 5.423 (X_1) + 5.719 (X_2) + 5.761 (X_3) – 0.03295 Age + 0.0844 Education (R^2_{adj}=0.65)

where

NoD = The number of digits for Digit Span Forward Test

Age= Age of the participant (years)

Education= The number of education year

X_1, X_2, X_3 = indicator (dummy) variables for Income level

Income Level	X_1	X_2	X_3
Low	1	0	0
Medium	0	1	0
High	0	0	1

Model 2

NoD= 4.675 (X_1) + 5.032 (X_2) + 5.194 (X_3) – 0.03453 Age + 0.0829 Education (R^2_{adj}=0.63)

where

NoD = The number of digits for Digit Span Backward Test

Age= Age of the participant (years)

Education= The number of education year

X_1, X_2, X_3 = indicator (dummy) variables for Income level

Income Level	X_1	X_2	X_3
Low	1	0	0
Medium	0	1	0
High	0	0	1

Model 3

LoS= 4.479 - 0.02587 Age + 0.1253 Education (R^2_{adj}=0.59)

where

LoS = The length of sequence for Corsi Span Forward Test

Age= Age of the participant (years)

Education= The number of education year

Model 4

LoS= 4.062 - 0.02446 Age + 0.0980 Education (R^2_{adj}=0.56)

where

LoS = The length of sequence for Corsi Span Backward Test

Age= Age of the participant

Education= The number of education year

Model 5

NoCA= 32.47 (X_1) + 37.06 (X_2) + 40.59 (X_3) – 0.3161 Age + 1.414 Education (R^2_{adj}=0.85)

where

NoCA = The number of correct answers for Raven Test

Age= Age of the participant (years)

Education= The number of education year

X_1, X_2, X_3 = indicator (dummy) variables for Income level

Income Level	X_1	X_2	X_3
Low	1	0	0
Medium	0	1	0
High	0	0	1

Model 6

NoP = 17.884 – 0.12331 Age (R^2_{adj}=0.65)

where

NoP = The number of pins for Purdue Pegboard Dominant Hand

Age= Age of the participant (years)

Model 7

NoP = 16.214 – 0.10965 Age (R^2_{adj}=0.61)

where

NoP = The number of pins for Purdue Pegboard Non-Dominant Hand

Age= Age of the participant (years)

Model 8

NoP = 15.555 – 0.09898 Age (R^2_{adj}=0.58)

where

NoP = The number of pins for Purdue Pegboard Both Hand

Age= Age of the participant (years)

Model 9

NoP= 51.03 – 0.3321 Age (R^2_{adj}=0.69)

where

NoP = The number of pins for Purdue Pegboard Total

Age= Age of the participant

Model 10

NoPCW = 53.57 – 0.4203 Age + 0.5623 Education (R^2_{adj}=0.75)

where

NoPCW= The number of pins, collars and washers for Purdue Pegboard Assembly Result

Age= Age of the participant (years)

Education= The number of education year

Model 11

MS = 245.56 + 10.643 Age (R^2_{adj}=0.50)

where

MS= Time in millisecond for Reaction Time Dominant Hand

Age= Age of the participant (years)

Model 12

MS = 258.67 + 10.44 Age (R^2_{adj}=0.21)

where

MS= Time in millisecond for Reaction Time Non-Dominant Hand

Age= Age of the participant

Model 13

S = 14.93 + 1.2234 Age – 4.199 Education + 0.541 Education^2 (R^2_{adj}=0.62)

where

S= Time in second for Stroop Color Word Test Part I

Age= Age of the participant (years)

Education= The number of education year

Model 14

S = 21.27 + 1.438 Age – 7.88 Education + 1.108 Education^2 (R^2_{adj}=0.62)

where

S= Time in second for Stroop Color Word Test Part II

Age= Age of the participant (years)

Education= The number of education year

Model 15

$S = 16.45 + 0.3203\ Age^2 - 1.523\ Education\ (R^2_{adj}=0.58)$

where

S= Time in second for Stroop Color Word Test Part III

Age= Age of the participant (years)

Education= The number of education year

Model 16

$S = 20.44 + 0.5047\ Age^2 - 1.760\ Education\ (R^2_{adj}=0.55)$

where

S= Time in second for Stroop Color Word Test Part IV

Age= Age of the participant (years)

Education= The number of education year

Model 17

$S = 50.21 + 3.692\ Age^2 - 13.86\ Age - 5.36\ Education\ (R^2_{adj}=0.78)$

where

S= Time in second for Stroop Color Word Test Part V

Age= Age of the participant (years)

Education= The number of education year

6. DISCUSSION

In this section, the results of the study were discussed. The effects of the factors on the test performances were examined and the reasons of the results were questioned. Moreover, results of the current study were compared with the results of the other studies in the literature.

6.1. Discussion on the Results

In general, the results of this study are consistent with a number of studies in the literature. The discussions about each factor effect can be found in the sections below.

6.1.1. Age Effect

The correlation analyses indicate that age is significantly negatively correlated with all test performances. ANOVA results support it as well. According to ANOVA and Tukey results, there is not significant difference on the test performance until the age of 40 or 50 depending on the test type. After that, test performance decreases gradually.

This is in agreement with number of other studies in the literature (e.g., Kessels *et al.*, 2008; Monaco *et al.*, 2012; Liewald and Deary, 2013). Indeed, this is an expected result since mental abilities and motor functions decrease with aging. Results also may be interpreted as ability of motor functions is effected by age before the decline of memory, decision making and problem-solving abilities.

Age was found as the most important factor of neuropsychological performance. It is probably due to the effect of aging on brain functions. The reason behind decreasing performance with aging can be cognitive slow down, reduced visual capacity and reduced inhibitory control of people.

6.1.2. Education Effect

Results indicate that education has positive effect on most of the test performances except Reaction Time and Purdue Pegboard tests. Higher educated participants have higher performance. However, education level did not affect motor performances. These results are also in agreement with the literature (e.g., Chan *et al.*, 2009; Kessels *et al.*, 2008; Choi *et al.*, 2013).

Effect of education on test performance could be the result of natural selection. That is, people with high cognitive abilities can also acquire academic knowledge easily or vice versa, people without high education level may lack the cognitive abilities needed to complete academics.

6.1.3. Income Level Effect

The results of this study show that income level has positive effect on Digit Span and Raven tests. For the rest of tests, there is no significant effect of income level at all.

When we look at literature, there is not mentionable study which investigate income effect on test performance. Most of studies examine age and education effects beside only a few of them also investigate gender effect.

6.1.4. Smoking Habit Effect

According to results of current study, both correlation analyses and ANOVA results indicate that there is not a significant effect of smoking habit on all test results. Since there is not any study examine smoking effect in literature, this result cannot be comparing with any other study.

6.1.5. Marital Status Effect

The performance of tests and marital status were found unrelated for all tests used in current study. There is not any other study shows opposite of this in literature.

6.1.6. Dominant/Non Dominant Hand Effect

For both Reaction Time and Purdue Pegboard tests, dominant hand performance was higher than non-dominant hand. This is also an expected result since people use their dominant hand more often. Dominant hand becomes more skillful and faster.

When we compare the results with the studies in literature, it is seen that reaction time is applied for only dominant hand (e.g., Nissan *et al.*,2013; Jacopsen *et al.*,2010). On the other hand, the studies in literature also support that dominant/non-dominant hand factor has significant effect on Purdue Pegboard test performance (e.g., Hamm and Curtis, 1980; Mccury *et al.*, 2001)

6.1.7. Correlation among the Response Variables

According to significant positive correlations between Raven, Digit and Corsi Span tests, it can be said that people with high memory ability are better at making decisions and solving problems. The negative correlation between Reaction Time and other test performances indicate that participants who are better in memory and other tested mental abilities are also better in motor performances.

It was also observed that people with high attention also have high memory abilities that means higher performance on Digit Span and Corsi Span tests.

6.2. Comparisons with Other Studies

In the literature, there is not a single study that covers all six different neuropsychological tests that are included in this study. Because of this reason, comparisons are made with matching tests. In addition, since most of studies in literature only examine the effects of gender, age and education level, male norms from current study are used by matching same age and education levels.

Roughly speaking, the study results indicate similarities between test performance of population of Turkey, Australia and Italy; and differences with the populations of China, Korea, USA, Germany and New Zeland. The statistical comparisons are shown in Tables 6.1-6.6. The details are provided below.

6.2.1. Digit Span Test

Comparisons of Digit Span Test results with other studies can be interpreted as follows:

- The results show that differences between the populations of China (Hiesh *et al.*, 2007) and Turkey are significant. Especially for the forward version of Digit Span Test, the population of China has higher mean than Turkish for the age groups of 30-40, 50-60 and 60-70. On the other hand, there is not a statistically significant difference on Digit Span Backward test performance for 50-60 and 60-70 age groups.

- For the study from Korea (Choi *et al.*, 2013), Digit Span Test is applied to only 60-70 and 71+ age groups. Comparison has been done with the same age groups which has the same educational background. Results indicate that the differences between populations are significant for most of the results. Koreans are better.

- Only backward version of the test is used in a study to gather normative data of population of Australia (Jorm *et al.*, 2004). It can be seen from the Table 6.1 that the mean of studies is not statistically different from each other.

- According to the results, the population of Netherland (Kessels *et al.*, 2008) has significantly higher performance on Digit Span Test than the population of Turkey for the following age groups: 50-59, 60-69, 70-79 and 80+ .

- Results for comparison between New Zeland (Woods *et al.*, 2010) and Turkey can be interpreted as there is not significant difference for backward version while there is significant difference for the forward version. Results of New Zeland are better.

- When comparison is done for the population of Turkey and Italy, similarities are seen for the backward version of Digit Span Test. On the other hand, only similarity on Corsi Span test performance is seen for 41-50 age group (Monaco *et al.*, 2013). For the rest of age groups, Italians have bigger means than Turkish participants.

- Results for comparison between Britian (Wongupparaja *et al.*, 2017) and Turkey can be interpreted as there is not significant difference for backward version while there is significant difference for the forward version. Results show that population of Britian has higher performance on Digit Span Forward Test than population of Turkey.

6.2.2. Corsi Span Test

Comparisons of Corsi Span Test results with other studies can be interpreted as follows:

- For a study on Dutch people, Corsi Span Test is conducted to the participants at the age of 50-59, 60-69, 70-79 and 80+ (Kessels *et al.*, 2007). According to results, the population of Netherland has better performance on Corsi Span Test from the population of Turkey except the forward performance of age group 50-59.

- Comparison with another study from USA (Pagulayan *et al.*, 2007) indicates that the population of USA has higher performance on Corsi Span Forward test than Turkish population for different age range from 18 to 30.

- According to Corsi Span comparison results between Britian and Turkey, there is not significant difference for both forward and backward versions (Wongupparaja *et al.*, 2017).

6.2.3. Raven Test

Comparisons of Raven Test results with other studies can be interpreted as follows:

- There are a few studies that comparisons can be done with current study for Raven test. According to comparison results, the population of Turkey in 30-40 age group has more correct answers that means higher performance on the Raven test than Chinese people at the same age group (Hsieh and Tori, 2007).

- There is another study in which Raven Test is conducted to Sub-Saharan African participants at the age of 18. The resuls have been compared with the same age in currect study show that performance of Turkish male at the age of 18 are higher than Africans (Dutton *et al.*, 2018).

6.2.4. Stroop Color Word Test

Comparisons of Stroop Color Word Test results with other studies can be interpreted as follows:

- The comparison results of Stroop Color Word Test between current study and other studies in literature. For the comparison with US (Moering *et al.*, 2004) and Portugal people (Martins *et al.*, 2013), no similarity is seen between means. On the other hand, there are significant similarity with another study in Turkey in 1999 (Karakas *et al.*, 1999).

- According to comparison results, the population of Tukey in the 60-71 age range has better performance than African Americans in the same age group.

6.2.5. Reaction Time Test

Comparisons of Reaction Time test results with other studies can be interpreted as follows:

- Comparison of reaction time results is done for only dominant hand results since reaction time is measured for only dominant hand in literature. Table 6.5. indicates that there is significant difference between Turkish and Australian people (Jorm *et al.*, 2004) and Australian people has shorter reaction time compared to Turkish people.

- When we look at the difference between the populations of Scotland (Nissan *et al.*, 2013) and Turkey, it is seen that Scottish people between the age of 18-25 and 65-80 is faster than Turkish people at the same age range. On the other hand, for the age group 45-60 there is not significant difference between means.

- Another comparison shows that the population of Turkey at the age range of 18-30 has shorter reaction time than the population of Germany (Cinaz *et al.*, 2012).

- Comparision is done with a previous study for Turkish wrestlers and results show that there is not significant difference on reaction time test performance (Koç and Aydos, 2018).

6.2.6. Purdue Pegboard Test

Comparisons of Purdue Pegboard Test results with other studies can be interpreted as follows:

- Most of the Purdue Pegboard Test studies are performed in the USA to examine age, education and gender effect on the test performance (e.g., Mccury *et al.*, 2001; Hamm and Curtis, 1980). Results indicate that there is no similarity between test performance of two populations except non-dominant result for the participants younger than 35 and both hand result for the participants older than 35 years old. Japanese-Americans are better.

- In Australia, Purdue Pegboard Test is conducted to the participants at the age of 18-30, 60-69 and 80+ (Corti *et al.*, 2017). Comparison results can be seen in Table 6.6 which has been done by taking account into the same age groups in current study. The Australian population in the 18-30 age range has better performance on Dominant Hand an Both Hand parts of the test. On the other hand, the population of Turkey has better performance on Assembly part.

Table 6.1. Comparisons between Population of Turkey and other nationalities for Digit Span Test

Population of Turkey vs.	Country	Age Group	Type	n	n*	Mean	SD	% difference	t-value	p-value
Hsieh *et al.* (2007)	China	30-40	Forward	142	50	7.85	1.21	-34.88	14.41	<0.001
			Backward			4.40	1.44	16.03	-5.25	<0.001
		50-60	Forward	71	50	7.55	1.05	-50.40	14.96	<0.001
			Backward			4.06	1.24	6.45	-1.42	0.16
		60-70	Forward	68	16	7.49	1.29	-53.80	7.75	<0.001
			Backward			3.82	1.29	-3.52	0.39	0.70
Chan *et al.* (2009)	China	Overall (70.65)	Forward	90	252	7.87	1.14	-47.65	18.75	<0.001
Choi *et al.* (2013)	Korea	60-70	Forward	60 (education 4-9)	5	5.52	2.48	-25.45	1.00	0.32
				109 (education 10+)	7	7.58	2.49	-43.29	2.41	0.02
		71+		41 (education 4-9)	21	5.20	2.10	-53.85	3.86	<0.0001
				39 (education 10+)	11	6.28	1.96	-57.00	3.78	<0.0001
Choi *et al.* (2013)	Korea	60-70	Backward	60 (education 4-9)	5	4.47	1.56	-49.00	2.09	0.04
				109 (education 10+)	7	5.42	1.55	7.51	-0.74	0.46
		71+		41 (education 4-9)	21	4.27	1.38	-72.18	5.73	<0.0001
				39 (education 10+)	11	5.23	1.75	-59.94	4.98	<0.0001
Jorm *et al.* (2004)	Australia	20-24	Backward	1163	13	5.47	2.31	-6.21	0.50	0.62
		40-44		1192	31	5.35	2.36	-2.29	0.75	0.46
		60-64		1319	7	5.00	2.26	-34.77	1.51	0.13
Monaco *et al.* (2013)	Italy	20-30	Forward	50	51	6.47	0.94	-6.41	2.28	0.025
		31-40		58	50	6.38	1.09	-9.62	3.13	0.002
		41-50		50	51	6.12	1.15	-7.18	2.07	0.04
		51-60		50	50	5.80	0.95	-15.54	4.72	<0.0001
		61-70		54	16	5.70	0.92	-17.04	3.25	0.002
		71-80		50	11	5.39	0.86	-34.75	4.94	<0.0001
		81-90		50	20	4.92	0.81	-42.61	-1.08	0.29
Wongupparaja *et al.* (2017)	Britain	Overall (36.76)	Forward	742	252	6.11	7.22	-14.63	-2.94	0.003
		Overall (41.27)	Backward	594	252	4.51	9.88	1.09	0.12	0.90

% difference = 100 x (mean of pop. of Turkey- mean for comparison nationality)/mean of pop. of Turkey. n*= sample size of current study

Table 6.1. Comparisons between Population of Turkey and other nationalities for Digit Span Test (cont.)

Population of Turkey vs.	Country	Age Group	Type	n	n*	Mean	SD	% difference	t-value	p-value
Monaco *et al.* (2013)	Italy	20-30	Backward	50	48	5.07	1.25	1.74	-0.41	0.68
		31-40		58	50	5.16	1.04	1.53	-0.45	0.65
		41-50		50	51	4.68	1.04	6.40	-1.74	0.09
		51-60		50	50	4.66	1.24	-7.37	2.63	0.01
		61-70		54	16	4.15	0.91	-1.47	1.86	0.07
		71-80		50	11	3.92	0.98	-30.67	3.11	0.003
		81-90		50	20	3.60	0.67	-35.85	5.83	<0.0001
Woods *et al.* (2010)	New Zeland	Overall (mean: 46,5)	Forward	749	252	6.35	1.15	-19.14	12.34	<0.0001
	New Zeland		Backward	749	252	4.61	1.22	-1.10	0.57	0.57
Kessels *et al.* (2008)	Holland	50-59	Forward	37	50	6.10	1.30	-21.51	4.60	<0.0001
		60-69		112	16	5.70	1.20	-17.04	2.68	0.01
		70-79		81	10	5.50	1.10	-34.15	3.90	<0.0001
		80+		16	25	5.60	1.10	-64.71	8.38	<0.0001
	Holland	50-59	Backward	37	50	4.80	1.30	-10.60	2.06	0.04
		60-69		112	16	4.30	1.20	-16.53	1.98	0.05
		70-79		81	10	4.00	1.20	-33.33	2.54	0.013
		80+		16	25	4.30	1.10	-65.38	6.51	<0.0001

Table 6.2. Comparisons between Population of Turkey and other nationalities for Corsi Span Test

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p value
Chan *et al.* (2009)	China	90	252	Overall	Forward	7.28	1.30	-43.87	15.36	<0.0001
Monaco *et al.* (2013)	Italy	50	48	20-30	Forward	6.00	1.09	-6.57	1.97	0.051
		58	50	31-40		5.94	1.06	-7.61	2.30	0.023
		50	51	41-50		5.50	1.02	-2.42	0.69	0.49
		50	50	51-60		5.56	1.02	-8.17	2.18	0.03
		54	16	61-70		5.17	0.98	-16.44	2.71	0.008
		50	11	71-80		5.02	0.75	-37.91	5.45	<0.0001
		50	20	81-90		4.42	0.89	-42.58	5.78	<0.0001
	Italy	50	48	20-30	Backward	5.24	0.90	-8.71	2.69	0.008
		58	50	31-40		5.38	1.14	-12.55	3.16	0.002
		50	51	41-50		4.70	0.91	-0.64	0.17	0.864
		50	50	51-60		5.04	1.05	-20.57	4.71	<0.0001
		54	16	61-70		4.66	0.95	-20.10	1.83	0.071
		50	11	71-80		4.43	0.84	-31.85	4.05	<0.0001
		50	20	81-90		3.50	1.00	-37.25	4.24	<0.0001
Kessels *et al.* (2008)	Holland	37	50	50-59	Forward	5.30	0.70	-3.11	0.90	0.372
		112	16	60-69		5.00	0.80	-12.61	2.62	0.010
		81	10	70-79		5.20	0.80	-36.84	5.23	<0.0001
		16	25	80+		4.80	0.80	-57.89	7.26	<0.0001
	Holland	37	50	50-59	Backward	5.50	1.10	-31.58	6.65	<0.0001
		112	16	60-69		5.10	1.10	-31.44	4.27	<0.0001
		81	10	70-79		4.90	1.10	-40.00	3.95	<0.0001
		16	25	80+		4.60	0.90	-82.54	9.46	<0.0001
Pagulayan *et al.* (2007)	America	91	51	18-30	Forward	7.10	1.00	-26.11	9.09	<0.0001
Wongupparaja *et al.* (2017)	Britain	307	252	Overall (29.31)	Forward	5.25	6.35	-3.75	-0.52	0.60
		111	252	Overall (43.06)	Backward	4.74	4.81	-9.72	-0.92	0.36

Table 6.3. Comparisons between Population of Turkey and other nationalities for Raven Test

Population of Turkey vs.	Country	n	n*	Age Group	Mean	SD	% difference	t-value	p-value
Hsieh and Tori (2007)	China	74	50	30-40	42.38	11.47	10.85	-2.75	0.01
Dutton *et al.* (2018)	Sub-Saharan Africa	46	5	18	20.54	7.06	57.02	17.17	<0.001

Table 6.4. Comparisons between Population of Turkey and other nationalities for Stroop Color Word Test

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p-value
Moering *et al.* (2004)	America (African Americans)	54	16	60-71	Part I	21.11	6.24	-55.68	4.66	<0.0001
					Part III	32.20	12.81	-62.71	3.74	<0.0001
					Part V	72.30	14.57	-53.60	5.37	<0.0001
Moering *et al.* (2004)	America (African Americans)	54	16	71+	Part I	20.28	4.52	-16.15	3.09	0.003
					Part III	28.28	10.96	-11.16	1.35	0.180
					Part V	56.52	17.31	40.27	-8.56	<0.0001
Martins *et al.* (2013)	Portuguese	72 (education: 5-9)	8	50-65	Part I	31.00	9.00	-131.52	5.46	<0.0001
		71 (education: 9+)	55			32.00	9.00	-169.59	18.39	<0.0001
		59 (education: 5-9)	24	65+		22.00	8.00	-21.21	2.25	0.027
		44 (education: 9+)	17			26.00	9.00	-77.84	7.70	<0.0001
	Portuguese	72 (education: 5-9)	8	50-65	Part II	57.00	12.00	-275.49	9.75	<0.0001
		71 (education: 9+)	55			59.00	13.00	-338.34	28.85	<0.0001
		59 (education: 5-9)	24	65+		51.00	12.00	-130.56	15.01	<0.0001
		44 (education: 9+)	17			53.00	11.00	-223.56	20.23	<0.0001
	Portuguese	72 (education: 5-9)	8	50-65	Part V	80.00	15.00	-61.39	5.10	<0.0001
		71 (education: 9+)	55			85.00	15.00	-145.74	20.90	<0.0001
		59 (education: 5-9)	24	65+		78.00	15.00	18.52	-3.81	<0.0001
		44 (education: 9+)	17			83.00	13.00	-28.28	3.84	<0.0001

Table 6.4. Comparisons between Population of Turkey and other nationalities for Stroop Color Word Test (cont.)

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p-value
Karakas *et al.* (1999)	Turkey	100 (education: 5-8)	8	20-54	Part I	12.13	6.29	-6.96	1.09	0.28
		100 (education: 9+)	152			8.81	1.76	13.62	-5.85	<0.0001
		100 (education: 5-8)	8		Part II	13.61	7.41	-3.02	0.44	0.66
		100 (education: 9+)	152			9.43	2.52	17.21	-6.24	<0.0001
		100 (education: 5-8)	8		Part III	17.46	9.60	-8.78	0.41	0.68
		100 (education: 9+)	152			12.32	2.71	11.56	-4.25	0.0001
		100 (education: 5-8)	8		Part IV	28.07	13.85	-33.16	1.41	0.16
		100 (education: 9+)	152			16.95	6.70	7.28	-1.81	0.07
		100 (education: 5-8)	8		Part V	40.57	24.24	-32.92	1.16	0.25
		100 (education: 9+)	152			26.38	12.29	-1.07	0.21	0.83
	Turkey	100 (education: 5-8)	10	55-74	Part I	13.51	5.49	6.57	-0.53	0.59
		95 (education: 9+)	39			10.09	3.71	17.57	-4.57	<0.0001
		100 (education: 5-8)	10		Part II	16.47	6.76	-0.06	0.00	0.99
		95 (education: 9+)	39			11.63	5.41	15.11	-3.11	0.002
		100 (education: 5-8)	10		Part III	24.45	13.36	-18.29	0.88	0.38
		95 (education: 9+)	39			15.93	4.06	8.55	-1.94	0.05
		100 (education: 5-8)	10		Part IV	38.39	18.52	-33.02	1.60	0.11
		95 (education: 9+)	39			24.87	10.94	-1.34	0.17	0.87
		100 (education: 5-8)	10		Part V	47.93	20.82	12.6	-0.99	0.32
		95 (education: 9+)	39			35.96	16.23	4.77	-0.59	0.55

Table 6.5. Comparisons between Population of Turkey and other nationalities for Reaction Time Test

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p-value
Jorm *et al.* (2004)	Australia	1163	13	20-24	Dominant	214.01	28.96	17.72	-5.72	<0.0001
		1192	31	40-44		228.43	40.50	16.86	-21.57	<0.0001
		1319	7	60-64		248.21	55.52	19.83	-22.85	<0.0001
Nissan *et al.* (2013)	Scotland	50	36	18-25	Dominant	230.80	31.20	10.78	-5.81	<0.0001
		50	72	45-60		276.20	50.30	1.91	-0.71	0.481
		50	20	65-80		270.70	47.70	12.29	-3.41	0.001
Jacopsen *et al.* (2010)	Denmark	74	252	Overall	Dominant	242.00	31.00	13.21	-10.66	<0.0001
Cinaz *et al.* (2012)	German	20	51	18-30	Dominant	321.40	25.70	-24.07	10.44	<0.0001
Koç and Aydos (2018)	Turkey	36	26	20-26	Dominant	253	40	2.07	0.75	0.458

Table 6.6. Comparisons between Population of Turkey and other nationalities for Purdue Pegboard Test

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p value
Chan *et al.* (2009)	China	91	252	Overall	Both Hand	9.41	1.89	13.83	-5.31	<0.0001
Mccury *et al.* (2001)	America (Japanese)	120	10	70-79	Dominant	13.70	2.00	-75.64	9.15	<0.0001
		80	25	80+		12.50	2.30	-90.55	12.14	<0.0001
		120	10	70-79	Non-Dominant	12.70	2.30	-85.40	7.97	<0.0001
		80	25	80+		11.30	1.90	-87.09	12.91	<0.0001
Hamm and Curtis (1980)	America	116	80	<35	Dominant	13.59	1.25	4.09	-2.71	0.007
		60	172	35+		12.96	1.81	-16.86	4.86	<0.0001
		116	80	<35	Non-Dominant	13.18	3.84	-2.41	0.76	0.446
		60	172	35+		11.90	3.02	-15.76	3.98	<0.0001

Table 6.6. Comparisons between Population of Turkey and other nationalities for Purdue Pegboard Test (cont.)

Population of Turkey vs.	Country	n	n*	Age Group	Type	Mean	SD	% difference	t-value	p value
Hamm and Curtis (1980)	America	116	80	<35	Both Hand	10.81	2.93	12.89	-5.00	<0.0001
		60	172	35+		10.23	1.70	-0.10	0.03	0.977
		116	80	<35	Total	37.60	3.64	4.71	-3.21	0.002
		60	172	35+		35.10	4.31	-11.11	4.35	<0.0001
		116	80	<35	Assembly	27.86	11.12	43.74	-18.83	<0.0001
		60	172	35+		28.31	3.97	26.24	-10.33	<0.0001
Corti *et al.* (2017)	Australia	30	51	18-30	Dominant Hand	16.93	1.36	-17.73	-7.23	<0.001
		9	23	80+		8	1.29	-23.07	-2.81	0.01
		30	51	18-30	Both Hand	13.77	1.96	-10.87	-3.21	0.002
		9	23	80+		5.75	0.5	4.48	0.78	0.44
		30	51	18-30	Assembly	43.37	2.48	13.70	9.39	<0.001
		9	23	80+		15.5	0.58	20.51	3.53	0.002

7. CONCLUSIONS

Based on the statistical analysis results, the following conclusions can be drawn:

(i) An estimation of cognitive and motor capabilities of adult male population of Turkey were established.

(ii) Age had a negative effect on all responses. Depending on the test, after age 50 cognitive abilities decreases. On the other hand, decrease on motor function performance is seen after the age of 40.

(iii) Education has significant effect on the short-term memory, learning, attention and intellectual functions such as problem-solving and decision making.

(iv) Smoking habit and marital status effect are not observed on test results.

(v) When compared to results of other nationalities test performance with the male population of Turkey, in general it is similar to Australia and Italy for some of the tests and lower than Chinese, Korean and US and higher than Germans. Though it is not certain whether the differences are attributable only to the differences in geographical area, genetics, cultural or some other factors.

7.1.Contributions and Recommendation to Practitioners

Since normative data on cognitive and motor abilities of people is essential for designing product, user interface systems and functionality, the established norms through this study may serve as a reference values in cognitive work system design, consumer product design and human-computer interaction design for adult male population of Turkey. In addition, the data can be used as a reference for clinical applications.

7.2.Limitations of Current Study

Current study is done with the following limitations: Participants in this study were located in Istanbul which is metropolitan city and composed of people who have different type country of origin. For this reason, effect of living environment was ignored.

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APPENDIX A: FORMS

A.1. Brief Medical History Form

Check (×) if answer is "yes" only. Leave others blank.

	Do you have a problem with your hearing?
	Do you have a problem with your seeing?
	Do you have a problem with identifying colors?

	Do you currently smoke?
	Do you use alcohol?
	Do you have history of alcoholism or drug dependence or abuse during the lifetime?

Have you been diagnosed as having

	Past cerebrovascular accident
	Disorders of motility
	Cerebrovascular pathology
	Tumors of the nervous system
	Multiple sclerosis
	Epilepsy
	Parkinsonism,
	Dementia
	Organic psychosis
	Schizophrenia
	Affective psychosis
	Mental retardation
	Transient ischemic attacks,
	Hemodialysis for renal failure,
	Depression
	Cancer

	Have you ever had a serious head injury where you became unconscious for more than 15 minutes?
	Have you ever had a brain surgery?
	Have you ever had a electroconvulsive therapy?
	Have you ever had a stroke, mini stroke or TIA (Transient Ischemic Attack)?
	Have you ever had any chronic medical conditions such as lung, liver and kidney failures?
	Do you have any complaint of memory difficulties or any other cognitive deficits interfering or not with daily living activities
	Have you ever been diagnosed with any disorders in your arm joints (cysts or any other syndromes)?

Are you using any of these drugs?

	Anti-depressants
	Anti-psychotics
	Anxiolytics
	Anti-epileptics
	Any medication for treating neurological and psychiatric illnesses.

Check space (×) if you now have or recently had.

	Recurring pain in shoulders, elbows, wrists or hands?
	Glaucoma or increased pressure in the eyes?
	Hyperthyroidism?
	Diabetes mellitus?

How often do you take part in sports or activities? (In a week, what activities)

Please list any other disease or surgery you had.

Please list any other prescribed medications you are now taking.

Your Weight and Height:

Tıbbi Geçmiş Formu

Cevabınız evet ise (×) işaretleyiniz. Diğerlerini boş bırakabilirsiniz.

	İşitsel bir probleminiz var mı?
	Görme ile ilgili bir sorununuz var mı?
	Renkleri ayırt etme ile ilgili bir sorununuz var mı?

	Sigara kullanıyor musunuz?
	Alkol kullanıyor musunuz?
	Alkolizm ve uyuşturucu bağımlılığı geçmişiniz var mı?

Şimdiye kadar teşhisi koyulmuş hastalıkları işaretleyiniz.

	Beyin damarlarında tıkanıklık
	Hareket düzensizliği
	Beyin damarlarında kitle ya da pıhtılaşma
	Sinir sistemi tümörleri
	Çoklu doku sertleşmesi (skleroz)
	Epilepsi
	Parkinson
	Bunama
	Ruhsal denge bozukluğu
	Şizofreni
	Duygusal psikoz
	Zihinsel gelişim bozukluğu
	Beyin damarlarının geçici tıkanması – geçici zihinsel bozukluklar
	Diyaliz
	Depresyon
	Kanser

	15 dakikadan fazla kafa karışıklığına yol açan ciddi bir beyin sarsıntısı veya çarpma geçirdiniz mi?
	Beyin ameliyatı geçirdiniz mi?
	Şok tedavisi uygulandı mı?
	Felç geçirdiniz mi?
	Kronik tıbbi bir rahatsızlığınız var mı?
	Şimdiye kadar hayatınızda hafızayla ilgili ciddi bir sorun yaşadınız mı?
	Kol eklemlerinizde hastalığınız oldu mu (kist veya çeşitli sendromlar gibi)

Aşağıdaki ilaçlardan birini kullanıyor musunuz?

	Anti-depresan
	Anti-psikoz
	Anti-epilepsi

Aşağıdaki sorunlarla daha önce karşılaşmışsanız veya şu anda bu sorunlar sizde mevcut ise çarpı işaretiyle işaretleyiniz. yoksa lütfen boş bırakınız.

	Omuz, dirsek, el bileği ve ellerinizde sürekli ağrı
	Glokom (karasu hastalığı) veya yüksek göz tansiyonu
	Hipertansiyon
	Şeker hastalığı

Hangi sıklıkla spor yapıyorsunuz? (haftada ne kadar ve hangi aktiviteler?)

Lütfen geçirdiğiniz başka hastalık veya ameliyat varsa sıralayınız.

Lütfen şu anda kullandığınız ilaçları sıralayınız.

Boyunuz ve Kilonuz:

A.2. Personal Consent Form

In this thesis study, the aim is to determine the cognitive capacity statistics of Turkish adult male population. You do not have any serious health problem which affects your participation to the experiments adversely.

The statistics that is determined via this study can be used to design technological functions of products and user interfaces which are appropriate to the usage of Turkish male in the daily life and industrial life.

If you decided to participate, please take into consideration the issues below.

1. Before the experiments, your birthday, birth place, your family origin, occupation, dominant hand, your educational background, your family income, your medical history, sport, alcohol and smoking abilities will be asked.

2. Experiments will be performed in a predetermined random order. The experiment includes 6 different applications. All applications will be performed in sitting posture. The instructions for applications will be provided by the experimenter. You can have a break any time you need during the experiment.

3. Before the tests, participants should not be full. Hungry, or sleepless, and should not consume harmful substances.

Your participation is completely voluntary. You may choose to withdraw from participation at any time. All information obtained during this study will be held in strict confidence.

If at any time you have questions regarding this research, you may contact either Tugba Koyun or Professor Dr. Mahmut Ekşioğlu from Department of Industrial Engineering of Boğaziçi University.

By placing your signature below, you will accept that your participation to this study is voluntary. However, you can choose to withdraw from participation at any time at no cost or obligation to you.

Signature of Participant: Date:

Kişisel Onay Formu

Bu tez çalışmasını amacı Türkiye yetişkin erkek nüfusunun bilişsel kapasitesinin belirlenmesidir. Sizin bu deney çalışmasına katılımınızı olumsuz etkileyecek ciddi bir sağlık sorununuz bulunmamaktadır.

Bu çalışmadan elde edilecek verilerin Türkiye yetişkin erkek nüfusuna uygun ürünlerin, teknolojik fonksiyonların ve kullanıcı ara yüzlerin tasarımında kullanılması planlanmaktadır.

Katılmaya karar vermeniz durumunda aşağıda belirtilenleri dikkate almanızı rica ediyoruz.

1. Deneyden önce size doğum tarihiniz, doğum yeriniz, memleketiniz, mesleğiniz, eğitim bilgileriniz, ailenizin gelir durumu, sağlık bilgileriniz, spor, alkol ve sigara kullanımınız ile ilgili sorular yöneltilecektir.

2. Deneyler önceden belirlenmiş, rassal sırayla gerçekleştirilecektir. Deney 6 uygulamadan oluşmaktadır. Tüm uygulamalar oturur pozisyonda gerçekleştirilecektir. Uygulamalarla ilgili talimatlar uygulamacılar tarafından size sağlanacaktır. Deney sırasında istediğiniz zaman ara verilecektir.

3. Uygulamalardan hemen önce katılımcı yemek yememelidir, ayrıca uygulama sırasında aç, uykusuz olmamalı ya da uygulama öncesi zararlı maddeler kullanmamış durumda olmalıdır.

Çalışmaya katılmanız tamamen isteğe bağlıdır. Dilediğiniz zaman, sebep göstermeksizin çalışmadan çekilebilirsiniz. Bize sağladığınız tüm bilgiler saklı kalacaktır.

Bu çalışmayla ilgili herhangi bir sorunuz olması durumunda Tuğba Koyun ya da Boğaziçi Üniversitesi Endüstri Mühendisliği Bölümünden Prof. Dr. Mahmut Ekşioğlu ile iletişime geçebilirsiniz.

Bu formu imzalayarak, bu çalışmaya gönüllü olarak katıldığınızı beyan ediyorsunuz. Dilediğiniz zaman, sebep göstermeksizin çalışmadan çekilebilirsiniz.

Katılımcı İmza: Tarih:

Participant No:

A.3. Personal Data Form

1. General Information about the Participant

Information	Datum
Birth date	Day: Month: Year:
Birthplace	
Gender	
The place he/she lives now	
Family origin city	
Mother and father's birthplace	
Marital Status	
Average Income of Family	
Residence	Alone ( ) With family ( ) With relatives or friends ( ) In household with paid care-giver ( ) Institution or group home ( )
Dominant Hand	

2. Educational Information about the Participant

Student or Employee	
Occupation (for employees)	
School (for students)	
Last school graduated	
Last school attended	
Father's educational status	
Mother's educational status	

Katılımcı No:

Kişisel Bilgi Formu

1. Genel Bilgiler

Bilgi	**Veri**
Doğum Tarihi	Gün: Ay: Yıl:
Doğum Yeri	
Cinsiyet	
Yaşadığı Yer	
Memleket	
Anne Baba Doğum Yeri	
Medeni Hal	
Ortalama Aile Geliri	
İkamet Durumu	Yalnız ( ) Ailesiyle ( ) Akrabalar ya da arkadaşlar ( ) Bakımevi ( ) Enstitü ya da grup evi ( )
El Kullanımı	Sağ ( ) Sol ( ) İki El ( )

2. Eğitim Bilgileri

Öğrenci ya da Çalışan	
Meslek (çalışanlar için)	
Okul (öğrenciler için)	
En son mezun olunan okul	
En son devam edilen okul	
Babanın eğitim durumu	
Annenin eğitim durumu	

A.4. Record Form

Katılımcı rahat ve sessiz bir ortamda, oturur pozisyonda olmalı.
(Participant sits comfortably in a quiet comfortable environment.)

Uygulayıcı katılımcının karşısında oturmalı.
(Experimenter sits across the participant.)

30 dakikada bir ara verilebilir.
(Breaks may be given after each 30 min sessions.)

Katılımcıya istediği zaman ara verilebileceği belirtilmeli.
(A participant can take break whenever he feels the need.)

Ortamda su bulundurulmalı.
(Provide drinking water in case of need.)

Öncelikle Katılımcı bilgi formu doldurulmalı.
(Firstly, personal data form should be filled.)

Ardından uygulamalara geçilir.
(Experimental procedure starts after these.)

Katılımcı No:	**Uygulama**	**Date**
	Digit Span Test	/ /
	Corsi Span Test	/ /
	Stroop Color Word Test	/ /
	Purdue Pegboard Test	/ /
	Reaction Time Test	/ /
	Raven Standard Progressive Matrices	/ /

Uygulayıcının Adı:
Uygulama Yeri:

A.5. Digit Span Kayıt Formu

Katılımcı No:

List (forward)	Result (√ or ×)	List (backward)	Result (√ or ×)
For Span = 3		**For Span = 3**	
829		928	
132		231	
152		251	
For Span = 4		**For Span = 4**	
6241		1426	
2359		9532	
7132		2317	
For Span = 5		**For Span = 5**	
84132		23148	
62143		34126	
97438		83479	
For Span = 6		**For Span = 6**	
587261		162785	
261384		483162	
632147		741236	
For Span = 7		**For Span = 7**	
2941378		8731492	
1285394		4935821	
8693735		5373968	
For Span = 8		**For Span = 8**	
65148279		97284156	
18472913		31927481	
42785921		12958724	
For Span = 9		**For Span = 9**	
679174382		283471976	
746231958		859132647	
398724615		516727893	
For Span = 10		**For Span = 10**	
4982176453		3546712894	
5731298426		6248921375	
8182397465		5647932818	

EN UZUN SAYI ADEDİ:

A.6. Corsi Span Kayıt Formu

Katılımcı No:

SPAN	FORWARD				BACKWARD			
3	5,8,2		6,9,4		6,2,9		4,1,5	
4	6,4,3,9		7,2,8,6		3,2,7,9		1,9,6,8	
5	4,2,7,3,1		7,5,8,3,6		1,5,2,8,6		6,1,8,4,3	
6	6,1,9,4,7,2		3,9,2,4,8,7		5,3,9,4,1,8		7,2,4,8,5,6	
7	5,9,1,7,4,2,8		4,1,7,9,3,8,6		8,1,2,9,3,6,5		4,7,3,9,1,2,8	
8	5,8,1,9,2,6,4,7		3,8,2,9,5,1,7,4		9,4,3,7,6,2,5,6		7,2,8,1,9,6,5,2	
9	2,7,5,8,6,2,5,8,4		7,1,3,9,4,2,5,6,8					

EN UZUN SIRA:

A.7. Stroop Color Word Test Kayıt Formu

Katılımcı No:

KAYIT FORMU

Adı Soyadı : ....
Doğum Tarihi : ..../....../.............
Yaşı : ....
Cinsiyeti : ....
Eğitim Düzeyi : ....

Uygulayıcının
Adı Soyadı : ....
Uygulama Tarihi : ....../..../..........
Uygulama Yeri : ....

Bölüm I: Siyah Basılmış Renk İsmi Okuma

M	S	K	Y
Y	M	S	K
Y	K	M	S
K	Y	S	M
S	K	Y	M
K	M	S	Y

Bölüm II: Renkli Basılmış Renk İsmi Okuma

M	S	K	Y
Y	M	S	K
Y	K	M	S
K	Y	S	M
S	K	Y	M
K	M	S	Y

Bölüm III: Şekil Rengi Söyleme

Y	M	S	K
S	K	Y	M
M	Y	S	K
M	S	K	Y
K	Y	M	S
S	Y	M	K

Bölüm IV: Renk İsmi Olmayan Kelime Rengi Söyleme

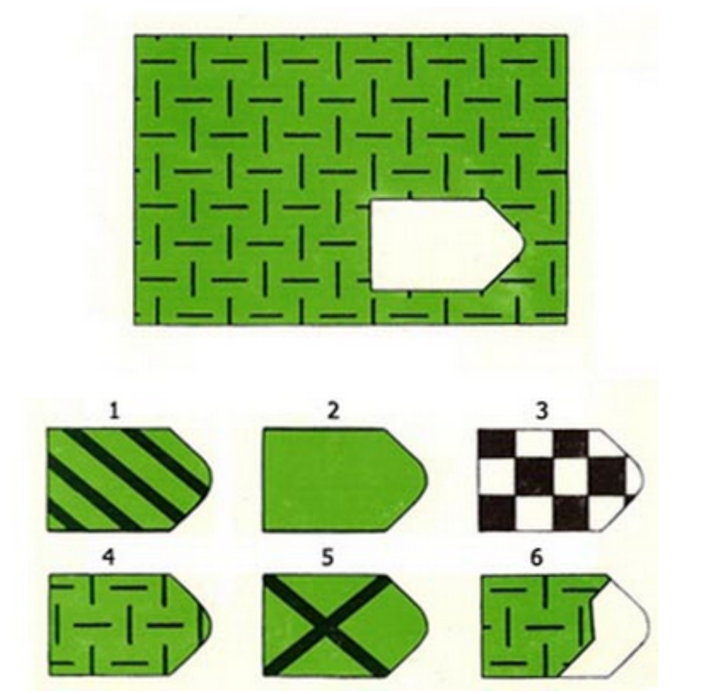
Y	M	S	K
S	K	Y	M
M	Y	S	K
M	S	K	Y
K	Y	M	S
S	Y	M	K

Bölüm V: Renk İsmi Olan Kelime Rengi Söyleme

Y	M	S	K
S	K	Y	M
M	Y	S	K
M	S	K	Y
K	Y	M	S
S	Y	M	K

	TOPLAM SÜRE	HATA SAYISI
BÖLÜM I		
BÖLÜM II		
BÖLÜM III		
BÖLÜM IV		
BÖLÜM V		

A.8. Raven Kayıt Formu



"Bu şekilde resmi tamamlayacak olan element aşağıdaki 6 seçenekten hangisidir? "

DOĞRU CEVAP SAYISI:

A.9. Purdue Pegboard Kayıt Formu

Purdue Pegboard Score Sheet
For Model #32020

Quick Reference Means (normative population averages) in Parts

Occupational Area	Right Hand	Left Hand	Both Hands	Right + Left + Both	Assembly
Male & Female Applicants for Assembly Jobs*	17.86	16.60	14.38	48.81	43.58
Male & Female Applicants for Gen. Factory Work*	17.15	16.01	13.79	46.76	39.30
Male & Female Applicants for Production Work*	17.94	16.81	14.10	48.85	40.67
Female Applicants for Electronic Prod. Work*	18.47	16.77	14.53	49.84	43.76
Female Hourly Production Workers*	18.02	16.81	14.34	49.14	38.08
Male Hourly Production Workers*	16.45	16.31	13.37	46.11	36.89
Male Maintenance and Service Employees*	15.49	15.25	12.31	43.04	38.71
Female Applicants for Sewing Machine Operator: Three Trial Sum*	55.20	51.78	44.03	151.09	133.41

* *Data taken from the Appendix A (Tables 8-15) in the original Purdue Pegboard Manual*

Subject Record

Name: ______________________ Dominant Hand: Right or Left

Reason for Administering: ____________________________________

____

Test Administrator Name: ____________________ Test Date:____/____/____

Scoring Grid Based on Number of Parts

	Trial One	Trial Two	Trial Three	Trial Average	Score A**	Score B**
Right Hand						
Left Hand						
Both Hands						
Right + Left + Both						
Assembly						

***You can use the Verbal Scale, Standard Scale, or Percentile Scale.*

Lafayette Instrument Company
1-800-428-7545

Please Call to
Reorder #32107

A.10. Reaction Time Kayıt Formu

http://cognitivefun.net/test/1
Katılımcı No:

TRIAL	RIGHT HAND	LEFT HAND
1		
2		
3		
4		
5		

ORTALAMA:

A.11. Test Prosedürleri - Türkçe

Digit Span Test Prosedürü:

Digit Span Forward test için aşağıdaki adımlar takip edilir;

(i) Katılımcıya, "Size bir sayı dizisi dinletilecektir; ardından sayıları duyduğunuz sırada tekrar etmeye çalışmanızı istiyoruz." şeklinde bilgi verilerek teste başlanır.

(ii) Sayı dizileri her bir rakam normal ses tonunda, rakamlar arası 1 saniye olacak şekilde, ses kayıt cihazı ile kaydedilmiştir. Katılımcılara bu cihazdan sayı dizileri dinletilmeye başlanır.

(iii) Eğer katılımcı diziyi doğru tekrar ederse, bir sayı daha içeren daha uzun sayı dizisi dinletilir. Ama eğer doğru tekrar edemez ise aynı uzunlukta yeni bir dizi dinletilir, tekrar hata yaparsa test sonlandırılır. Doğru tekrar ederse bir sayı daha içeren daha uzun sayı dizisi dinletilir. En uzun doğru tekrar edilen sayı dizisindeki rakam adedi katılımcının Digit Span test sonucudur (Hebb, 1961).

(iv) Sayı dizilerinin uzunluğu üçten başlayıp teker teker maksimum 9 olacak şekilde artar.

Digit Span Backward için aynı prosedür uygulanır; sadece katılımcının sayı dizisindeki rakamları duyduğu sıranın tam tersinden tekrar etmesi istenir.

Corsi Span Test Prosedürü:

Corsi Span Forward Test içim aşağıdaki prosedür takip edilir;

(i) Test, deneyi uygulayan kişinin işaret parmağı ile Corsi Span tahtasındaki 3 küpe 1 saniye aralıklarla dokunması ile başlar. Katılımcıdan aynı sıra ile küplere dokunması istenir.

(ii) Her bir sıralama için katılımcıya 2 deneme hakkı verilir, iki denemede de başarısız olursa deney sonlandırlır. Eğer birinde başarılı olursa, bir küp daha fazla içerecek şekilde yeni bir sıralama gösterilir (Postma *et al.,* 2004).

(iii) Sıralamalar üç küpten başlayarak dokuz küpe kadar gidebilir. Maksimum tekrar edilebilen sıralamadaki küp sayısı katılımcının Corsi Span sonucu olarak kaydedilir.

Sıralamalar rassal olarak üretilmiştir ve hiçbir sıralamada aynı küpe iki kere dokunulmaz. Backward versiyonunda katılılmcıları gösterilen sıralamayı tersten tekrar etmesi beklenir. Makisumum sekiz küpe kadar sıralama içerir.

Stroop Color Word Test Prosedürü:

Test 5 kısımdan oluşur, her kısım eşzamanlı olarak kronometreye basılması ve "Başla" komutu ile başlar, katılımcı kartların üstündeki son maddeyi okuyunca biter. Ölçülen zaman forma kaydedilir.

Testin başında katılımcıya şu bilgilendirme yapılır; "Size elimde tutarak bazı kartlar göstereceğim, ardından "Başla" komutunu verdiğimde kartın üzerindeki kelimeleri ya da kelimelerin renklerini okumanızı isteyeceğim. Elinizden geldiğince hızlı olmalısınız; herhangi bir hata yaparsanız düzeltmeden geçebilirsiniz.

(i) Kart 1 katlımcıya gösterilir ve bilgi verilir; "Bu karttaki kelimeleri olabildiğince hızlı olarak okumanızı istiyorum, buradan başlayarak devam etmelisiniz. (Deneyi yapan eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.)

(ii) İlk kart bitince ikinci karta geçilir. İkinci kart için bilgi verilir; "Şimdiki kartta gördüğünüz kelimeleri söylemenizi istiyorum, olabildiğince hızlı olmalısınız ve buradan başlayarak devam etmelisiniz." (Deneyi yapan eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.)

(iii) Üçüncü kart gösterilir ve “Şimdi kartta gördüğünüz yuvarlakların renklerini söylemenizi istiyorum, olabildiğince hızlı olmalısınız ve buradan başlayarak devam etmelisiniz.” şeklinde bilgi verilir.

(iv) Dördüncü kart gösterilir ve “Şimdi kartta gördüğünüz kelimlerin yazılı olduğu renkleri söylemenizi istiyorum, olabildiğince hızlı olmalısınız ve buradan başlayarak devam etmelisiniz.” şeklinde bilgi verilir.

(v) Son olarak beşinci kısım için tekrar ikinci kart gösterilir ve “Son olarak karttaki renk isimlerinin yazılı olduğu renkleri söylemenizi istiyorum; olabildiğince hızlı olmalısınız ve buradan başlayarak devam etmelisiniz.” (Deneyi yapan eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.) Lütfen kelimeleri okumayın, yazılı olduğu mürekkpe rengini söyleyin.” Şeklinde bilgi verilir (Karakaş, 2011).

Reaction Time Test Prosedürü:

Reaksiyon süresi baskın el ve baskın olmayan el olmak üzere iki el için ayrı ayrı ölçülür. Her el için beş deneme yapılarak reaksiyon süresi bu beş denemenin ortalaması olarak kabul edilir. Aşağıdaki prosedür takip edilir. Kullanıcıya istediği eli ile başlayabileceği bilgisi verilir.

(i) İlk olarak kullanıcıya test ile ilgili bilgi verilir: ‘Test başlayınca, ekranda küçük kırmızı bir daire gözükecek. Sizden istediğimiz bu küçük kırmızı daire, yeşil büyük bir daireye döner dönmez, yapabildiğiniz en hızlı şekilde butona (klavyedeki boşluk tuşuna) basınız.’

(ii) ‘Her iki el için de 5 deneme yapacağız. Denemeler arasında molaya ihtiyacınız olursa haber verebilirsiniz.’

(iii) Kullanıcıya ‘Hazır olduğunuzda butona tıklayarak testi başlatabilirsiniz’ şeklinde bilgi verilir.

Purdue Pegboard Test Prosedürü:

Test 5 ayrı küçük testten oluşmaktadır. Katılımcı rahat bir pozisyonda sandayeye oturur ve masaya test ekipmanı yerleştirilir. Katılımcı hazır olunca, teste başlanır. Her küçük test 2 defa tekrarlanır ve bu iki tekrarın ortalaması test sonucu olarak kaydedilir.

(i) İlk bölüm için kullanıcıya aşağıdaki talimatlar verilir: ‘Baskın elinle, baskın elinin tarafında bulunan kaptan, her defasında bir adet olmak üzere, pim al ve bunu en üstten başlayarak tahtanın üzerinde bulunan deliklere sırayla yerleştir. Her deliğe yalnızca 1 pim konacaktır. 30 saniye boyunca yapabildiğin kadar çok pimi yerleştirmeyi hedefle. Bunu iki kere tekrarlayacağız. Tekrarlar arasında molaya ihtiyacın olursa ara verebiliriz.’ Kullanıcı ‘Başla’ talimatı ile başlar ve zamanın dolduğu bildirilince durur. Dizilen pimler sayılır ve kaydedilir.

(ii) İkinci bölüm için kullanıcıya aşağıdaki talimatlar verilir: ‘Bu bölümde baskın olmayan elinle, baskın olmayan elinin tarafında bulunan kaptan bir adet pim al ve bunu en üstten başlayarak tahtanın üzerinde bulunan deliklere sırayla yerleştir. Her deliğe yalnızca 1 pim konacaktır. 30 saniye boyunca yapabildiğin kadar çok pimi yerleştirmeyi hedefle. Bunu iki kere tekrarlayacağız. Tekrarlar arasında molaya ihtiyacın olursa ara verebiliriz.’ Kullanıcı ‘Başla’ talimatı ile başlar ve zamanın dolduğu bildirilince durur. Dizilen pimler sayılır ve kaydedilir.

(iii) Üçüncü bölümde kullanıcıya aynı talimatlar verilir fakat bu sefer kullanıcıya iki elini kullanarak pimleri dizmesi gerektiği söylenir. İki el eş zamanlı olaeak kullanılacaktır. Kullanıcıya aşağıdaki talimatlar verilir: ‘Bu bölümde iki elini de aynı anda kullanarak sağ elinle sağ taraftan ve sol elinle de sol taraftaki pimlerden alarak aynı yönlerdeki deliklere yerleştir. 30 saniye boyunca yapabildiğin kadar çok pimi yerleştirmeyi hedefle. Bunu iki kere tekrarlayacağız. Tekrarlar arasında molaya ihtiyacın olursa ara verebiliriz.’ Kullanıcı ‘Başla’ talimatı ile başlar ve zamanın dolduğu bildirilince durur. Dizilen pimler sayılır ve kaydedilir.

(iv) Dördüncü bölüm gerçek bir test değildir. Bu bölüm ilk üç bölümün toplamından oluşan bir skordur. 4. Test skoru =1. Test skoru+2.test skoru+3. Test skoru

(v) Beşinci (son) bölüm montaj görevini içerir. Kullanıcıya aşağıdaki talimat verilir: ‘Kaptan baskın elinizle bir pim alın ve baskın eliniz tarafındaki deliğe koyarken baskın olmayan elinizle bir pul (washer) alın. Pimi (pin) yerleştirdikten sonra pulu üzerine koyun. Pulu, baskın olmayan el ile pimin üzerine yerleştirilirken baskın el ile bir rondela (collar) alın . Rondela pimin üstüne düşerken, baskın olmayan el ile başka bir pul alın ve rondelanın üzerine bırakın. Bu görevin adı montajdır ve 60 sn içerisinde mümkün olan en fazla montaj işini yapmayı hedefleyin.’

Raven Test Prosedürü:

Kullanıcıya testle ilgili bilgi verilir ve hazır olduğunda teste başlanır. Testteki toplam doğru sayısı test skoru olarak kaydedilir.

(i) Kullanıcıya aşağıdaki talimatlar verilir: ‘Bu test 60 soru içermektedir. Her soru çoktan seçmeli olup eksik parçayı bulman istenmektedir. İstediğin sorudan başlayabilirsin. Testi bitirmek için 40 dakikanız var; zaman dolunca kağıtları gelip sizden alacağım.’

APPENDIX B: QUESTIONS FOR RAVEN TEST

Raven progressive matrices

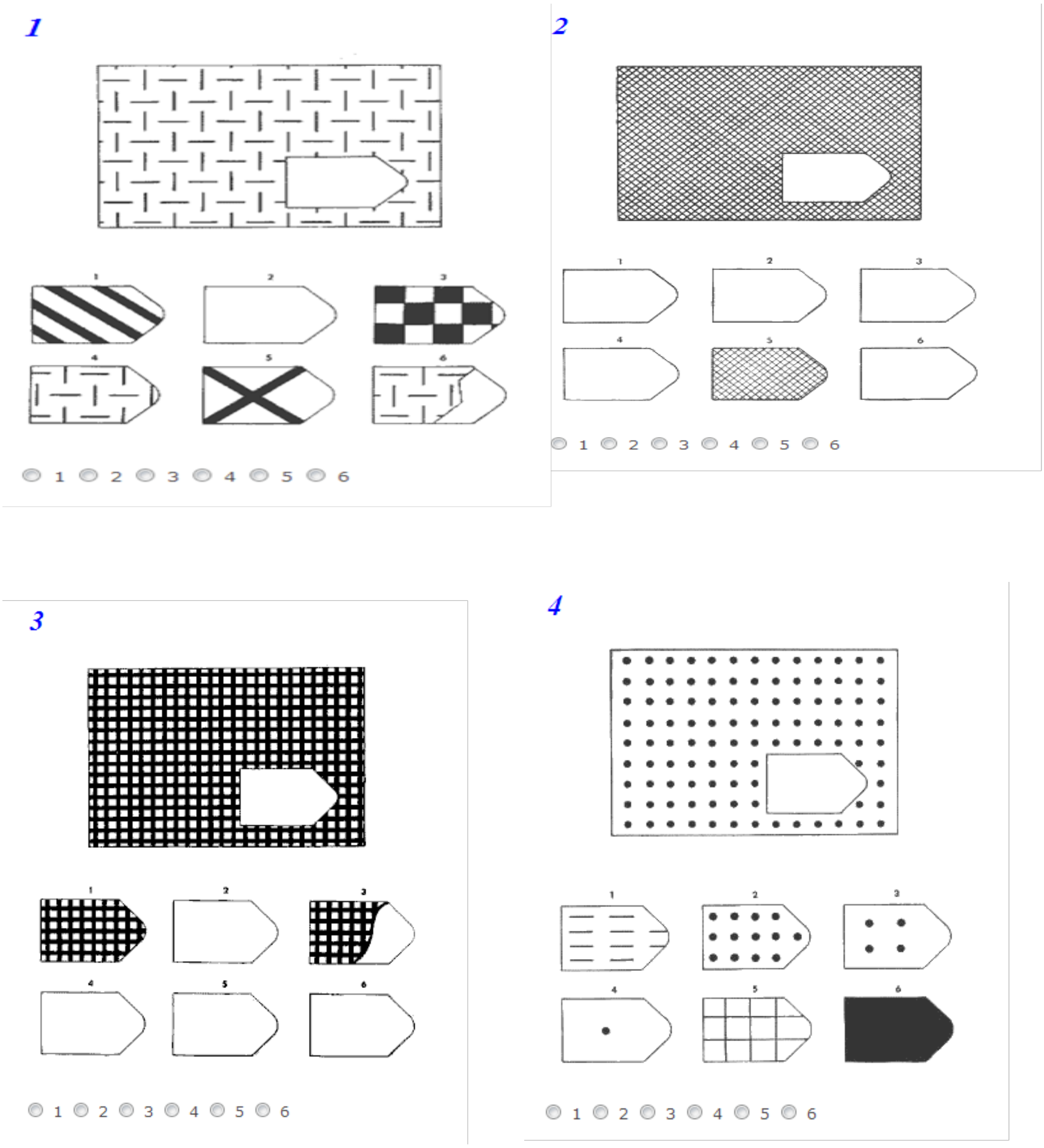


Figure B.1. Questions of Raven Test

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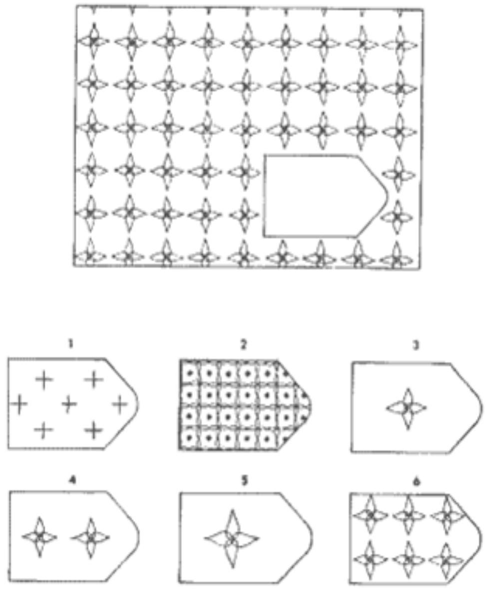

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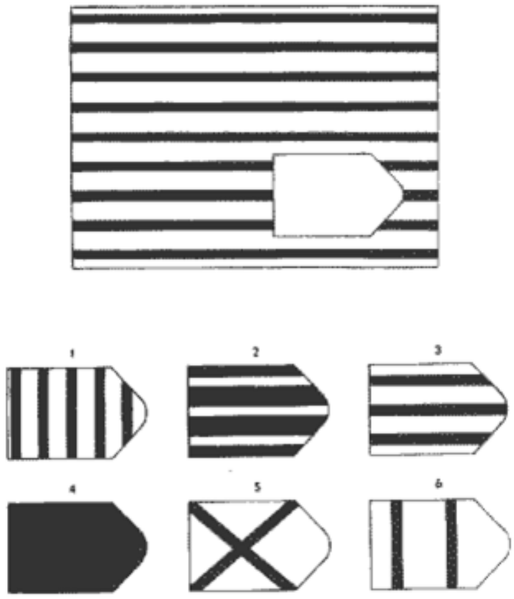

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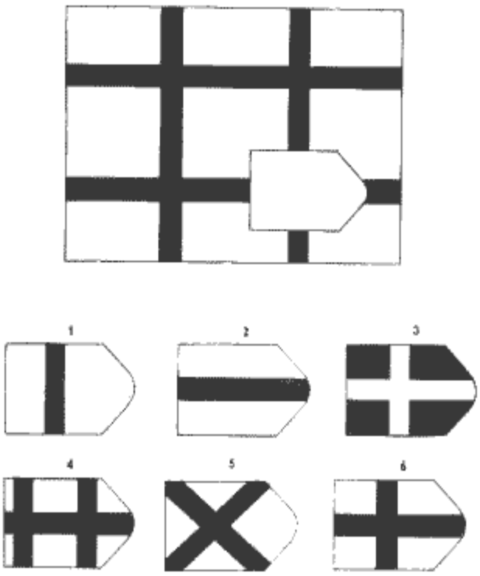

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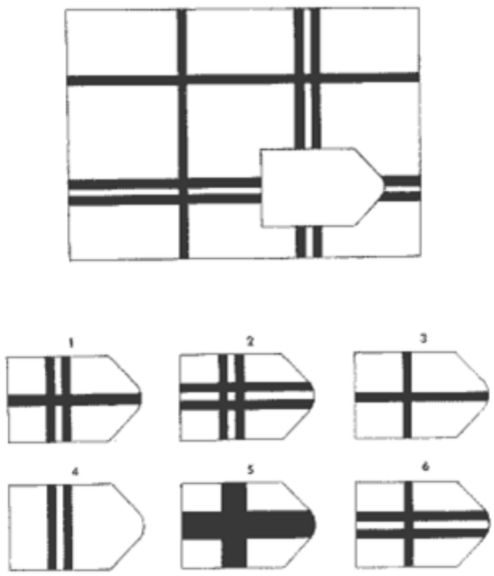

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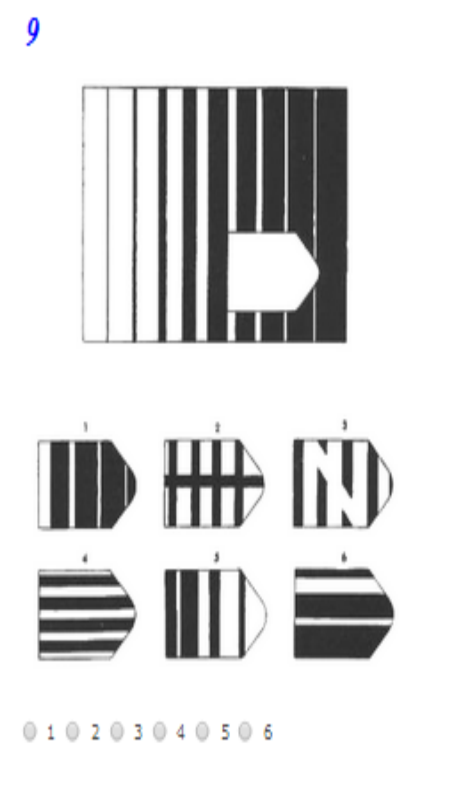
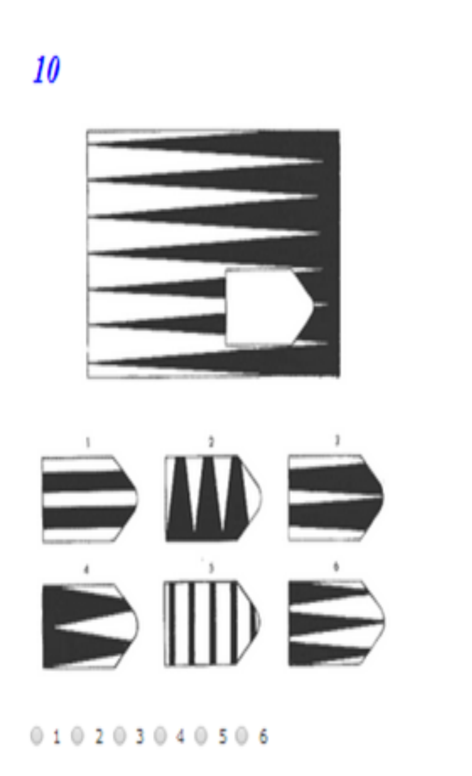
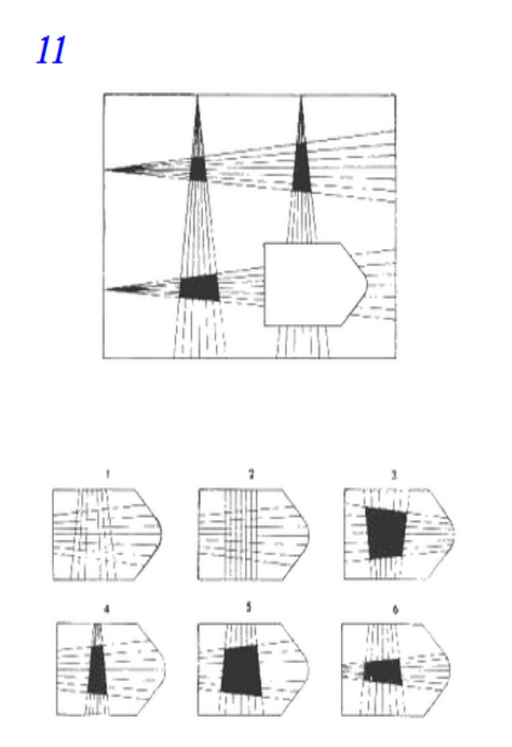
Figure B.1. Questions of Raven Test (cont.)







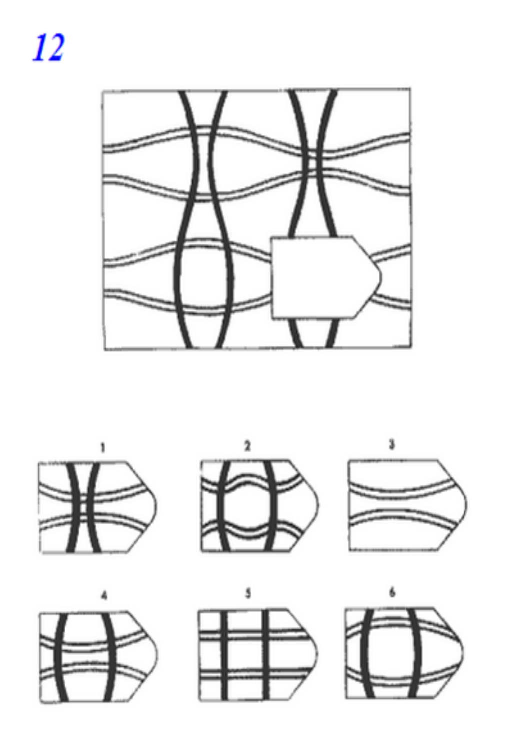


Figure B.1. Questions of Raven Test (cont.)

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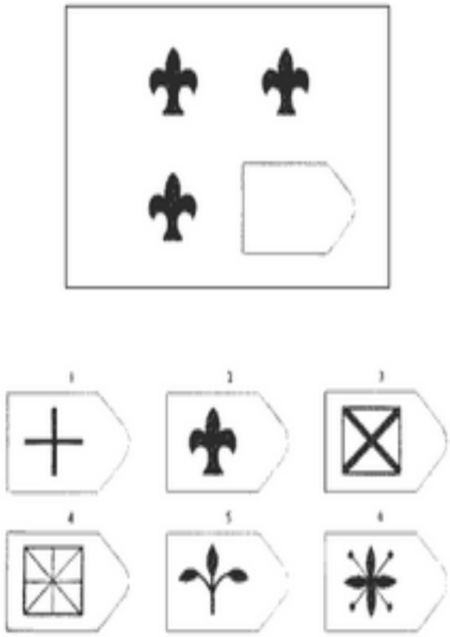

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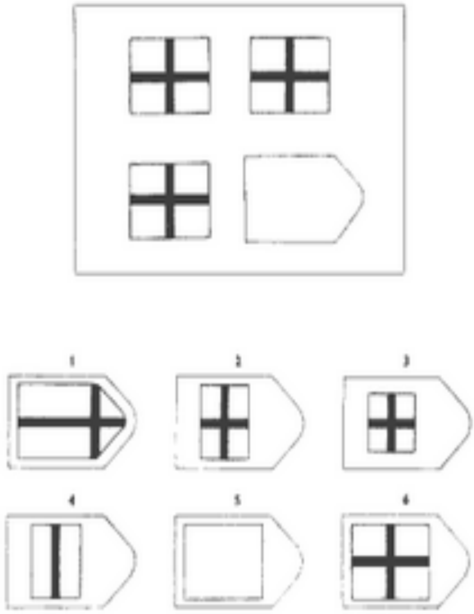

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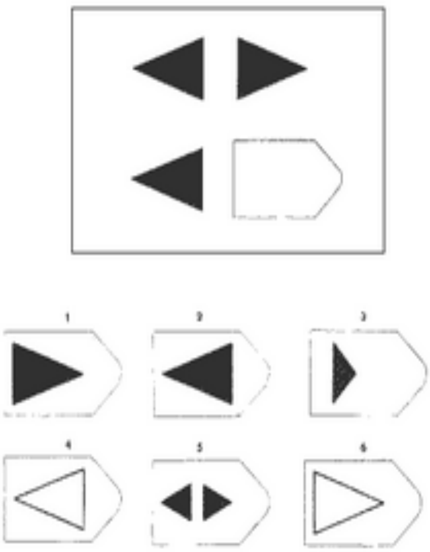

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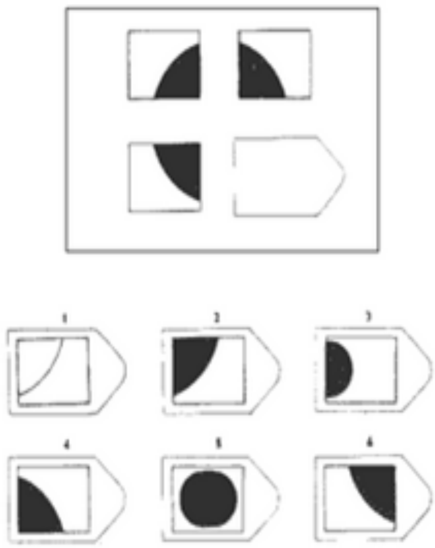

Figure B.1. Questions of Raven Test (cont.)

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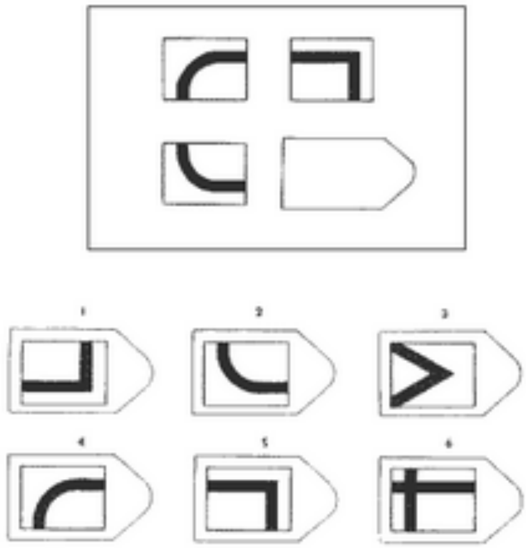

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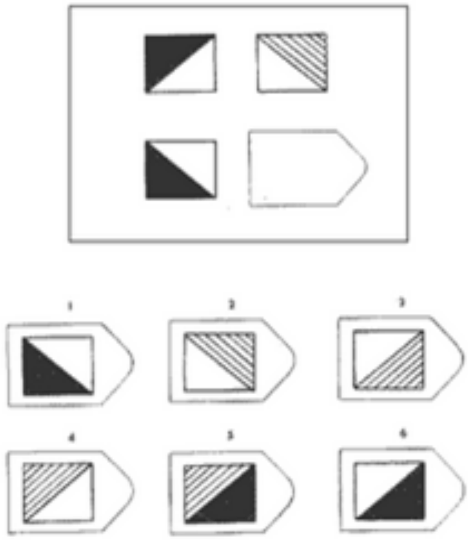

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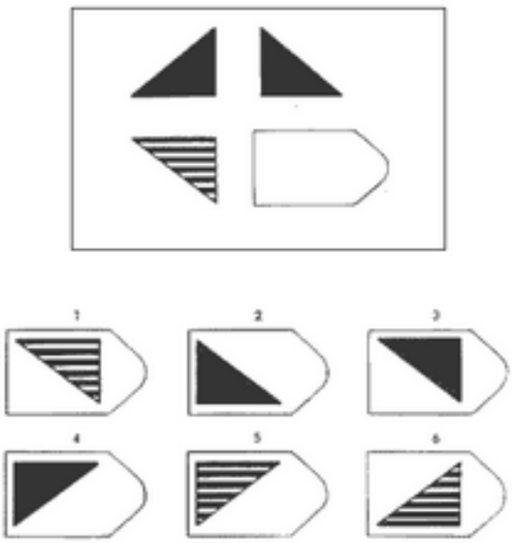

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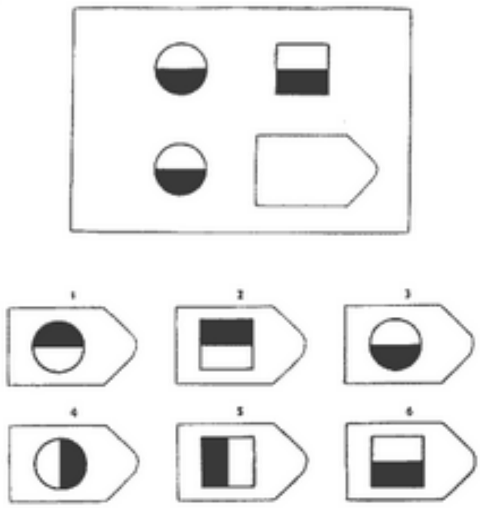

Figure B.1. Questions of Raven Test (cont.)

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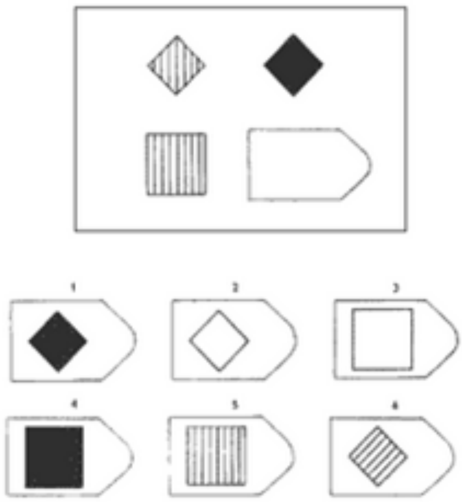

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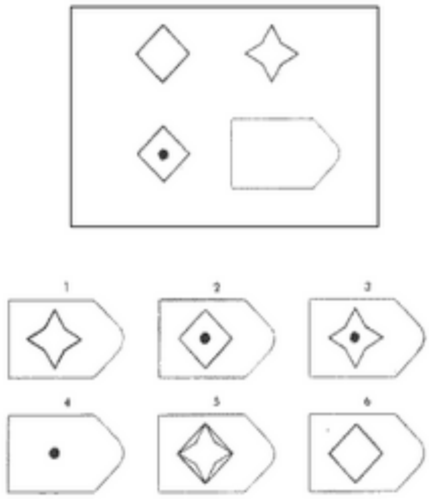

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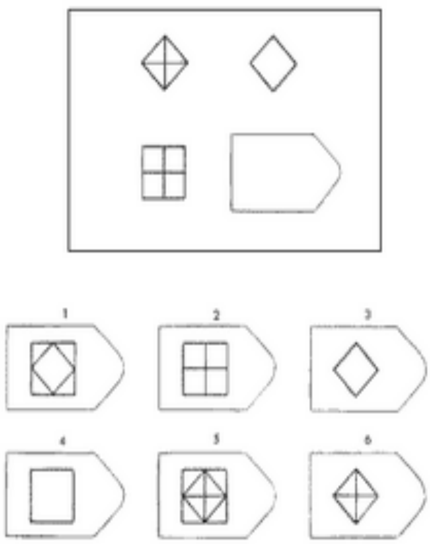

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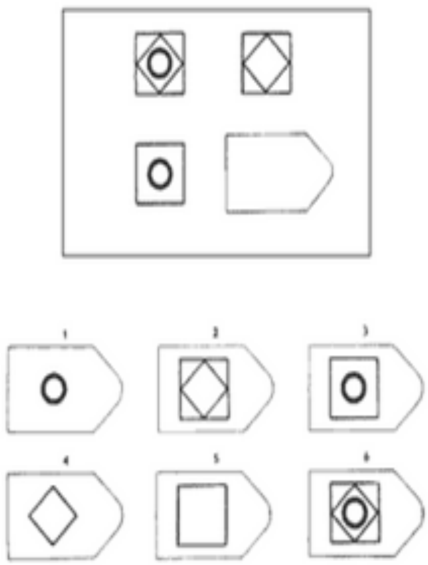

Figure B.1. Questions of Raven Test (cont.)

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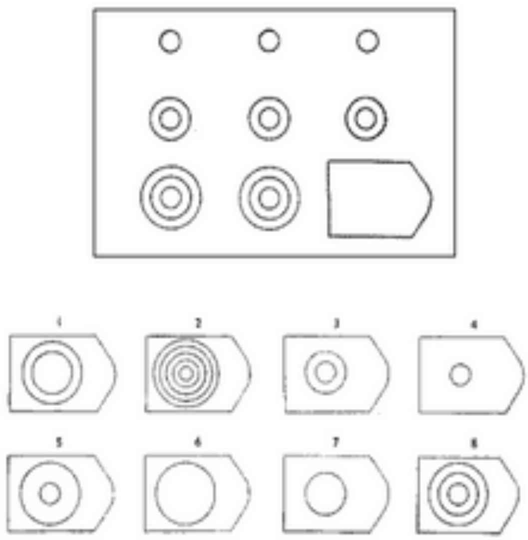

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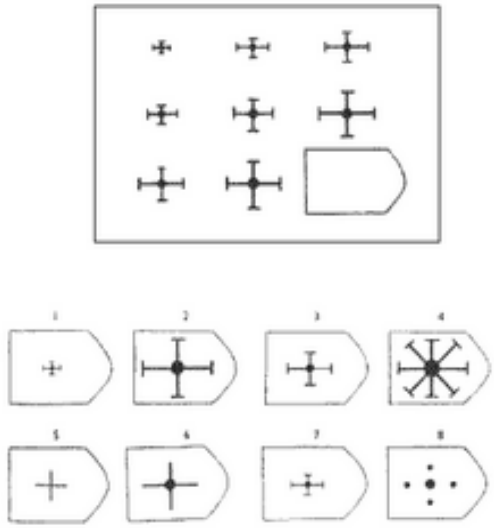

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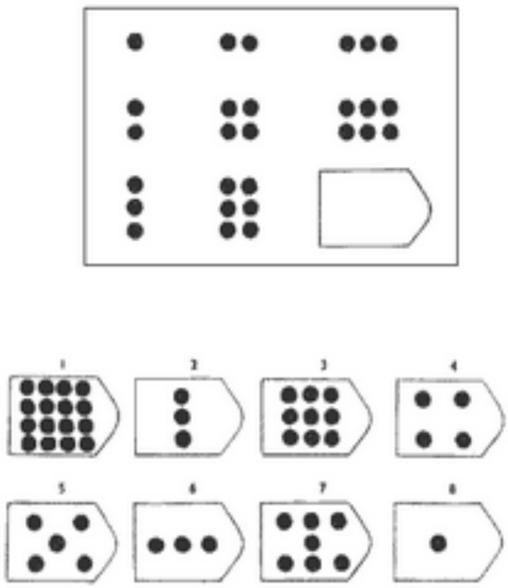

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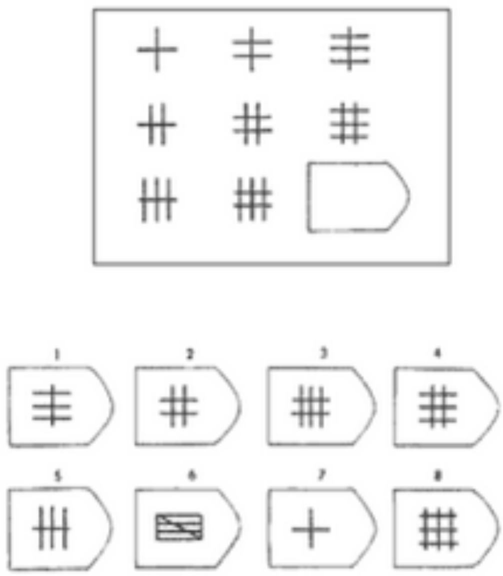

Figure B.1. Questions of Raven Test (cont.)

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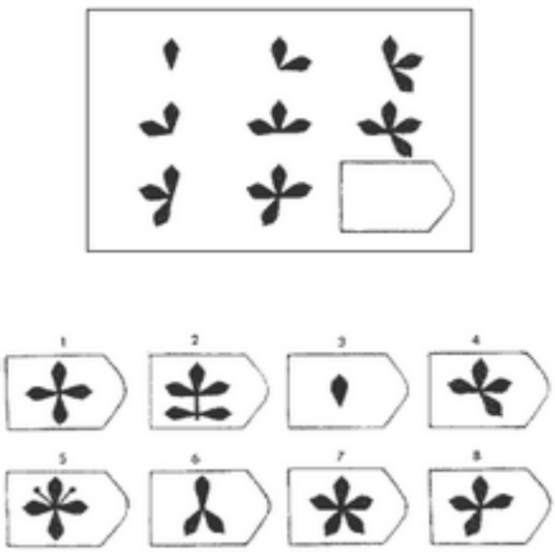

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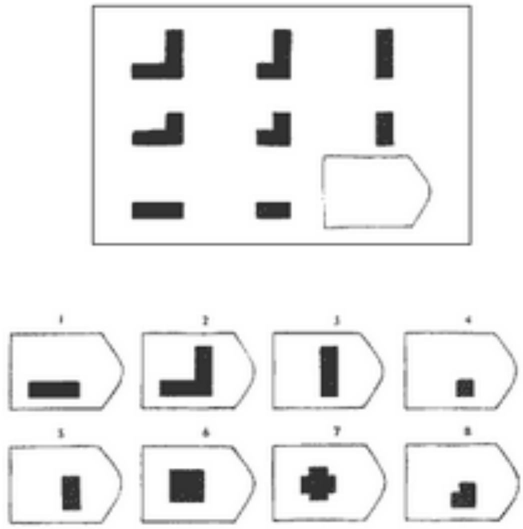

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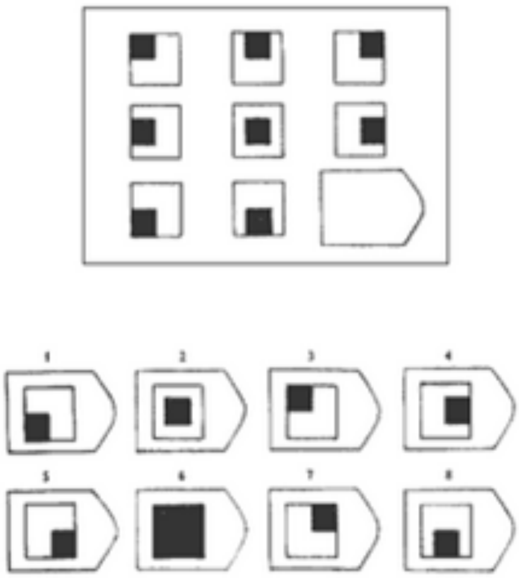

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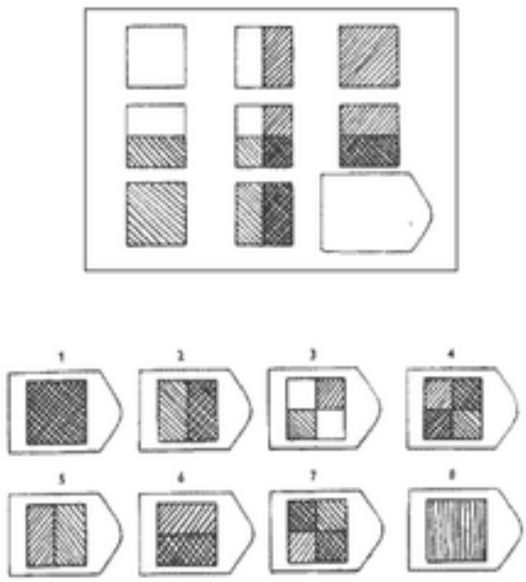

Figure B.1. Questions of Raven Test (cont.)

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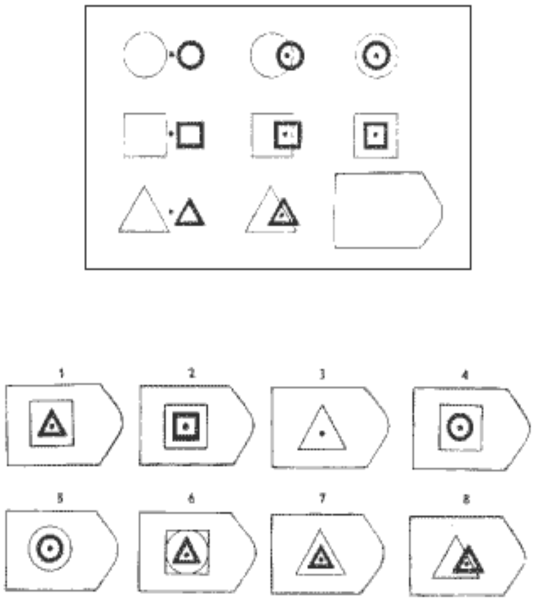

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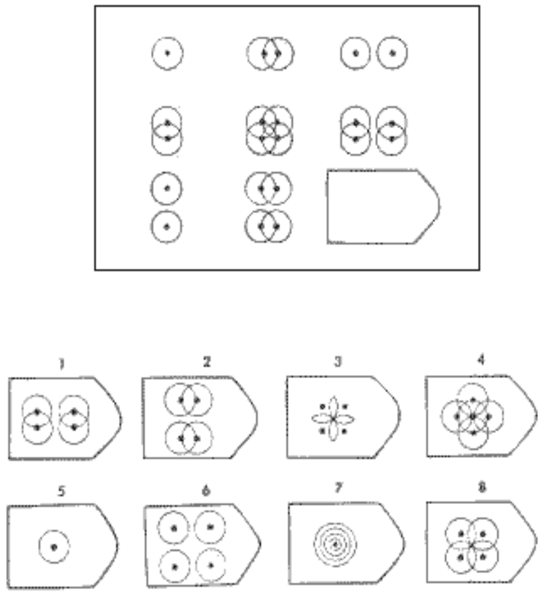

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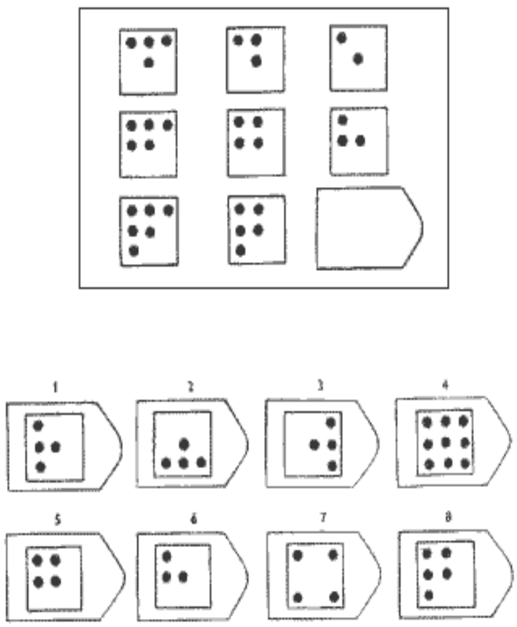

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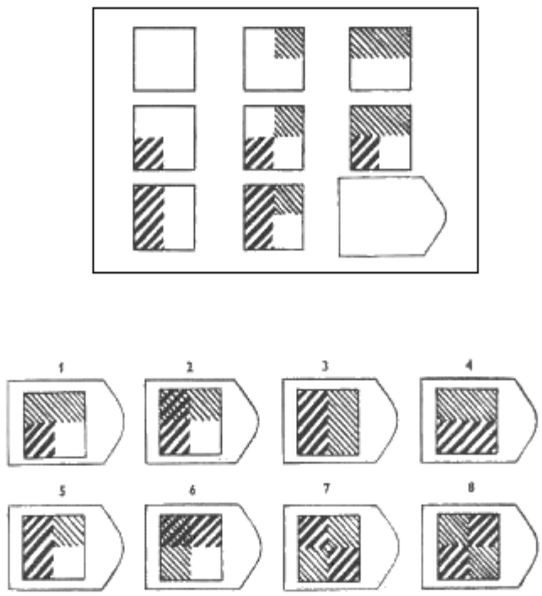

Figure B.1. Questions of Raven Test (cont.)

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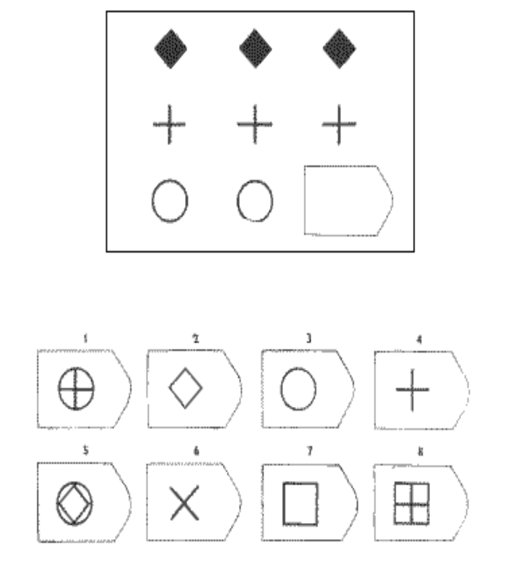

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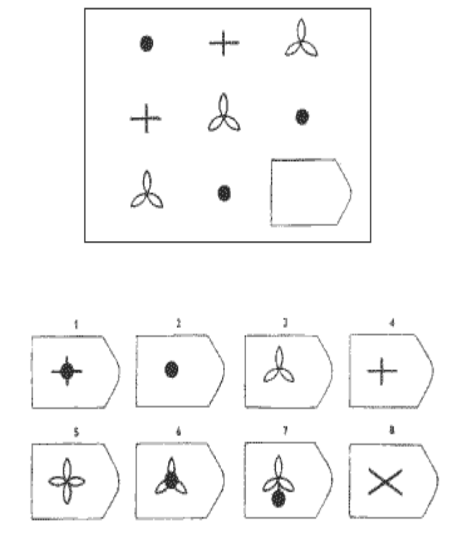

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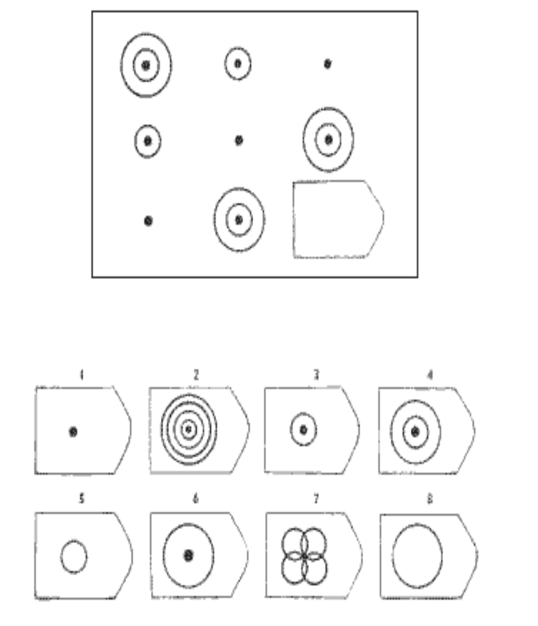

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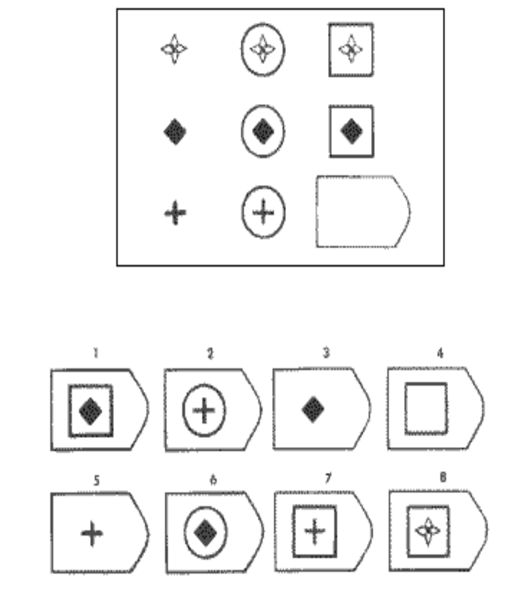

Figure B.1. Questions of Raven Test (cont.)

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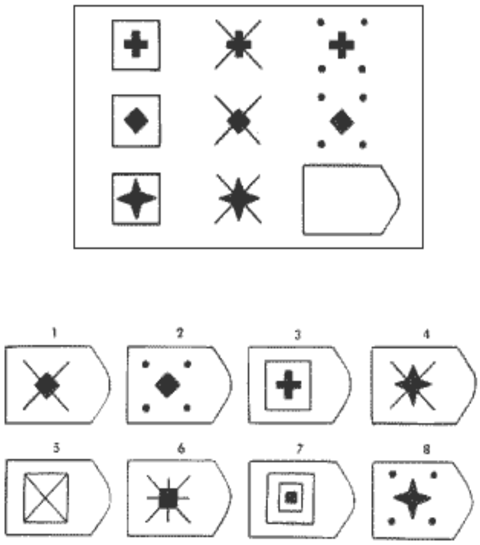

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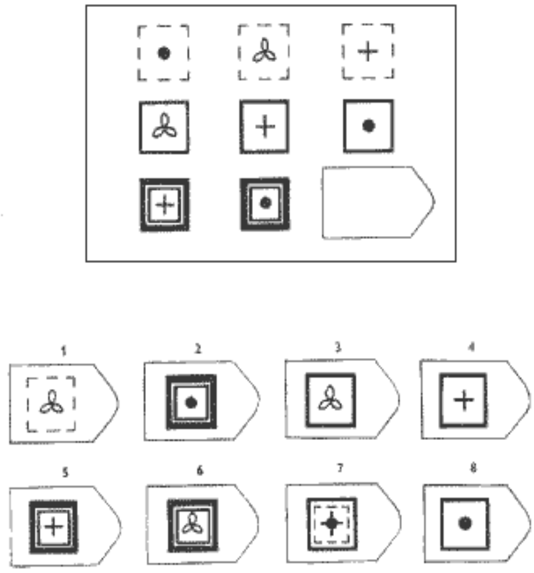

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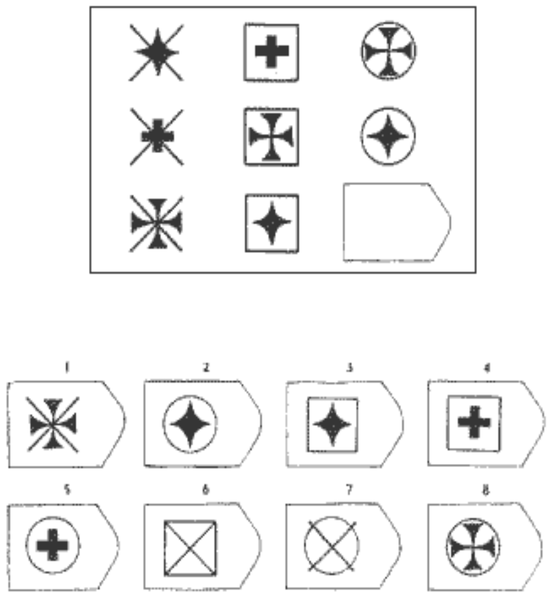

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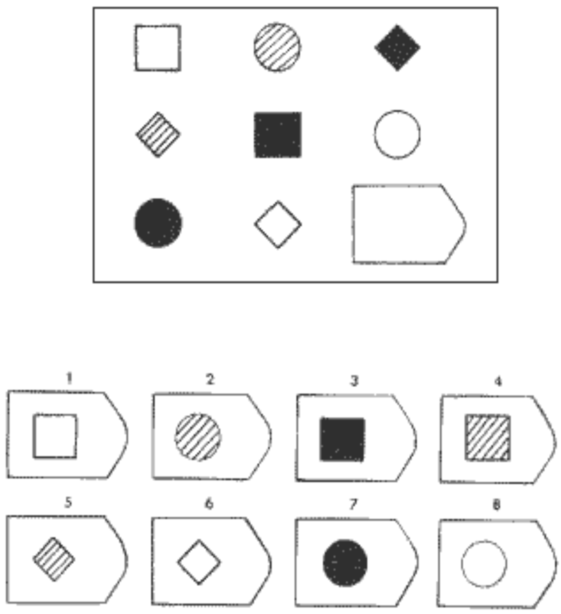

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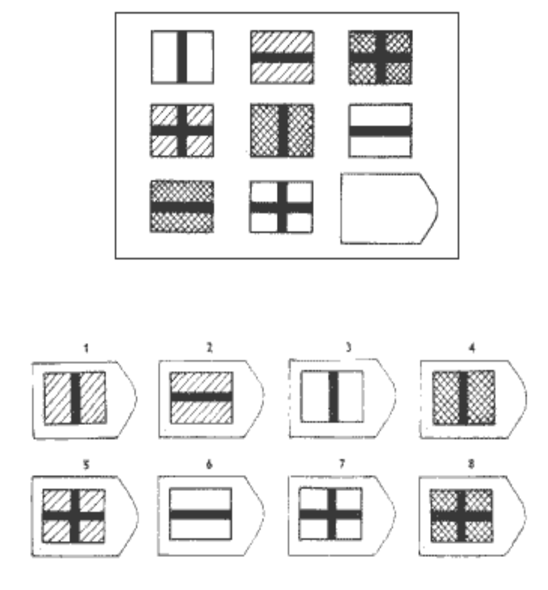

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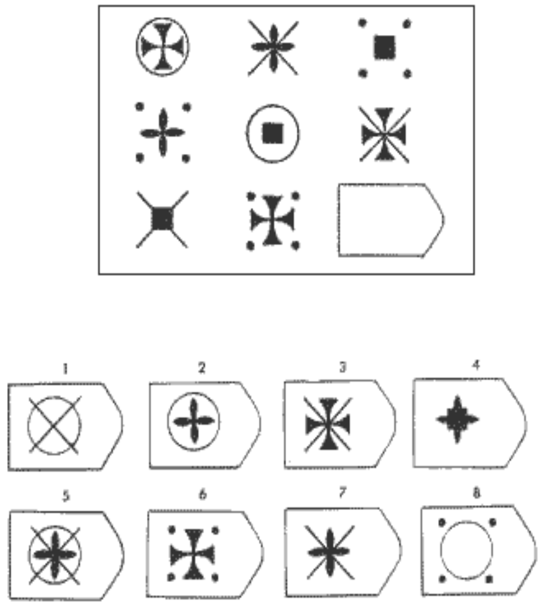

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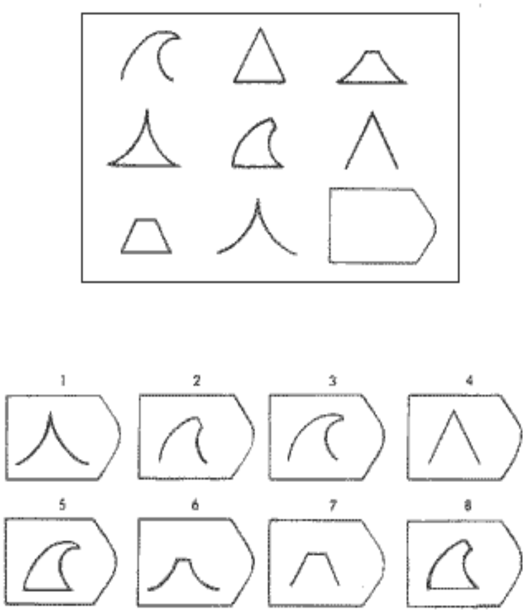

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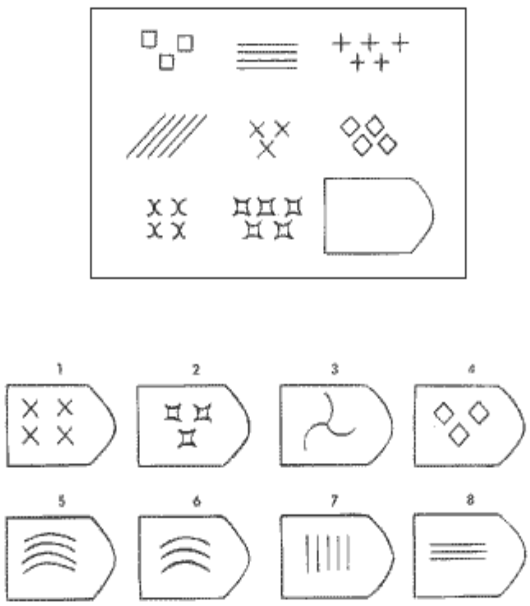
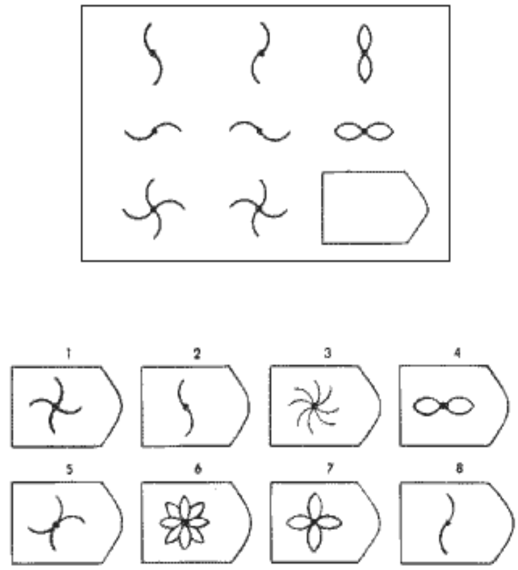


Figure B.1. Questions of Raven Test (cont.)

49



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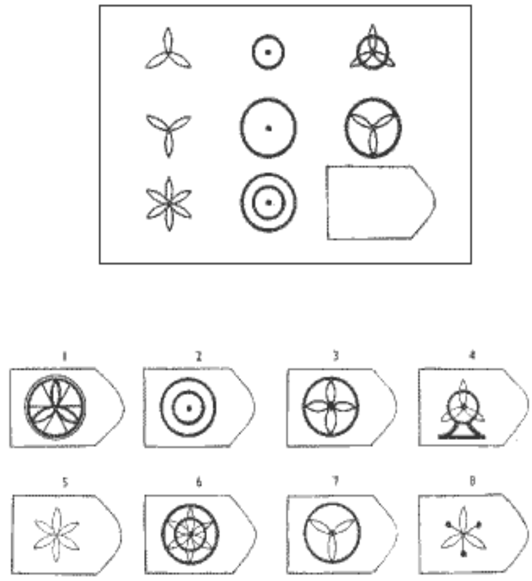

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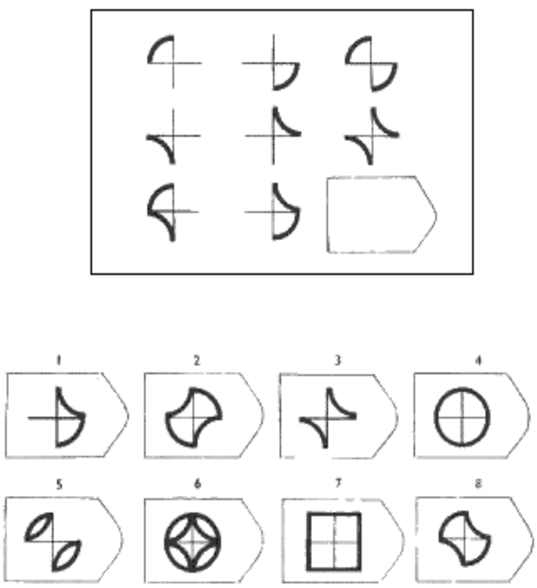

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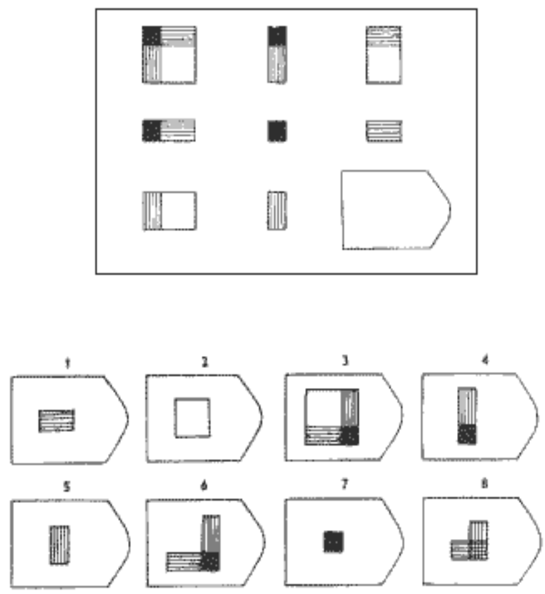
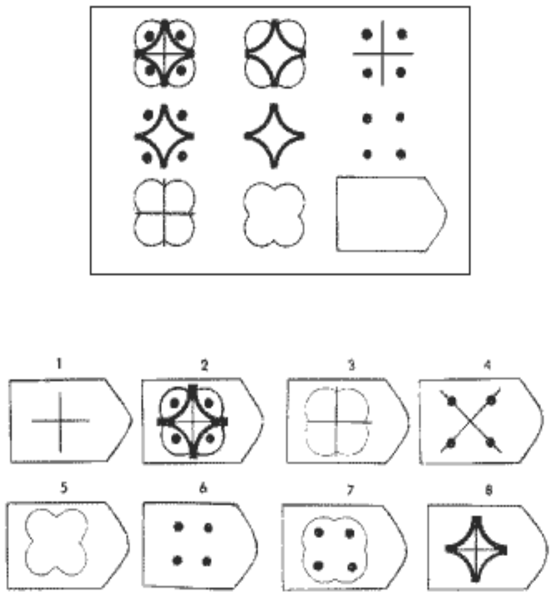


Figure B.1. Questions of Raven Test (cont.)

53



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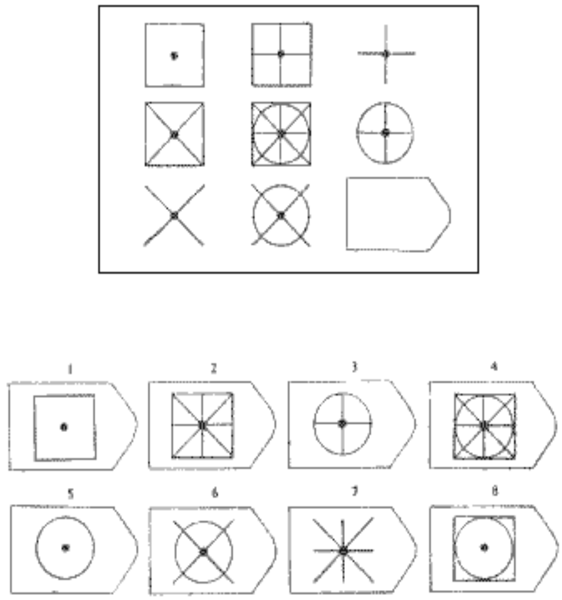

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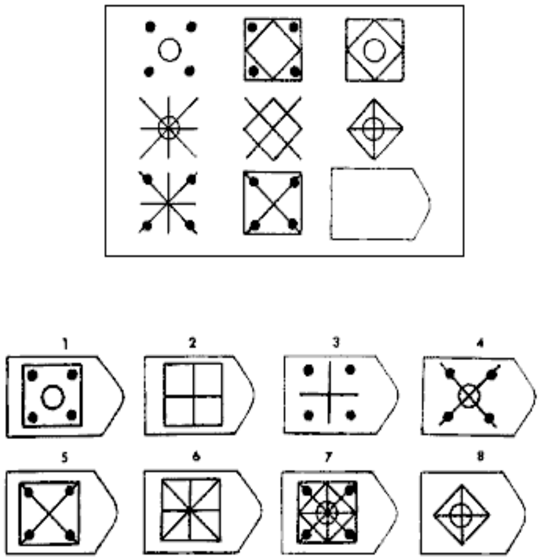

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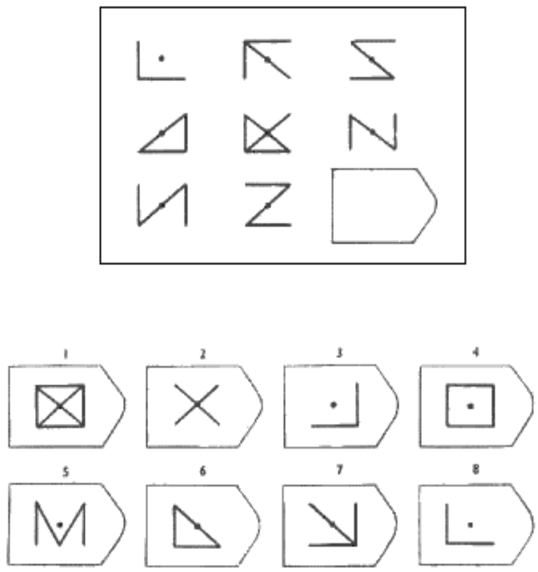
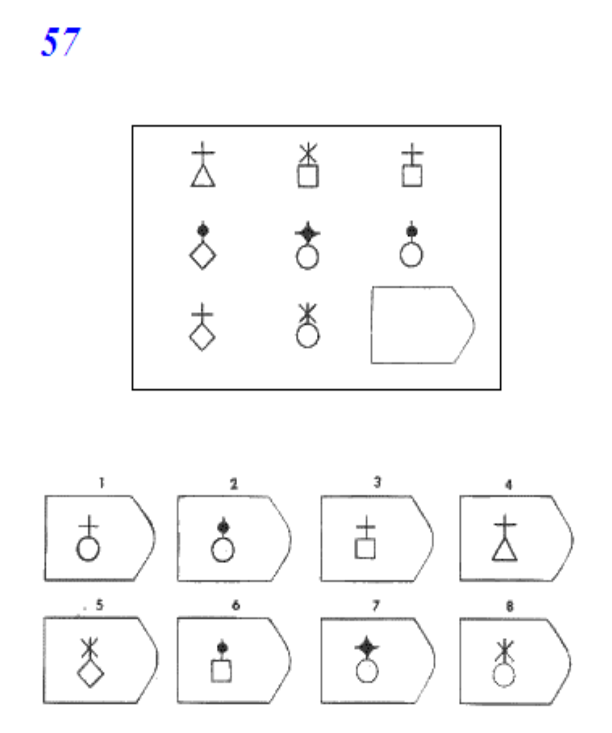
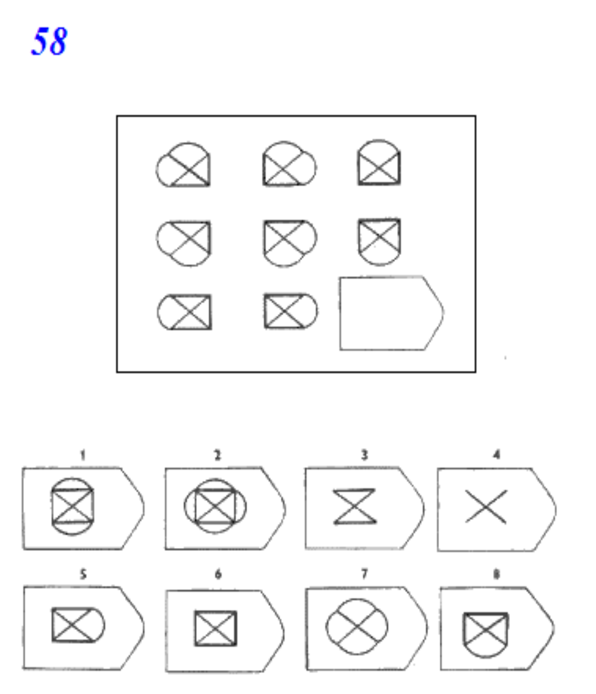
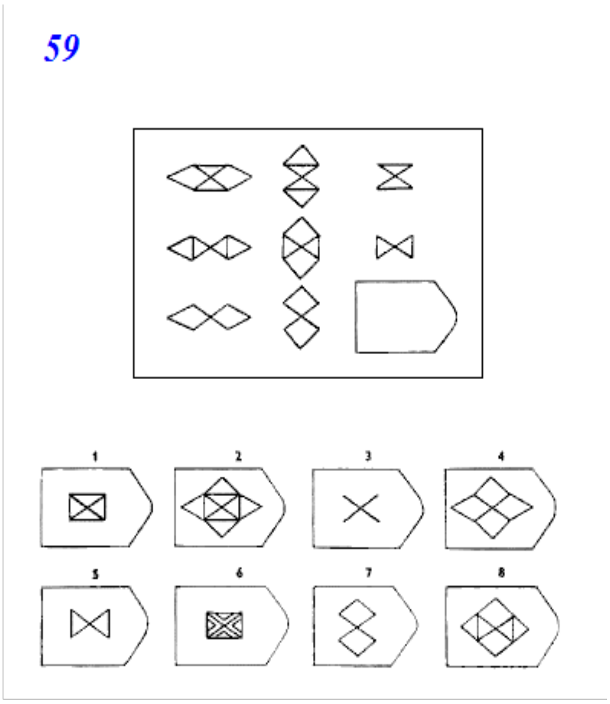


Figure B.1. Questions of Raven Test (cont.)







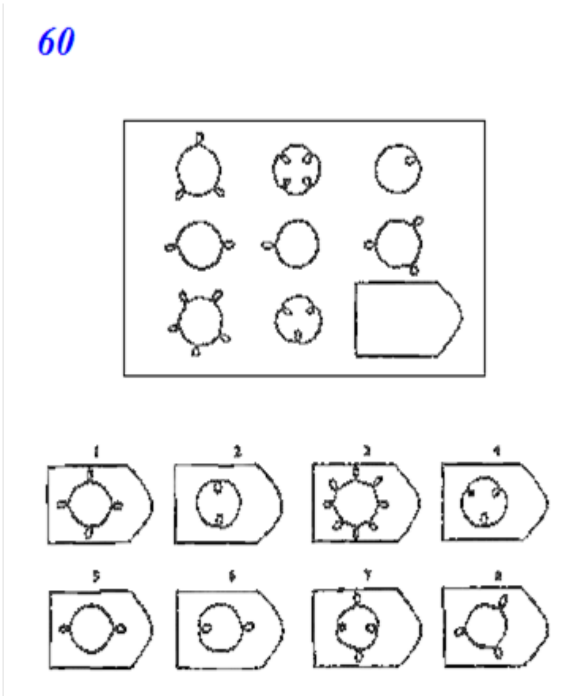


Figure B.1. Questions of Raven Test (cont.)

APPENDIX C: RESIDUAL PLOTS

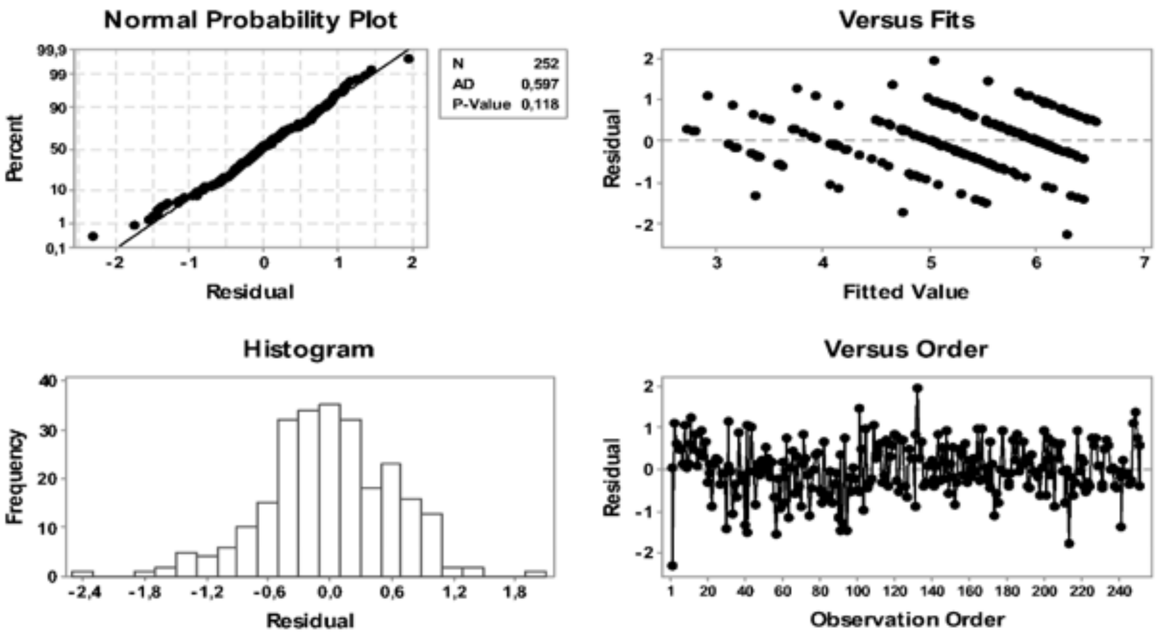


Figure C.1. Residual plots for Digit Forward Test Results

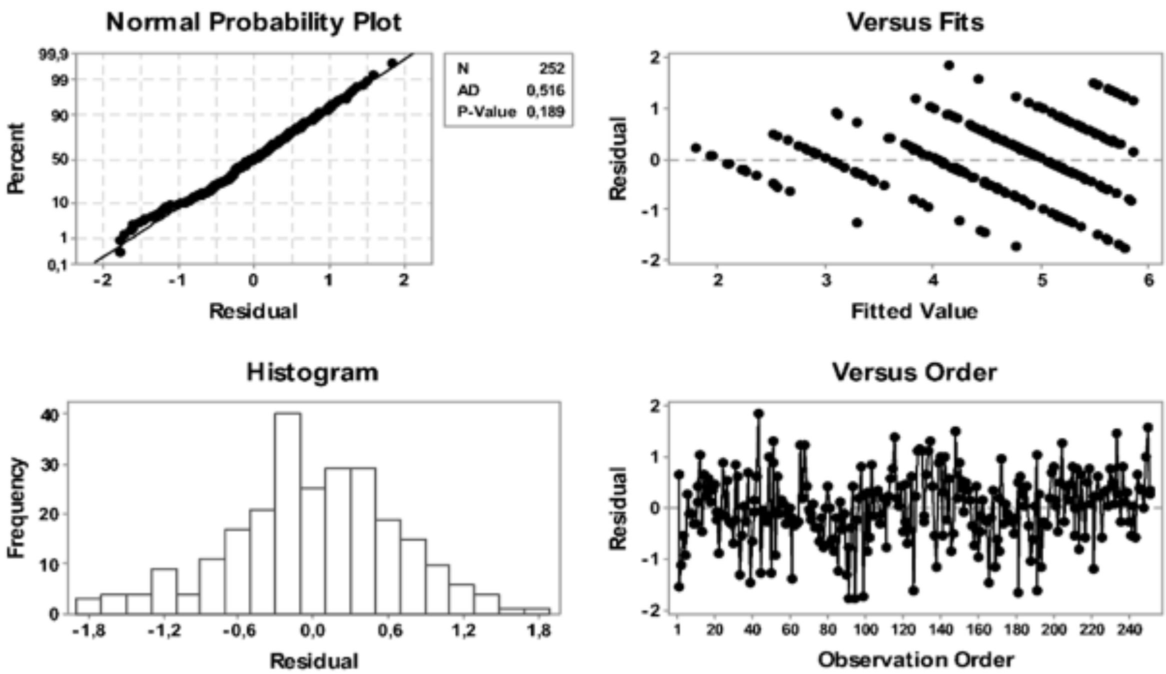


Figure C.2. Residual plots for Digit Backward Test Results

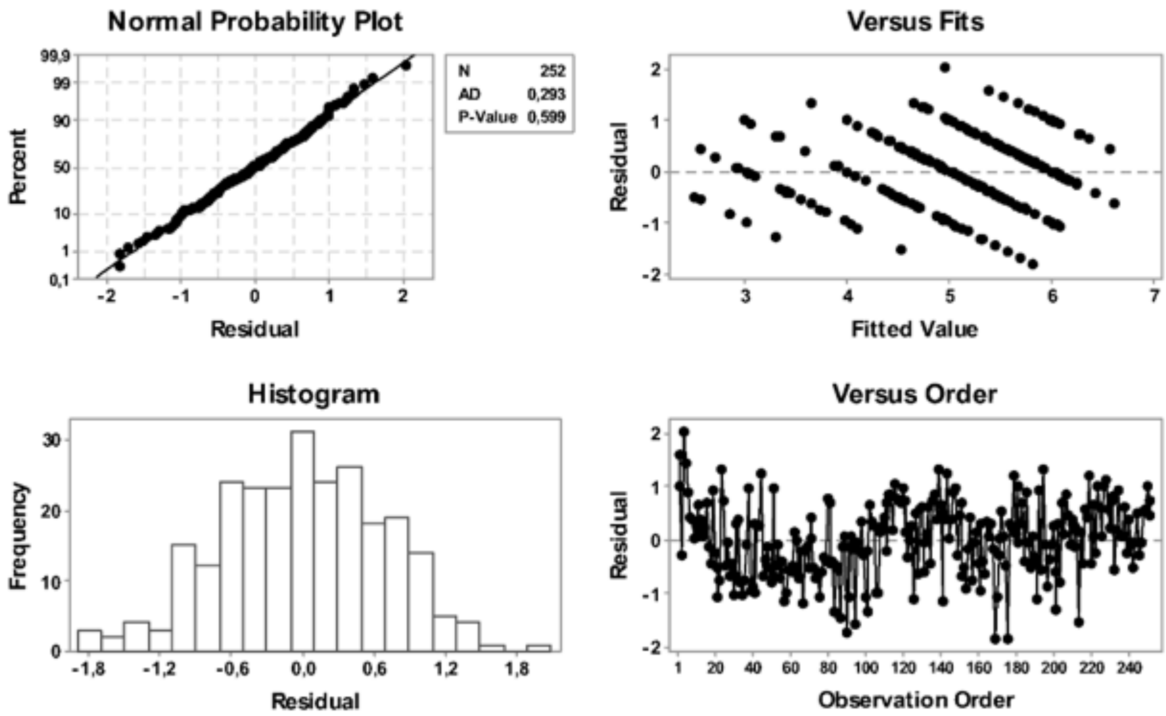


Figure C.3. Residual plots for Corsi Forward Test Results

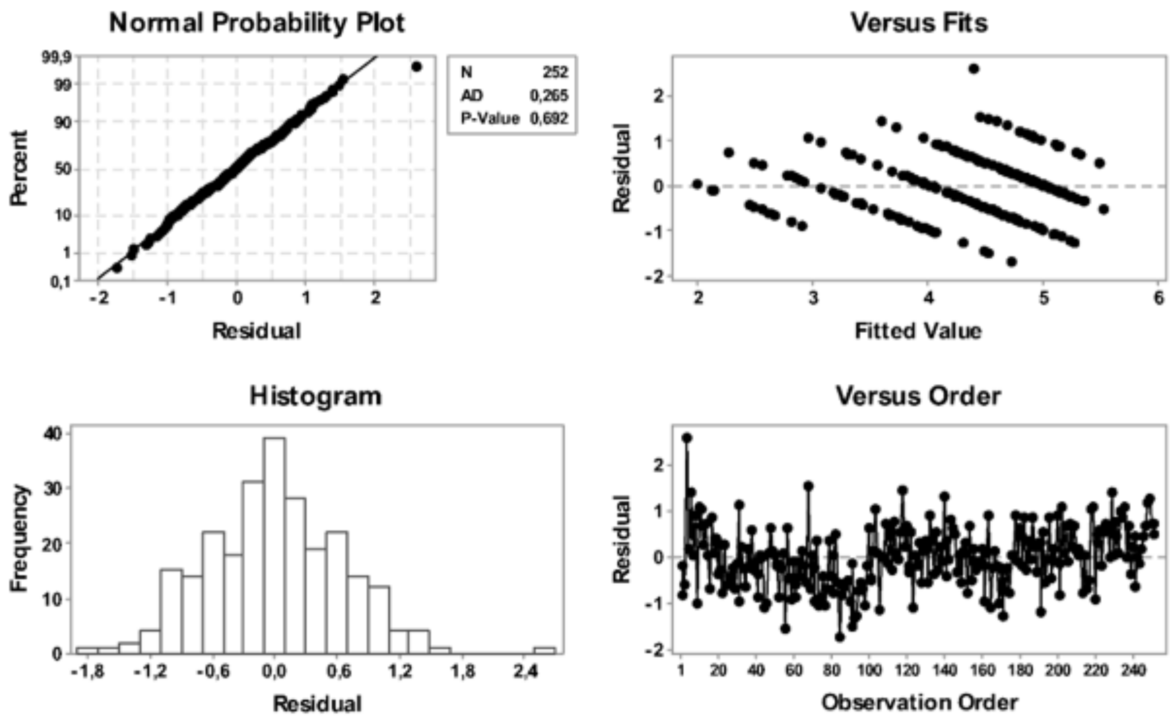


Figure C.4. Residual plots for Corsi Backward Test Results

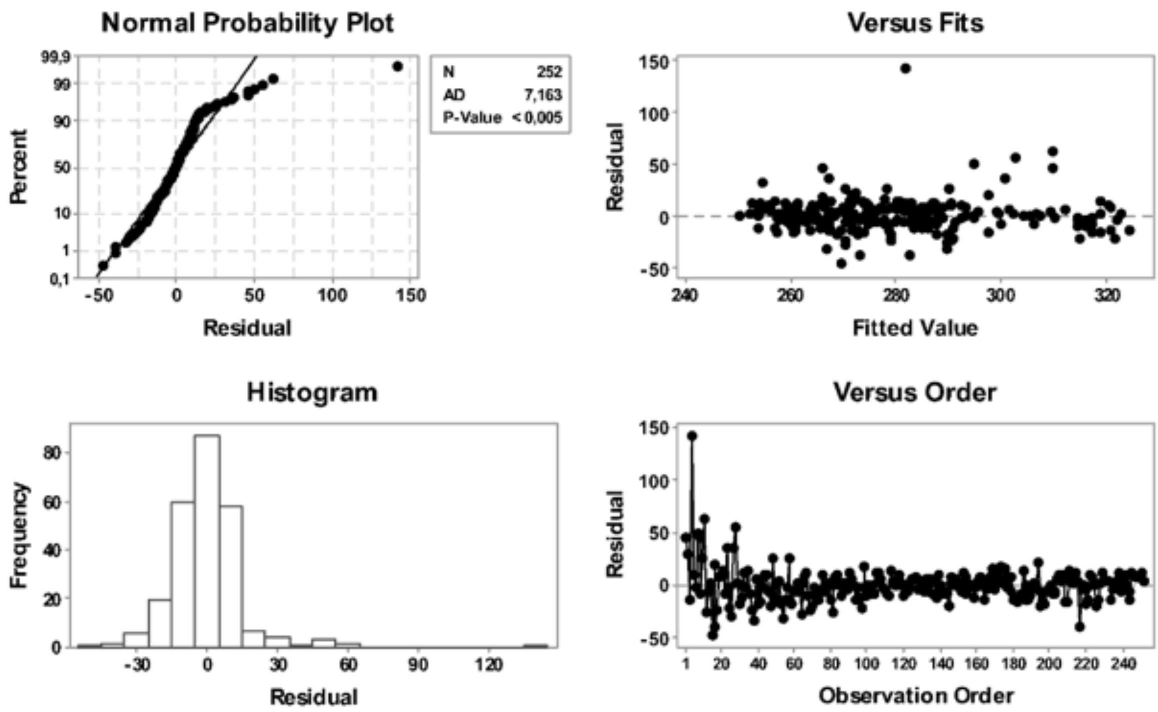


Figure C.5. Residual plots for Reaction Time Dominant Hand Results

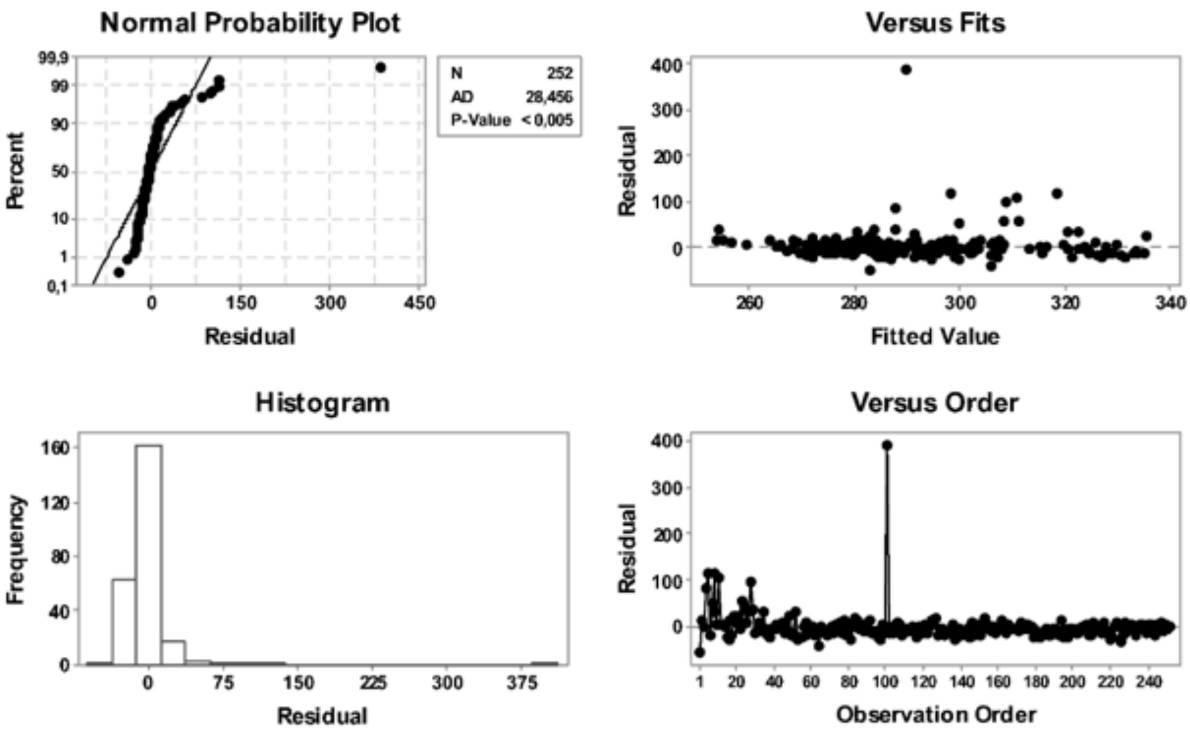


Figure C.6. Residual plots for Reaction Time Non Dominant Hand Results

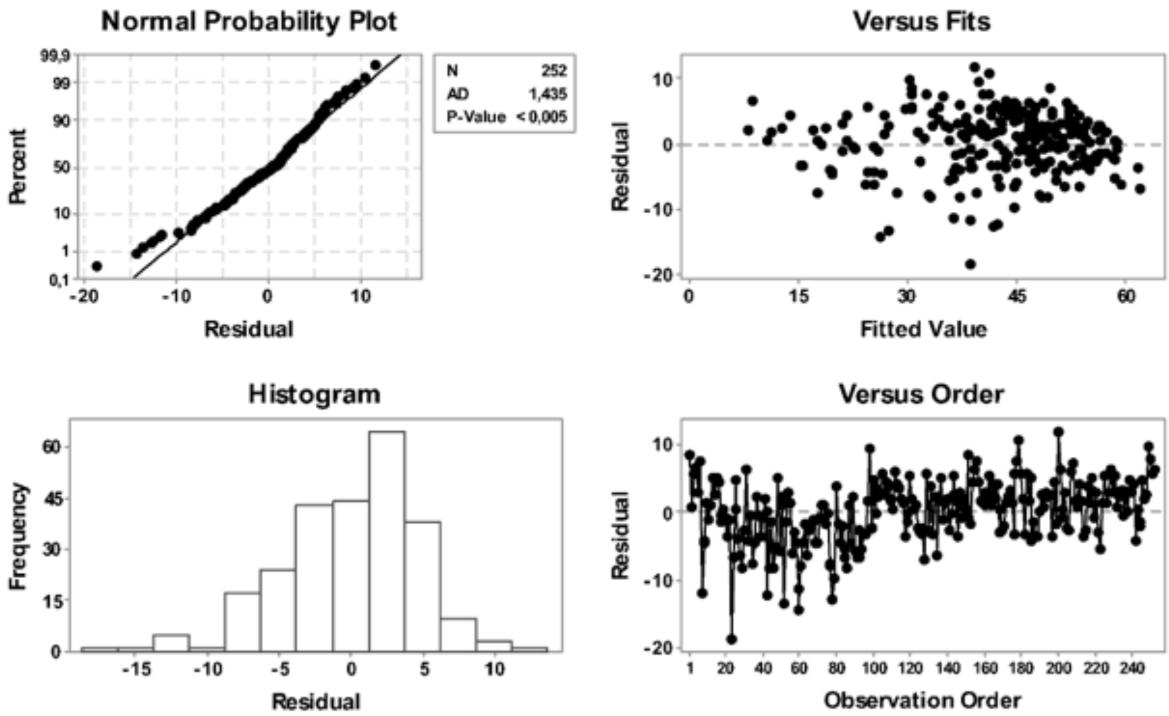


Figure C.7. Residual plots for Raven Test Results

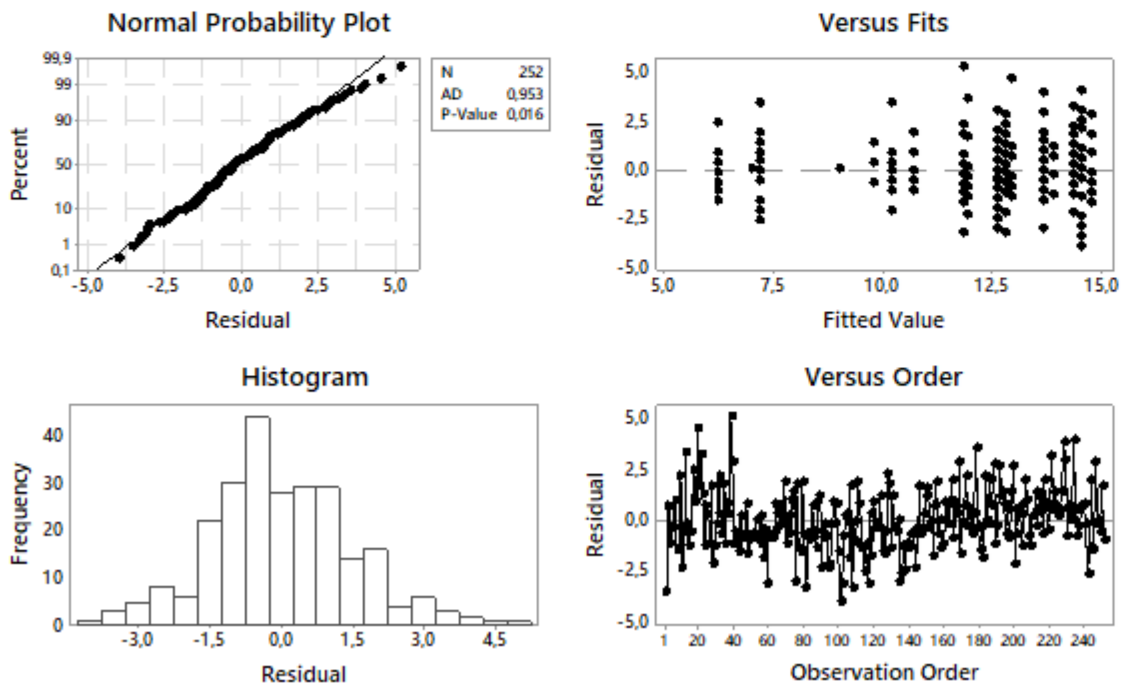


Figure C.8. Residual plots for Purdue Pegboard Dominant Hand Results

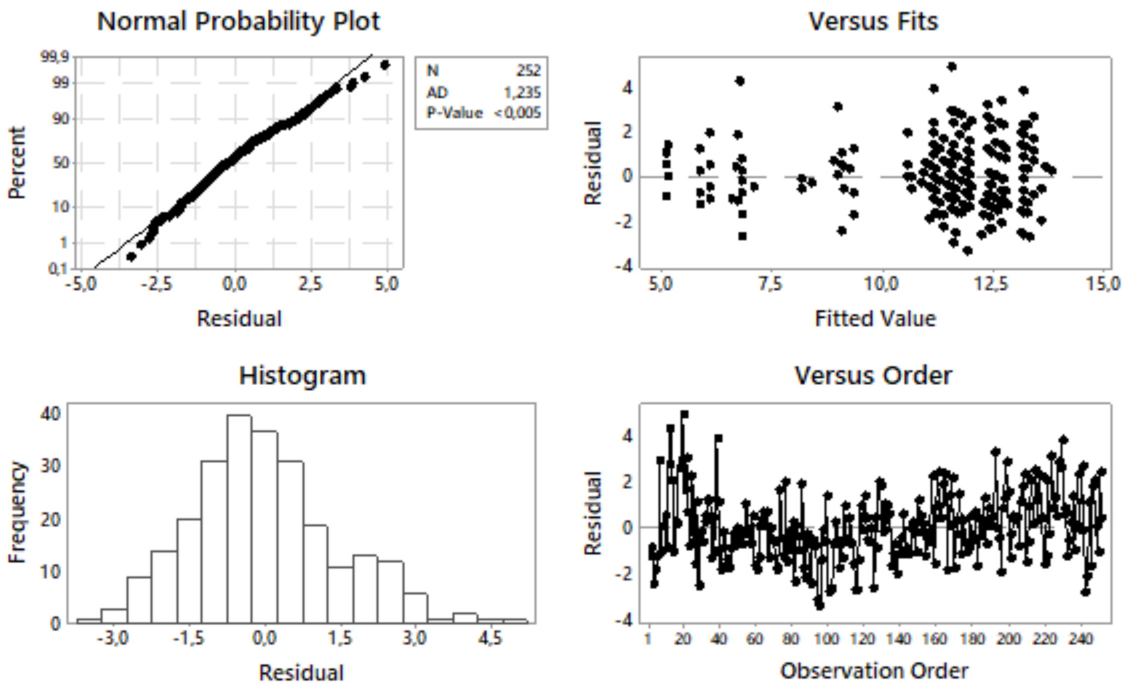


Figure C.9. Residual plots for Purdue Pegboard Non Dominant Hand Results

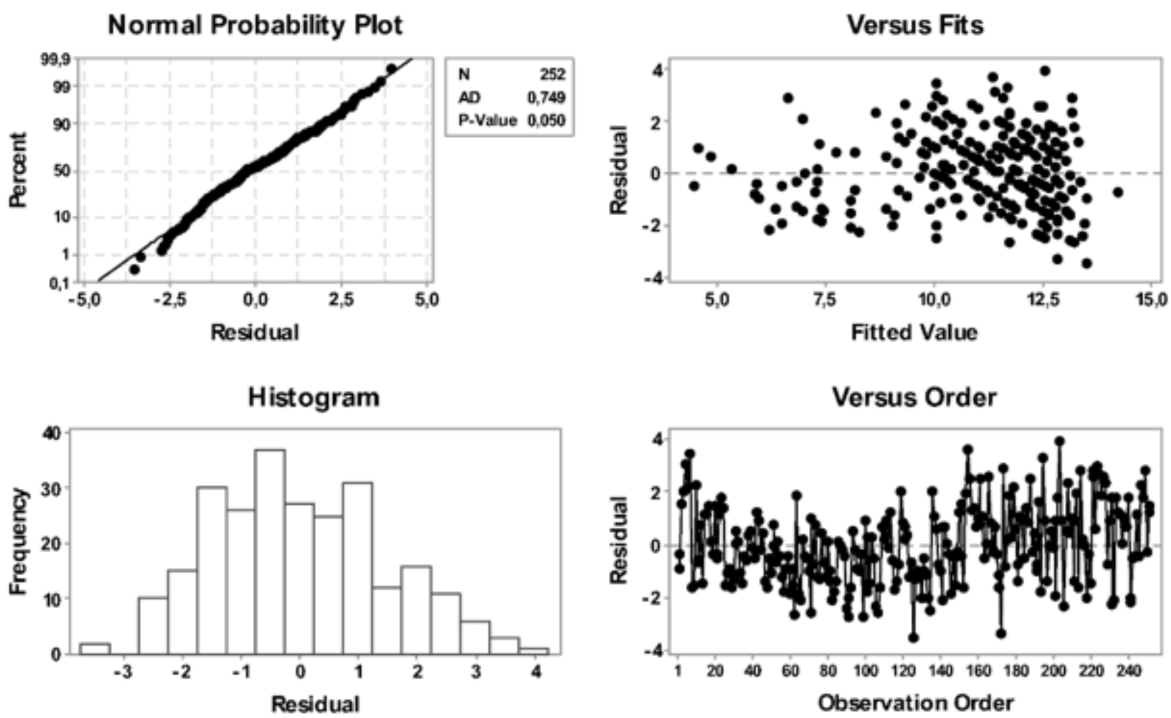


Figure C.10. Residual plots for Purdue Pegboard Both Hand Results

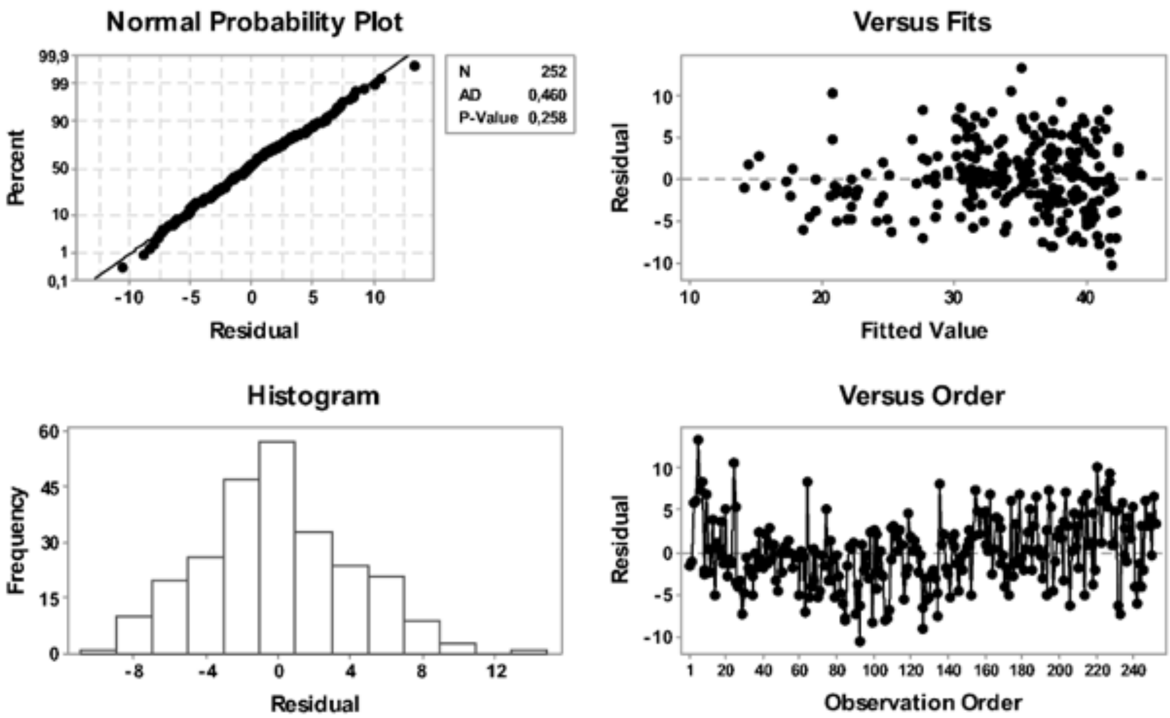


Figure C.11. Residual plots for Purdue Pegboard Total

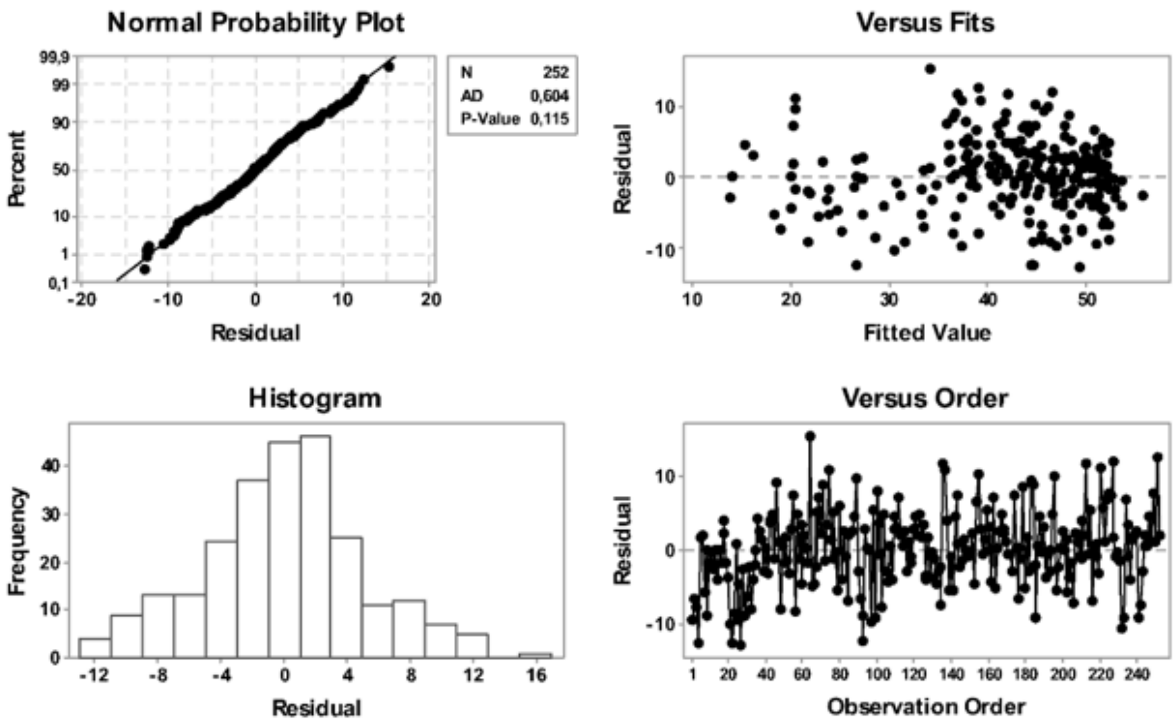


Figure C.12. Residual plots for Purdue Pegboard Assembly Results

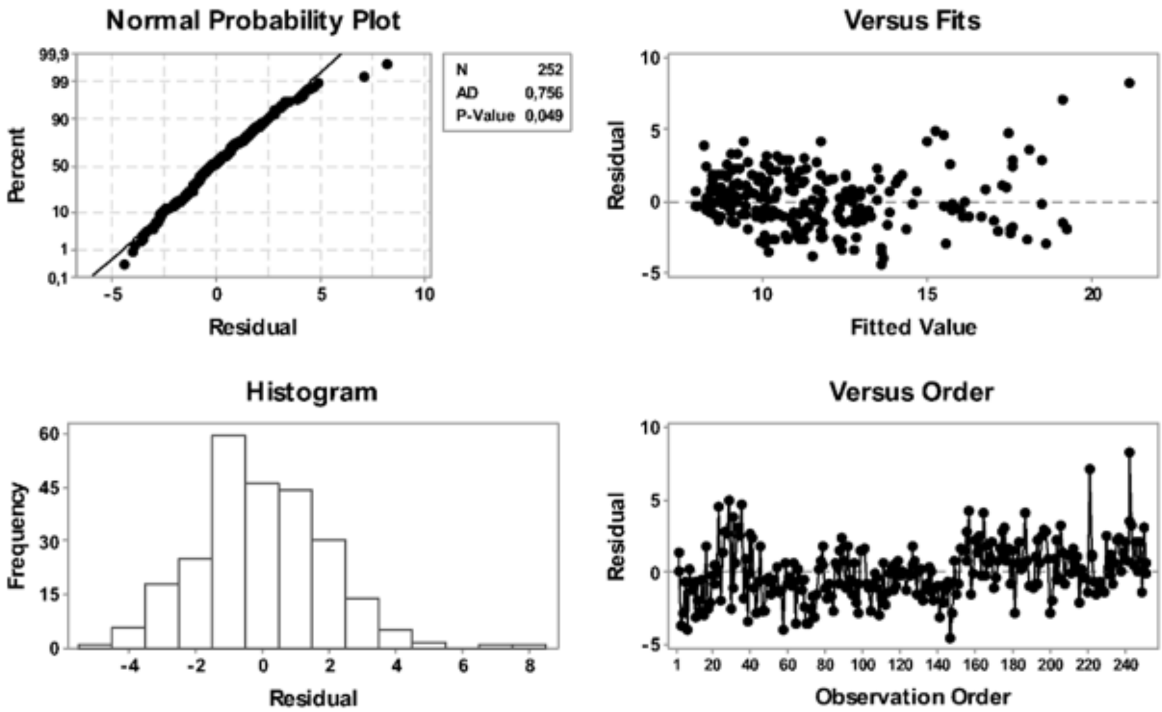


Figure C.13. Residual plots for Stroop Color Word Test Part I Results

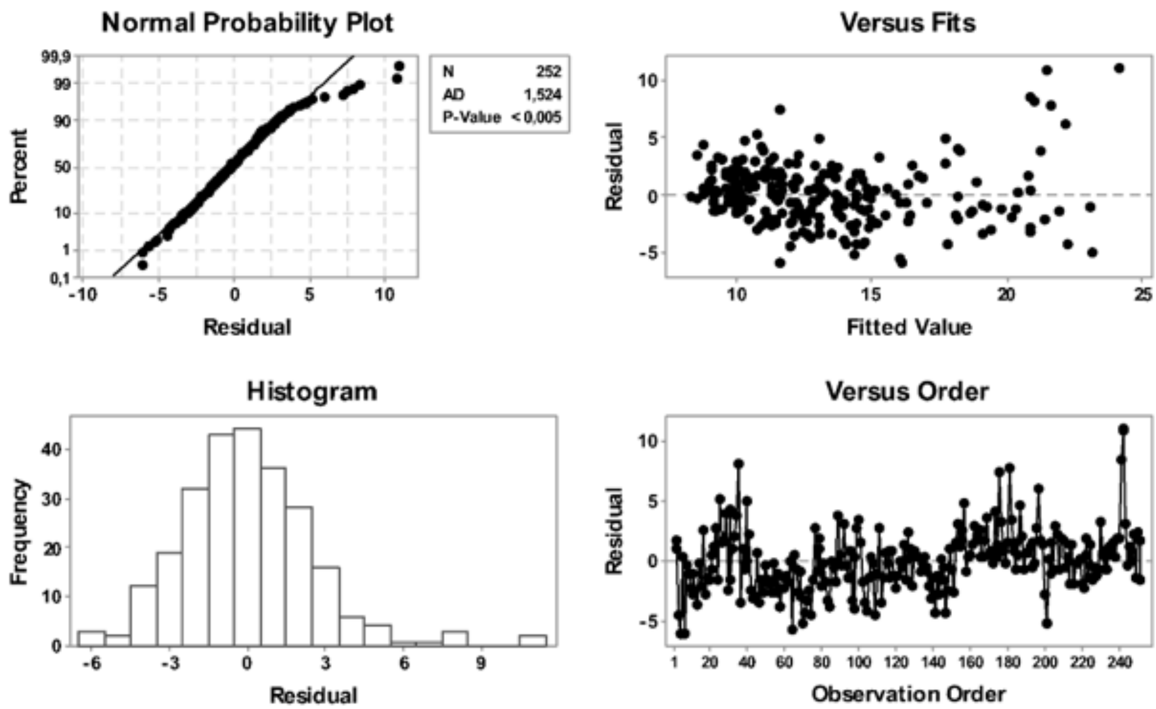


Figure C.14. Residual plots for Stroop Color Word Test Part II Results

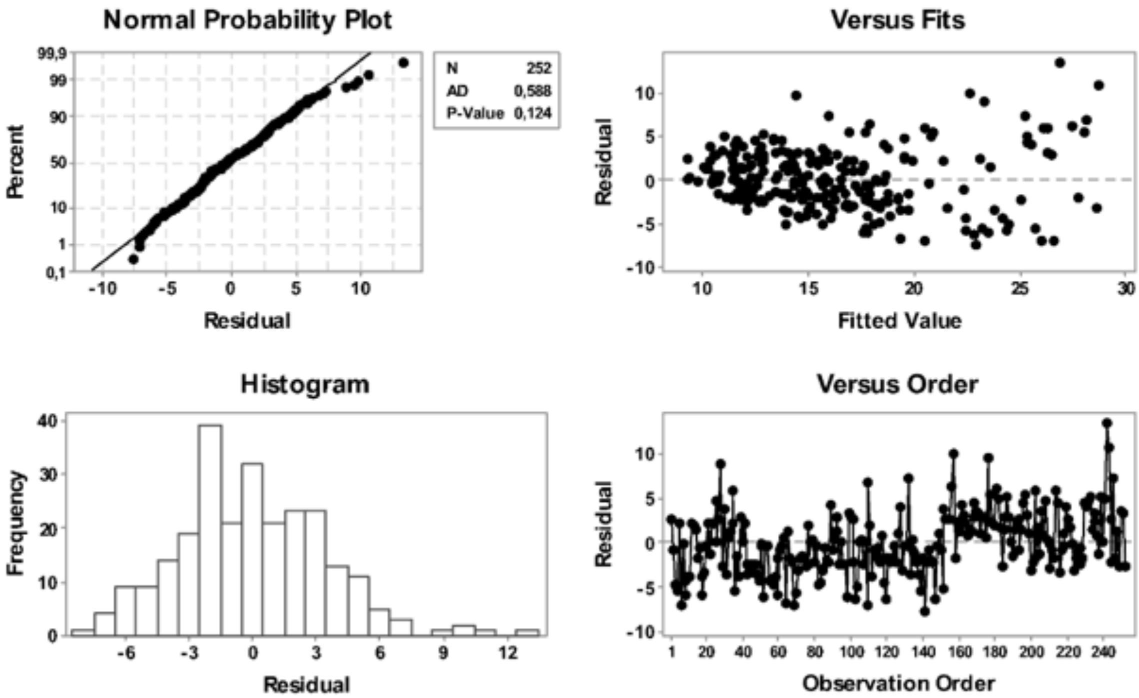


Figure C.15. Residual plots for Stroop Color Word Test Part III Results

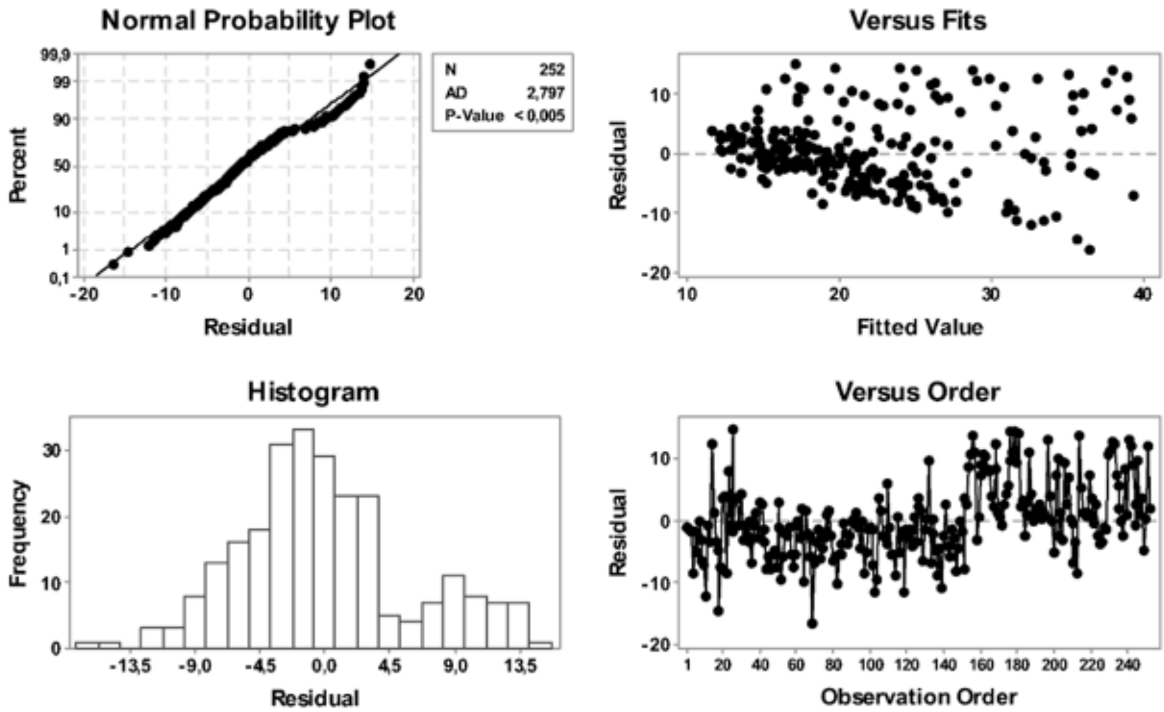


Figure C.16. Residual plots for Stroop Color Word Test Part IV Results

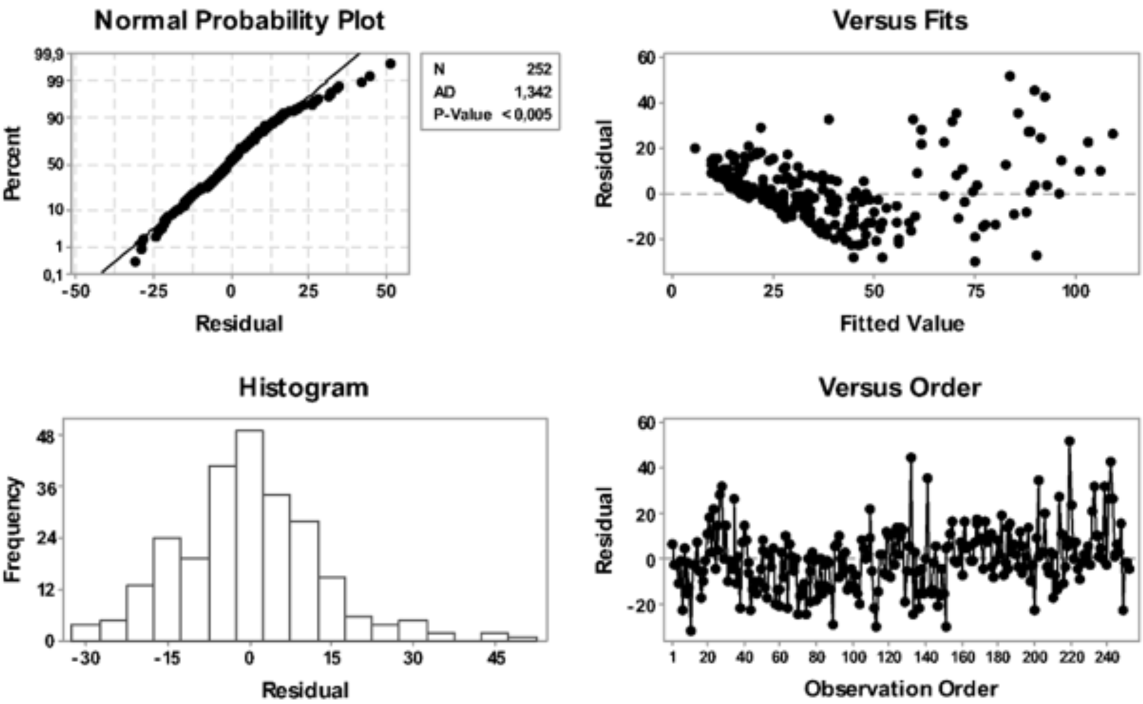


Figure C.17. Residual plots for Stroop Color Word Test Part V Results

APPENDIX D: TUKEY GROUPING TABLES

Table D.1. Tukey Test grouping results according to Age factor

Test	Grouping Information Using the Tukey Method and 95% Confidence			
	Factor	**N**	**Mean**	**Grouping**
Digit Forward	Age Group 1	51	6.08	A
	Age Group 2	50	5.82	A
	Age Group 3	51	5.71	A
	Age Group 4	50	5.02	B
	Age Group 5	16	4.87	B
	Age Group 6	34	3.55	C
Digit Backward	Age Group 2	51	5.24	A
	Age Group 1	50	5.16	A
	Age Group 3	51	5.00	A
	Age Group 4	50	4.34	B
	Age Group 5	16	3.69	C
	Age Group 6	34	2.71	D
Corsi Forward	Age Group 1	51	5.63	A
	Age Group 2	50	5.52	A, B
	Age Group 3	51	5.37	A, B
	Age Group 4	50	5.14	B
	Age Group 5	16	4.44	C
	Age Group 6	34	3.24	D
Corsi Backward	Age Group 1	51	4.83	A
	Age Group 2	50	4.78	A
	Age Group 3	51	4.67	A
	Age Group 4	50	4.18	B
	Age Group 5	16	3.88	B
	Age Group 6	34	2.77	C
Raven	Age Group 1	51	48.68	A
	Age Group 2	50	47.54	A
	Age Group 3	51	47.47	A
	Age Group 4	50	41.96	B
	Age Group 5	16	36.56	B
	Age Group 6	34	19.88	C
Purdue Pegboard Dominant Hand	Age Group 1	51	14.40	A
	Age Group 2	50	13.72	A
	Age Group 3	51	12.58	B
	Age Group 4	50	11.91	B
	Age Group 5	16	10.00	C
	Age Group 6	34	6.82	D

Table D.1. Tukey Test grouping results according to Age factor (cont.)

Test	**Grouping Information Using the Tukey Method and 95% Confidence**			
	Factor	**N**	**Mean**	**Grouping**
Purdue Pegboard Non-Dominant Hand	Age Group 1	51	13.04	A
	Age Group 2	50	12.34	A, B
	Age Group 3	51	11.65	B, C
	Age Group 4	50	11.20	C
	Age Group 5	16	8.94	D
	Age Group 6	34	6.22	E
Purdue Pegboard Both Hand	Age Group 1	51	12.42	A
	Age Group 2	50	12.16	A, B
	Age Group 3	51	11.59	B, C
	Age Group 4	50	11.11	C
	Age Group 5	16	9.34	D
	Age Group 6	34	6.26	E
Purdue Pegboard Total	Age Group 1	51	39.86	A
	Age Group 2	50	38.22	A
	Age Group 3	51	35.82	B
	Age Group 4	50	34.22	B
	Age Group 5	16	28.28	C
	Age Group 6	34	19.31	D
Purdue Pegboard Assembly	Age Group 1	51	50.27	A
	Age Group 2	50	47.48	A, B
	Age Group 3	51	45.19	B
	Age Group 4	50	41.70	C
	Age Group 5	16	32.72	D
	Age Group 6	34	20.94	E
Stroop Color Word Test 1	Age Group 6	34	17.46	A
	Age Group 5	16	13.56	B
	Age Group 4	50	11.94	B, C
	Age Group 3	51	10.93	C, D
	Age Group 2	50	9.92	D, E
	Age Group 1	51	9.06	E
Stroop Color Word Test 2	Age Group 6	34	20.75	A
	Age Group 5	16	15.37	B
	Age Group 4	50	13.57	B, C
	Age Group 3	51	12.02	C, D
	Age Group 2	50	11.12	D, E
	Age Group 1	51	10.11	E

Table D.1. Tukey Test grouping results according to Age factor (cont.)

Test	**Grouping Information Using the Tukey Method and 95% Confidence**			
	Factor	**N**	**Mean**	**Grouping**
Stroop Color Word Test 3	Age Group 6	34	25.44	A
	Age Group 5	16	19.79	B
	Age Group 4	50	16.90	B, C
	Age Group 3	51	14.91	C, D
	Age Group 2	50	13.28	D, E
	Age Group 1	51	12.05	E
Stroop Color Word Test 4	Age Group 6	34	35.87	A
	Age Group 5	16	26.90	B
	Age Group 4	50	23.15	B, C
	Age Group 3	51	19.83	C, D
	Age Group 2	50	17.69	D, E
	Age Group 1	51	15.26	E
Stroop Color Word Test 5	Age Group 6	34	94.63	A
	Age Group 5	16	47.07	B
	Age Group 4	50	34.80	C
	Age Group 3	51	28.37	C, D
	Age Group 2	50	25.36	D, E
	Age Group 1	51	20.89	E
Reaction Time Dominant Hand	Age Group 6	34	226.56	A
	Age Group 5	16	207.28	A
	Age Group 4	50	152.02	B
	Age Group 3	51	125.80	C
	Age Group 2	50	82.27	D
	Age Group 1	51	53.49	E
Reaction Time Non-Dominant Hand	Age Group 6	34	223.28	A
	Age Group 5	16	197.90	A
	Age Group 4	50	154.81	B
	Age Group 3	51	117.12	C
	Age Group 2	50	91.98	C
	Age Group 1	51	55.06	D

Table D.2. Tukey Test grouping results according to Education factor

Test	Grouping Information Using the Tukey Method and 95% Confidence			
	Factor	**N**	**Mean**	**Grouping**
Digit Forward	Education 4	60	6.02	A
	Education 3	99	5.64	B
	Education 2	81	4.71	C
	Education 1	12	3.42	D
Digit Backward	Education 4	60	5.35	A
	Education 3	99	4.82	B
	Education 2	81	3.97	C
	Education 1	12	2.33	D
Corsi Forward	Education 4	60	5.87	A
	Education 3	99	5.35	B
	Education 2	81	4.42	C
	Education 1	12	2.92	D
Corsi Backward	Education 4	60	4.97	A
	Education 3	99	4.57	B
	Education 2	81	3.78	C
	Education 1	12	2.58	D
Raven	Education 4	60	53.43	A
	Education 3	99	46.59	B
	Education 2	81	32.62	C
	Education 1	12	14.92	D
Purdue Pegboard Assembly	Education 4	60	46.6	A
	Education 3	99	45.06	A
	Education 2	81	37.91	B
	Education 1	12	19.58	C
Stroop Color Word Test 1	Education 1	12	19.19	A
	Education 2	81	12.74	B
	Education 3	99	10.78	C
	Education 4	60	9.89	C
Stroop Color Word Test 2	Education 1	12	24.55	A
	Education 2	81	14.37	B
	Education 3	99	12.09	C
	Education 4	60	10.99	C
Stroop Color Word Test 3	Education 1	12	29.69	A
	Education 2	81	17.63	B
	Education 3	99	14.93	C
	Education 4	60	13.38	C
Stroop Color Word Test 4	Education 1	12	39.79	A
	Education 2	81	23.93	B
	Education 3	99	20.2	C
	Education 4	60	17.76	C
Stroop Color Word Test 5	Education 1	12	102.01	A
	Education 2	81	46.73	B
	Education 3	99	30.13	C
	Education 4	60	24.98	C

Table D.3. Tukey Test grouping results according to Income factor

Test	Grouping Information Using the Tukey Method and 95% Confidence			
	Factor	**N**	**Mean**	**Grouping**
Digit Forward	High Income	54	5.89	A
	Medium Income	143	5.30	B
	Low Income	55	4.84	C
Digit Backward	High Income	54	5.22	A
	Medium Income	143	4.52	B
	Low Income	55	4.00	C
Raven	High Income	54	53.28	A
	Medium Income	143	41.43	B
	Low Income	55	33.42	C

APPENDIX E: SCATTER PLOTS of RESPONSE VARIABLES

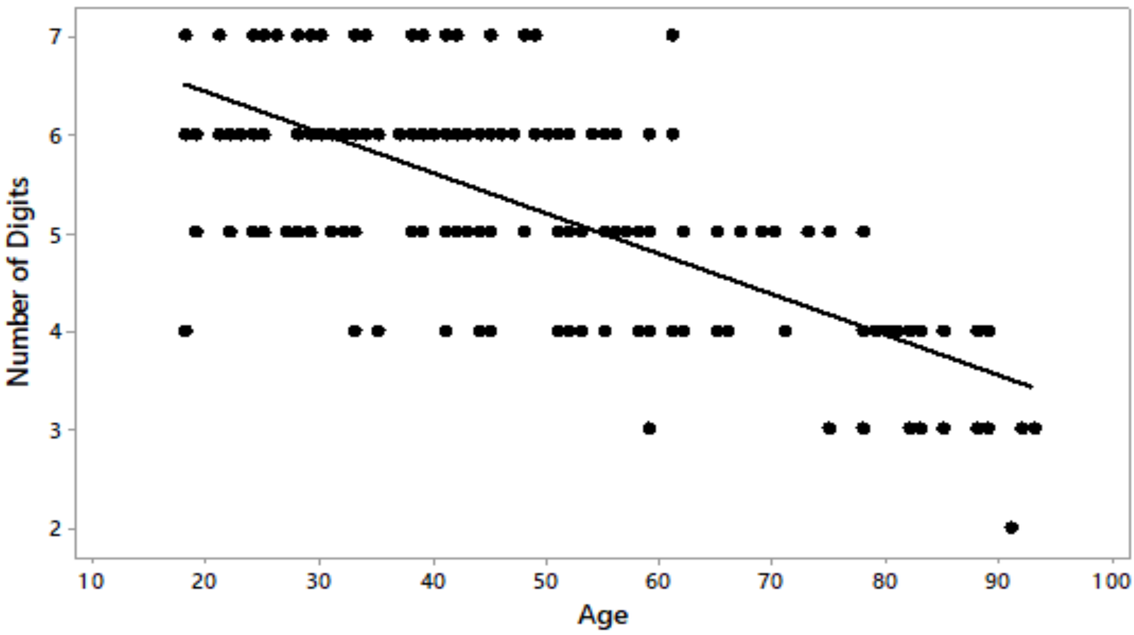


Figure E.1. Scatterplot of Digit Span Forward vs Age

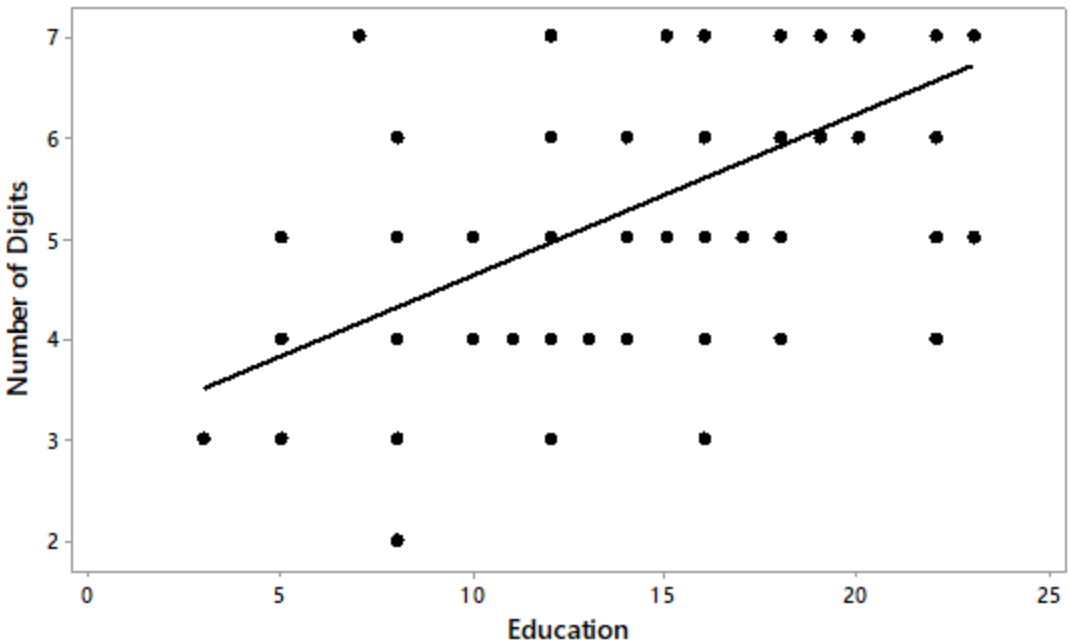


Figure E.2. Scatterplot of Digit Span Forward vs Education

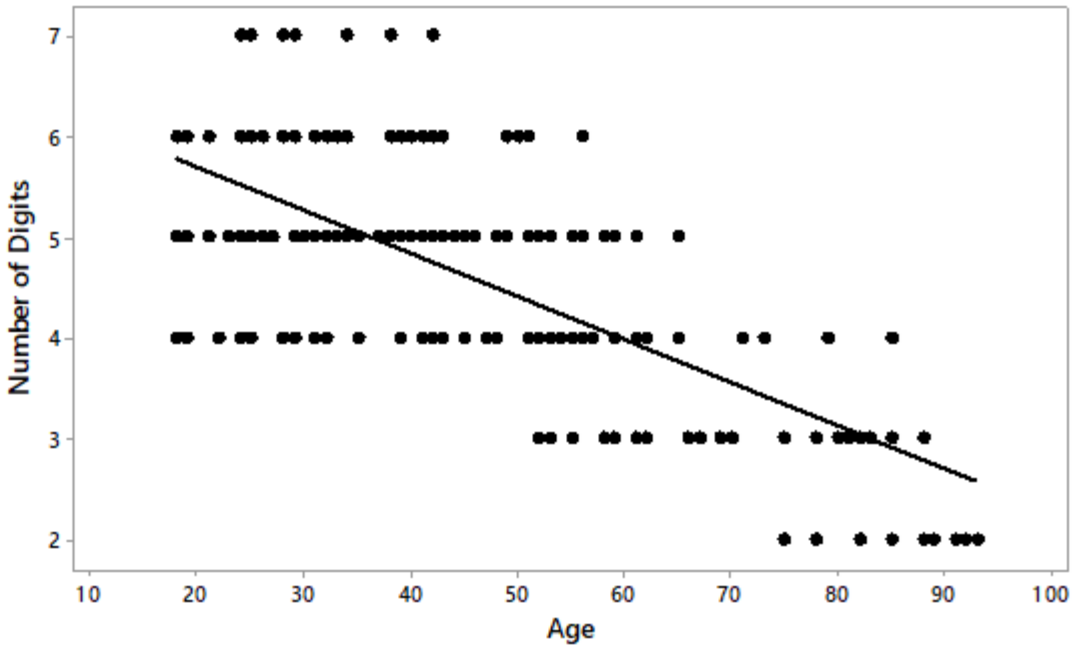


Figure E.3. Scatterplot of Digit Span Backward vs Age

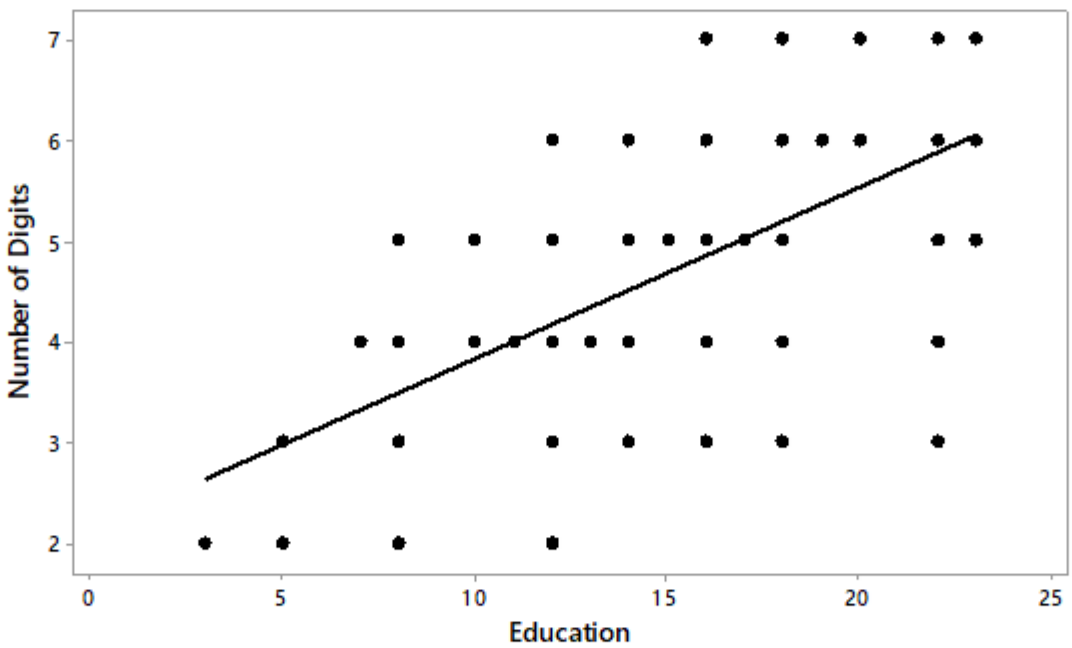


Figure E.4. Scatterplot of Digit Span Backward vs Education

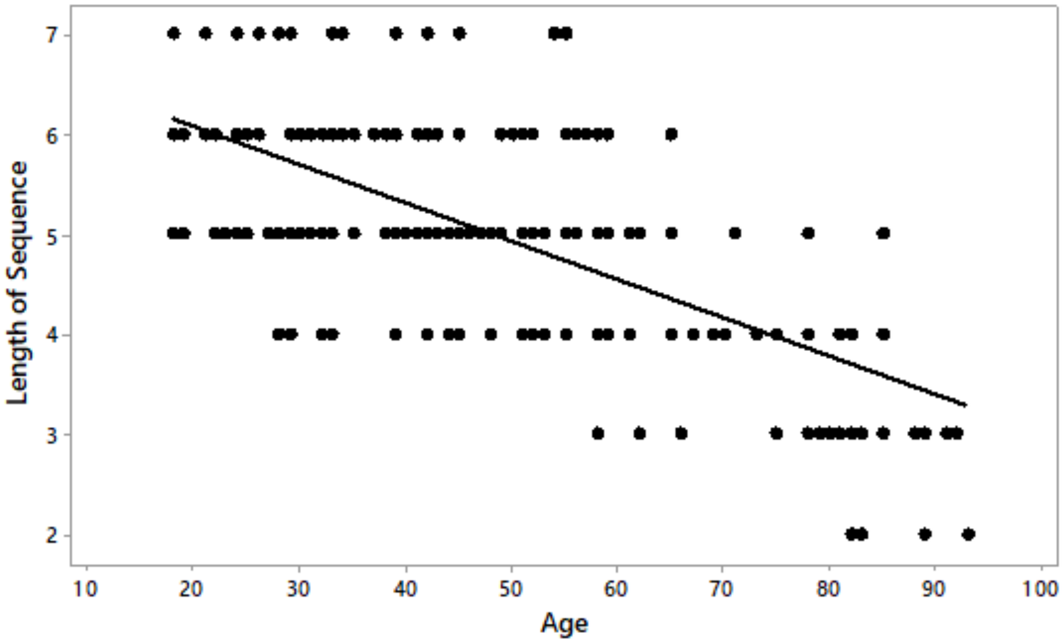


Figure E.5. Scatterplot of Corsi Span Forward vs Age

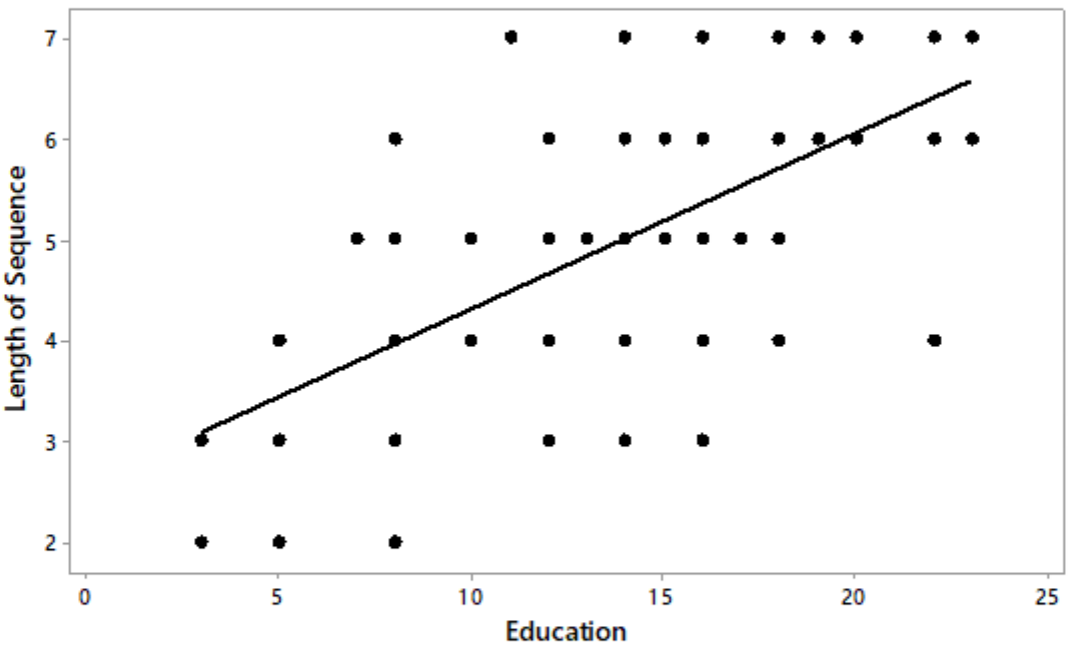


Figure E.6. Scatterplot of Corsi Span Forward vs Education

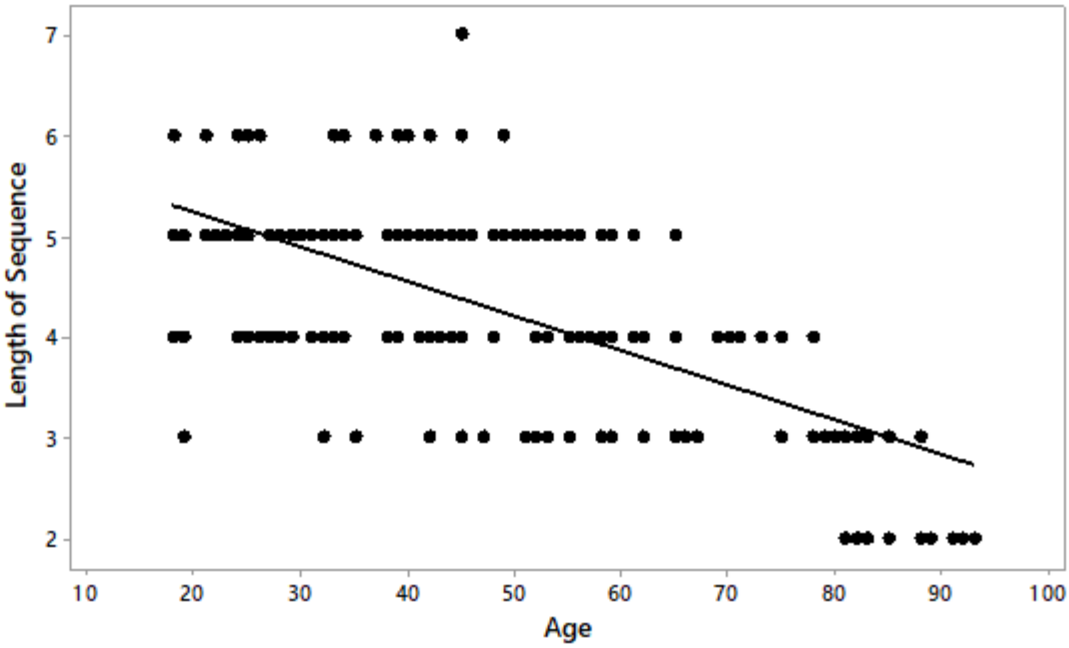


Figure E.7. Scatterplot of Corsi Span Backward vs Age

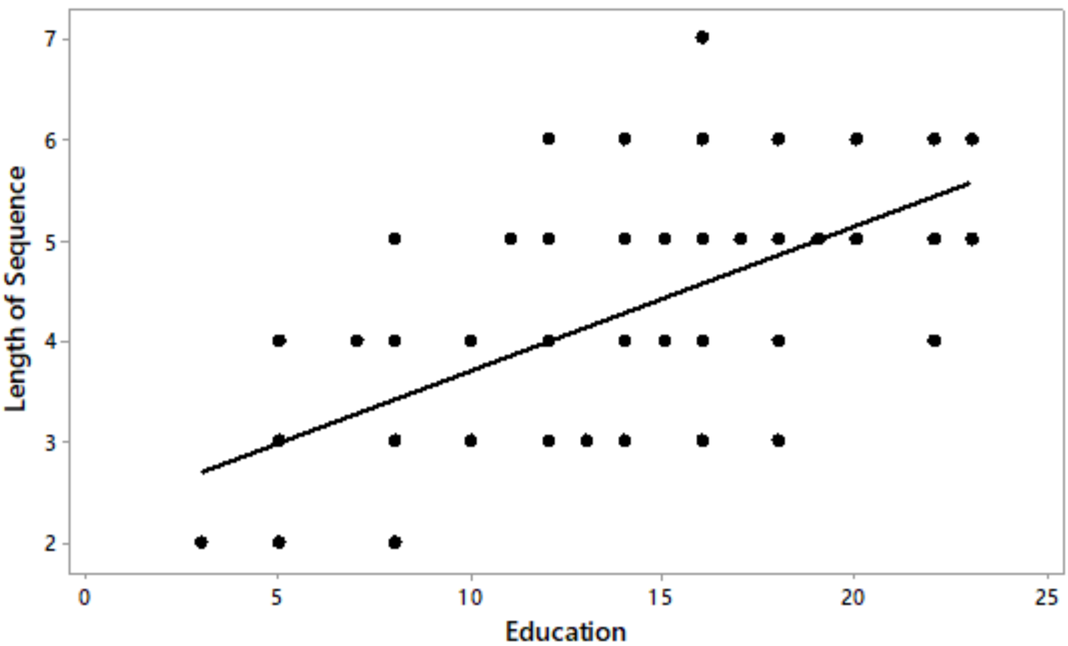


Figure E.8. Scatterplot of Corsi Span Backward vs Education

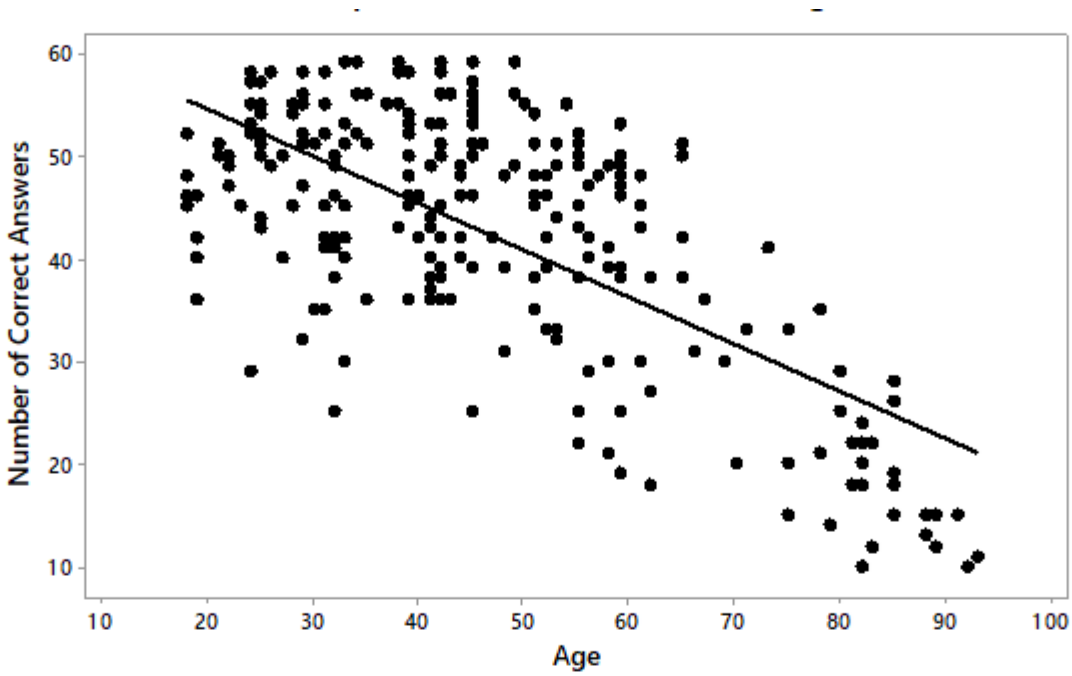


Figure E.9. Scatterplot of Raven Test vs Age

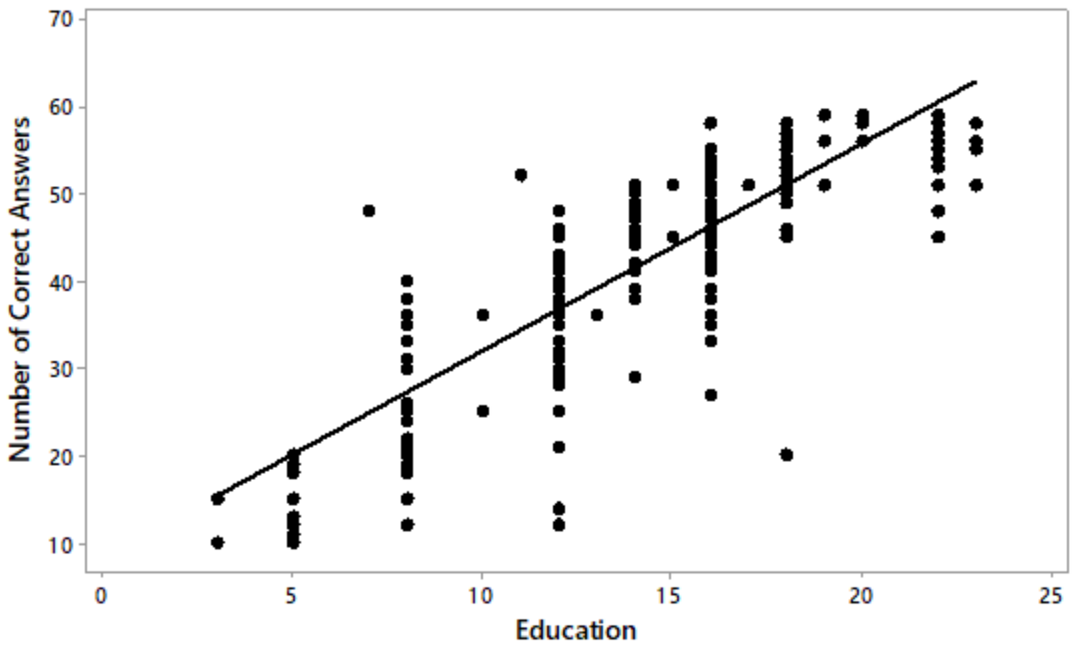


Figure E.10. Scatterplot of Raven Test vs Education

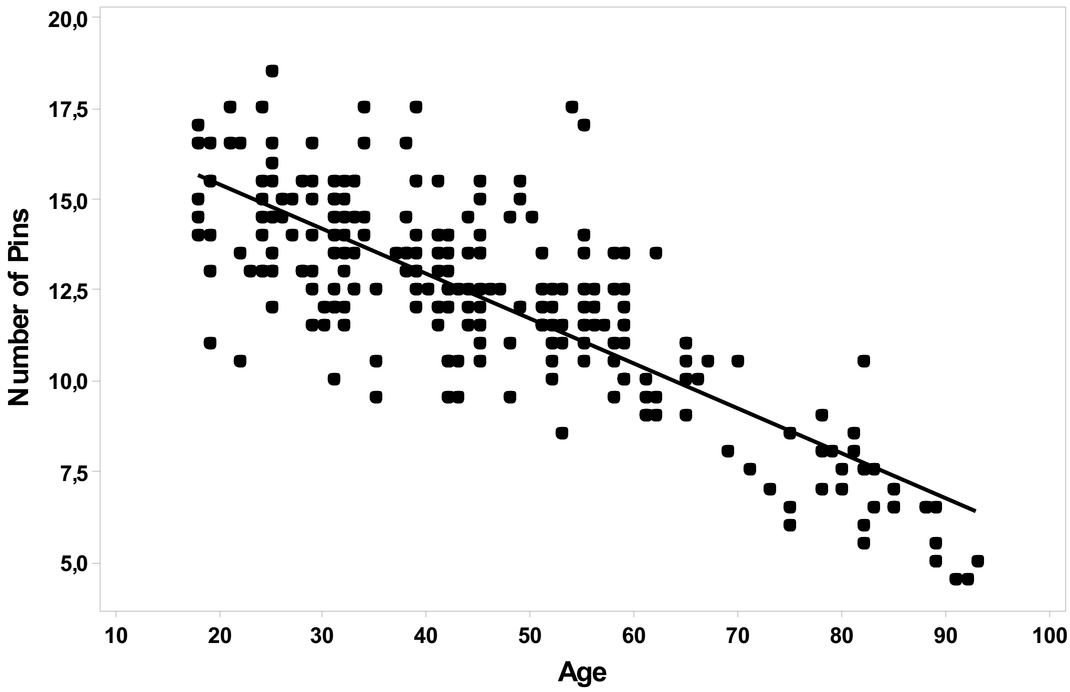


Figure E.11. Scatterplot of Purdue Pegboard Dominant Hand vs Age

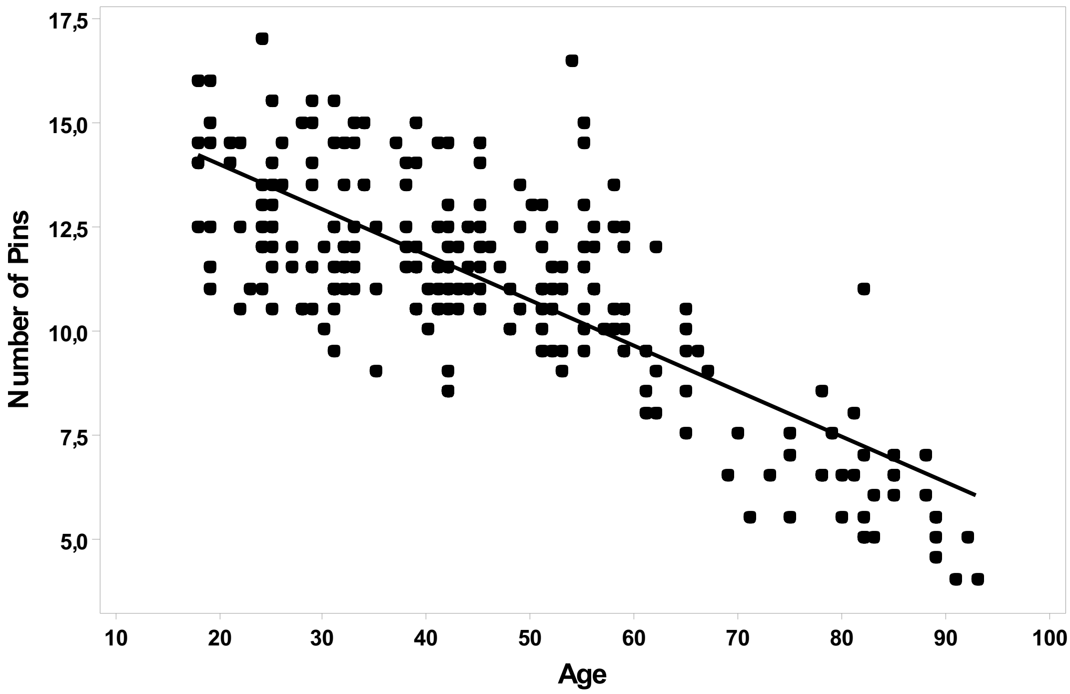


Figure E.12. Scatterplot of Purdue Pegboard Non-Dominant Hand vs Age

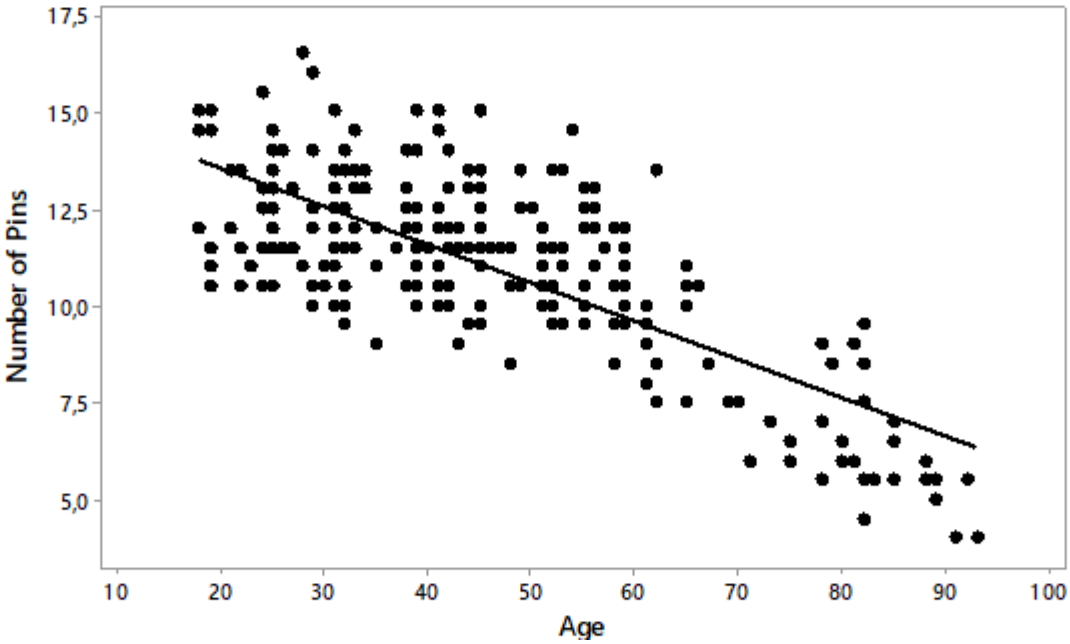


Figure E.13. Scatterplot of Purdue Pegboard Both Hand vs Age

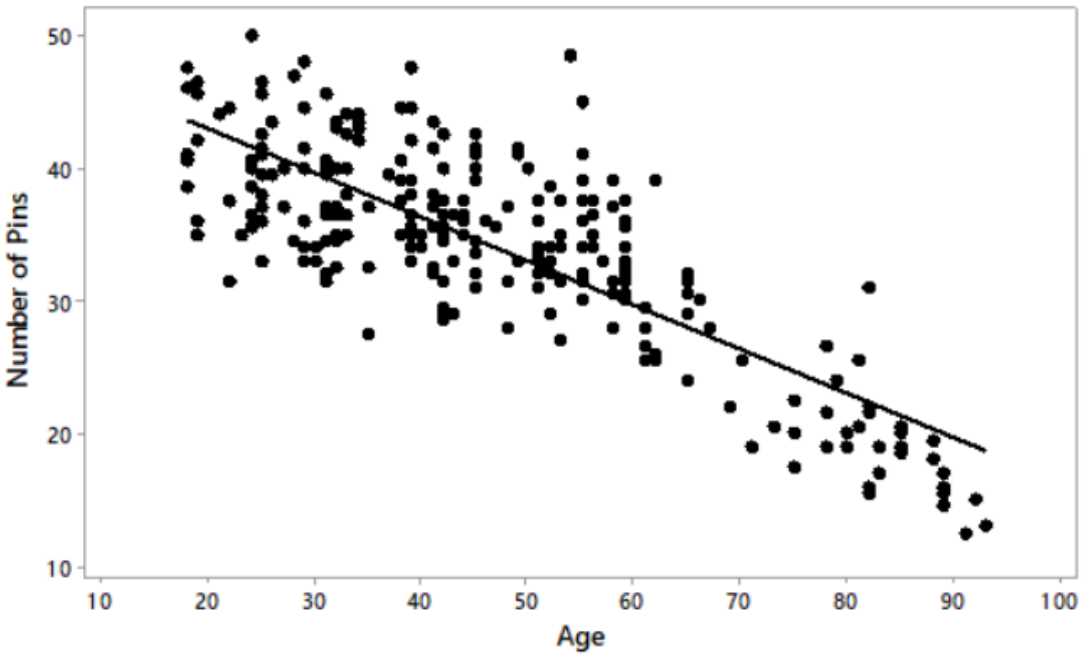


Figure E.14. Scatterplot of Purdue Pegboard Total Result vs Age

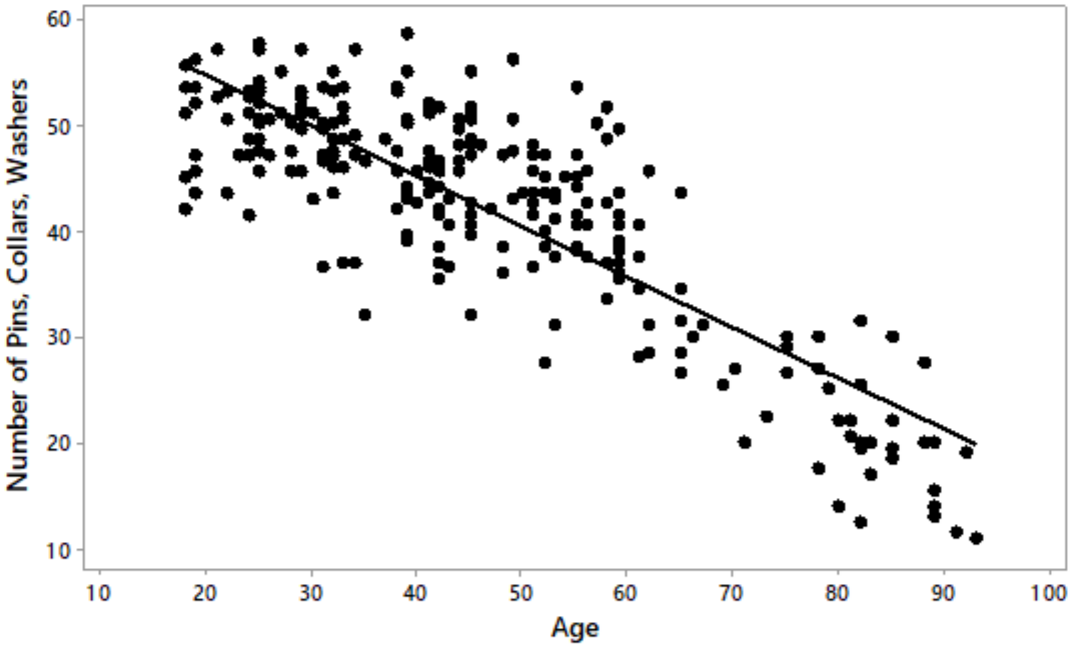


Figure E.15. Scatterplot of Purdue Pegboard Assembly Result vs Age

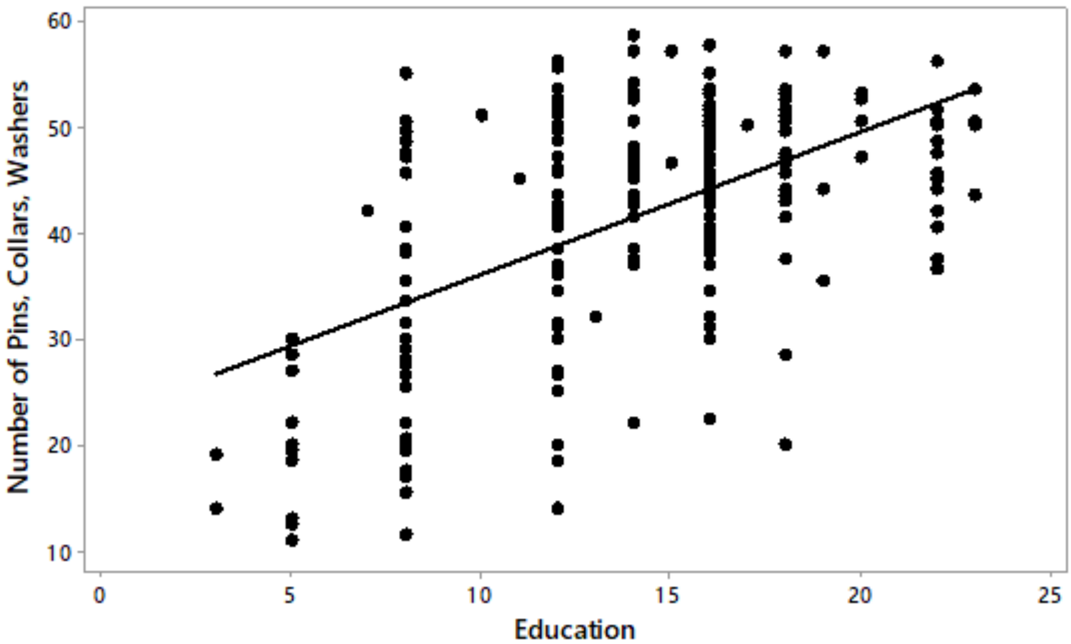


Figure E.16. Scatterplot of Purdue Pegboard Assembly Result vs Education

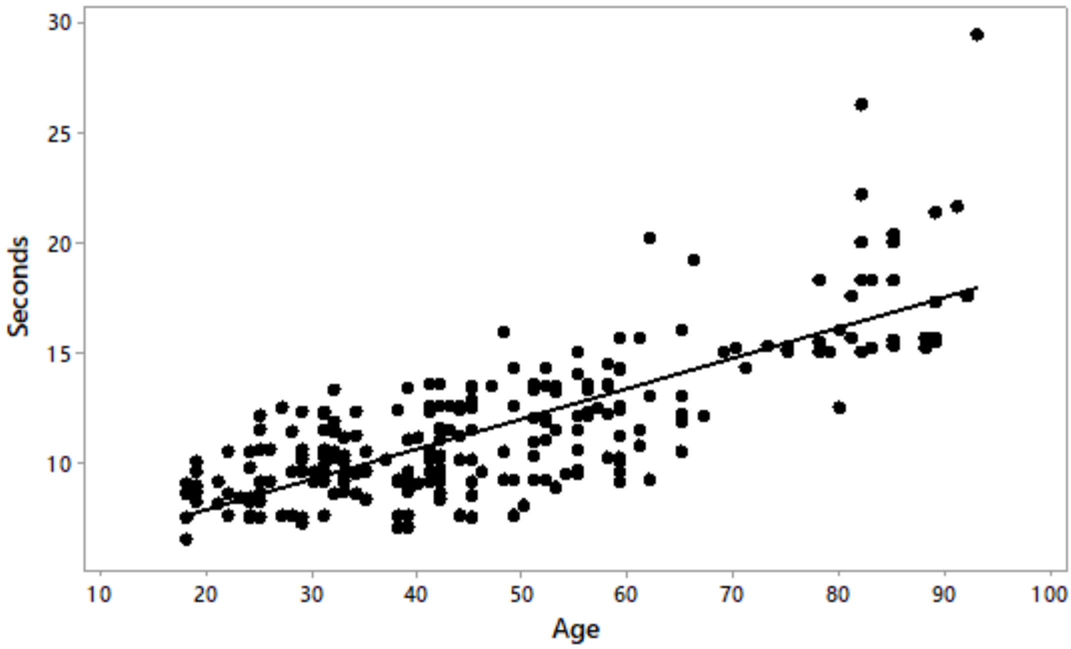


Figure E.17. Scatterplot of Stroop Color Word Part I vs Age

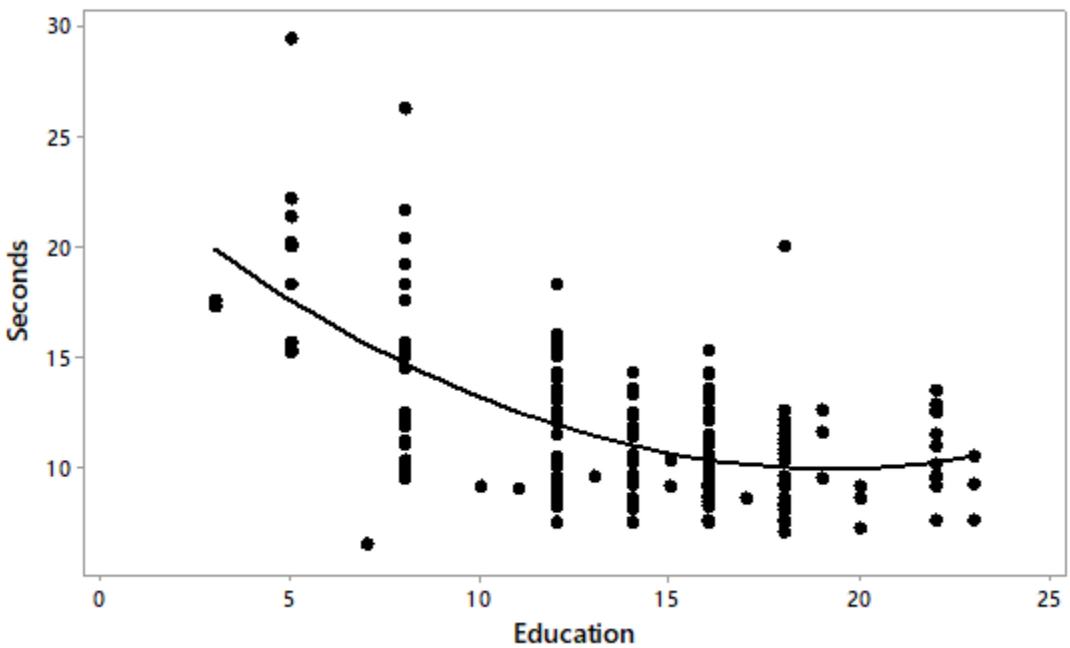


Figure E.18. Scatterplot of Stroop Color Word Part I vs Education

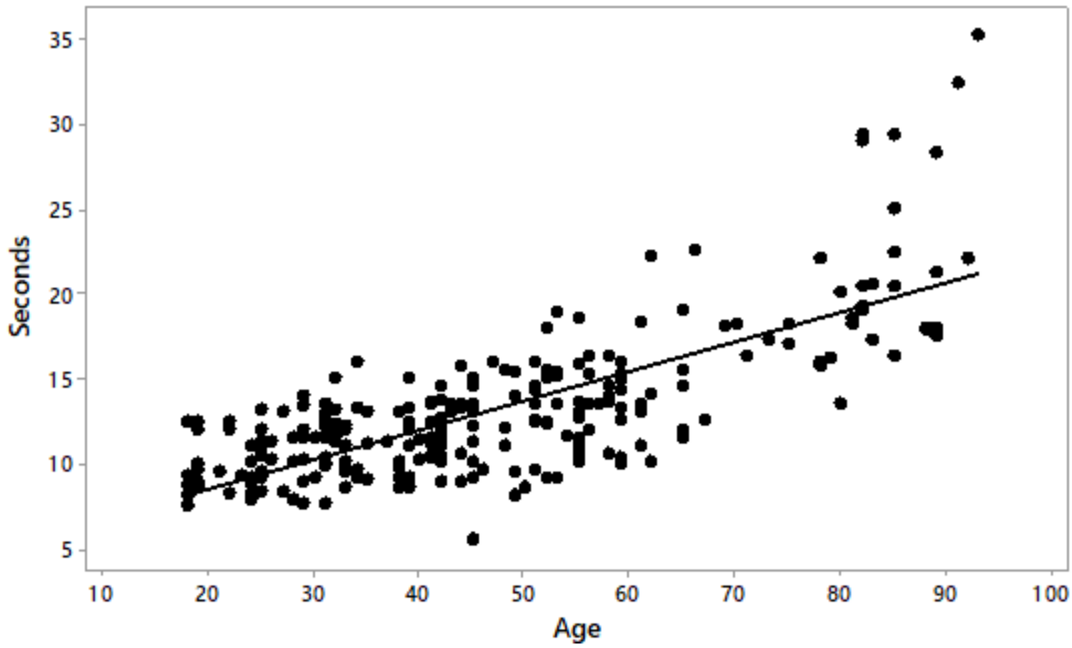


Figure E.19. Scatterplot of Stroop Color Word Part II vs Age

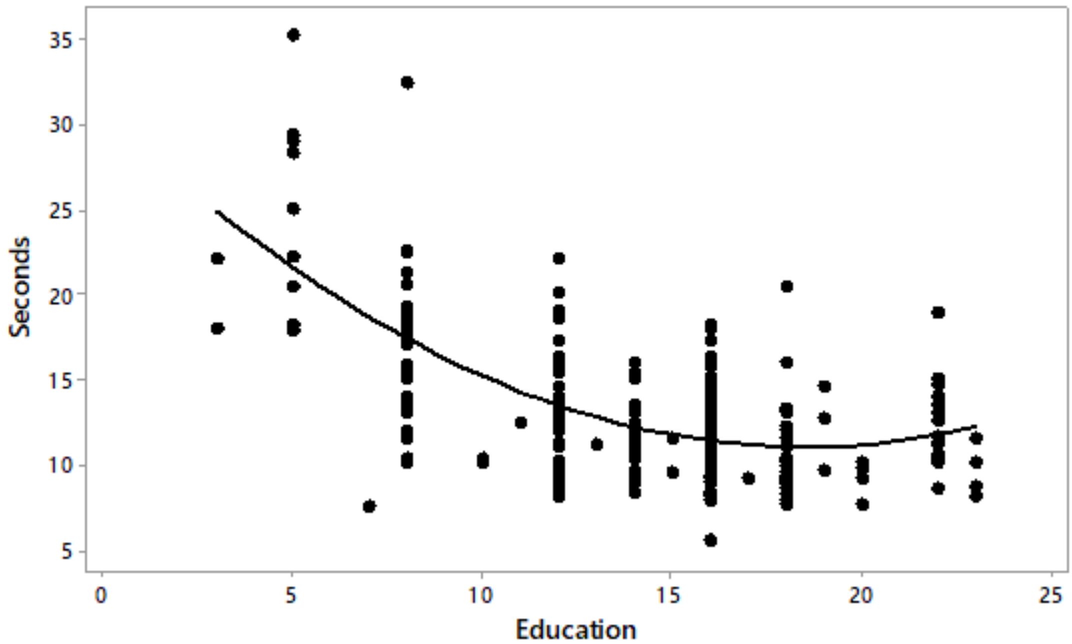


Figure E.20. Scatterplot of Stroop Color Word Part II vs Education

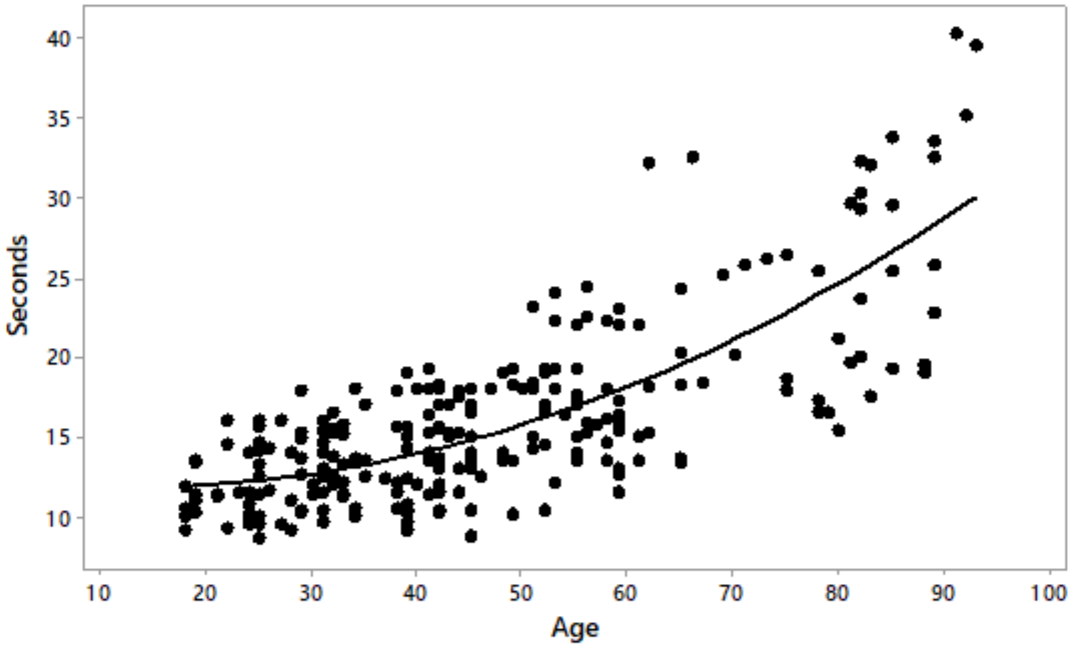


Figure E.21. Scatterplot of Stroop Color Word Part III vs Age

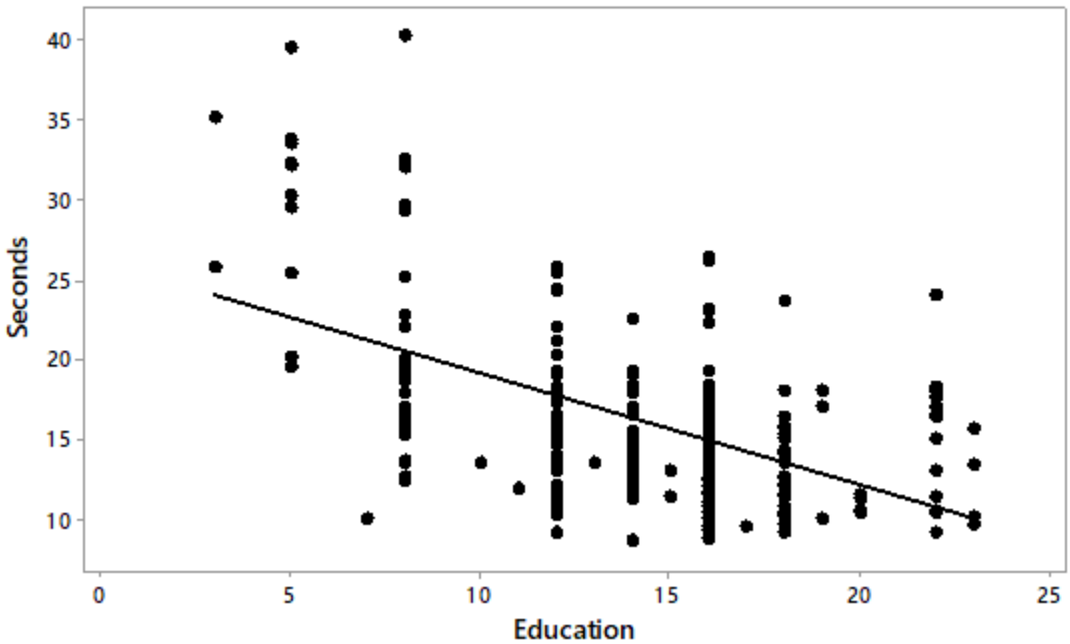


Figure E.22. Scatterplot of Stroop Color Word Part III vs Education

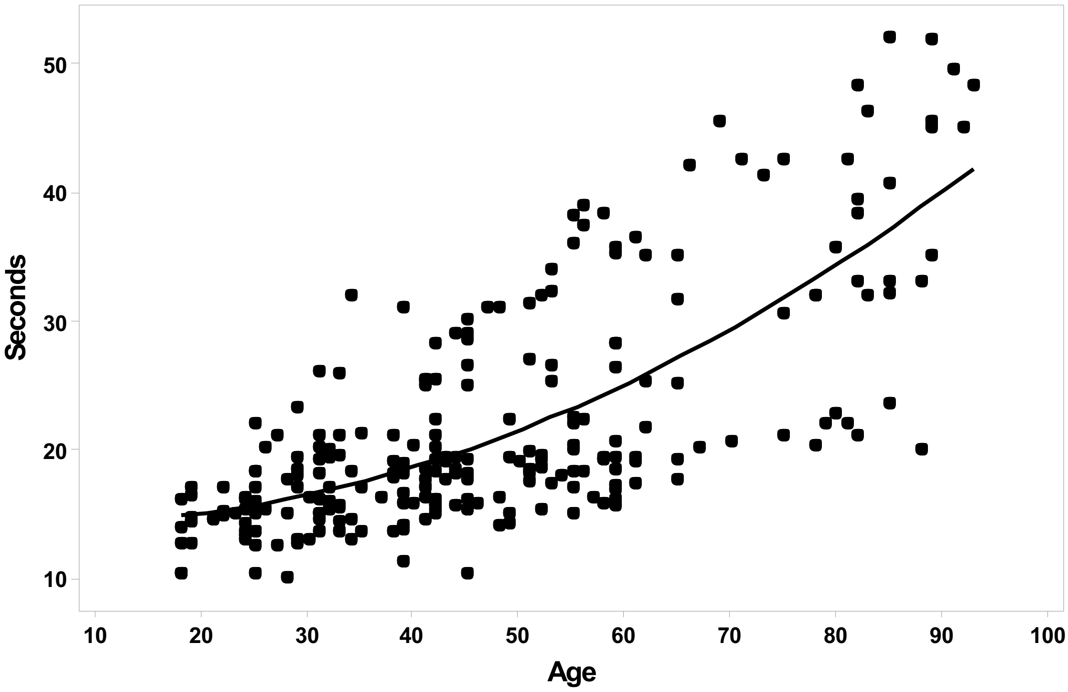


Figure E.23. Scatterplot of Stroop Color Word Part IV vs Age

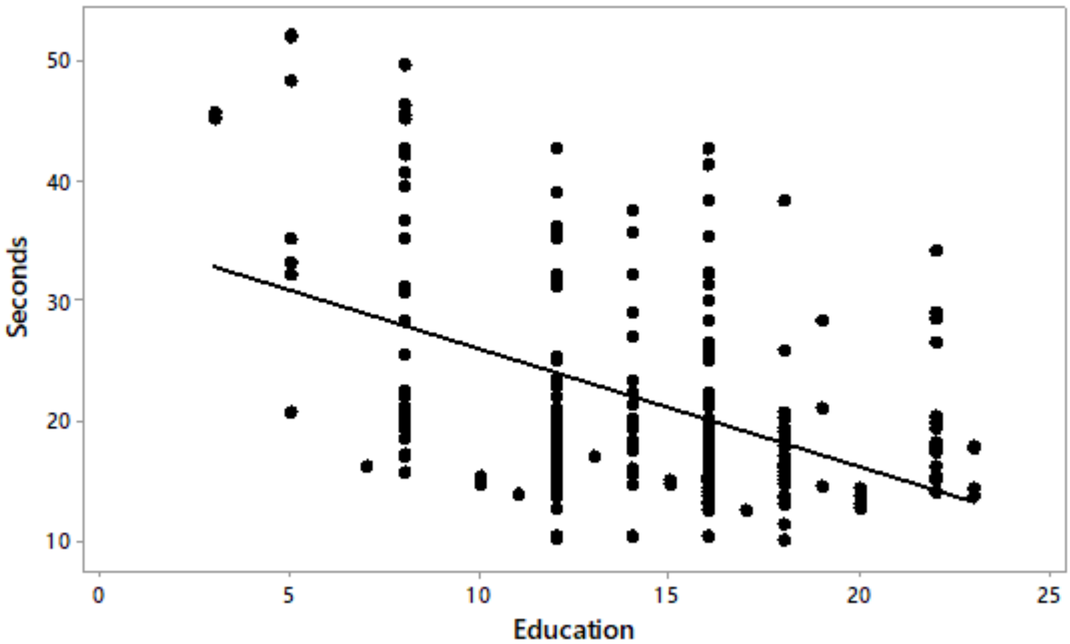


Figure E.24. Scatterplot of Stroop Color Word Part IV vs Education

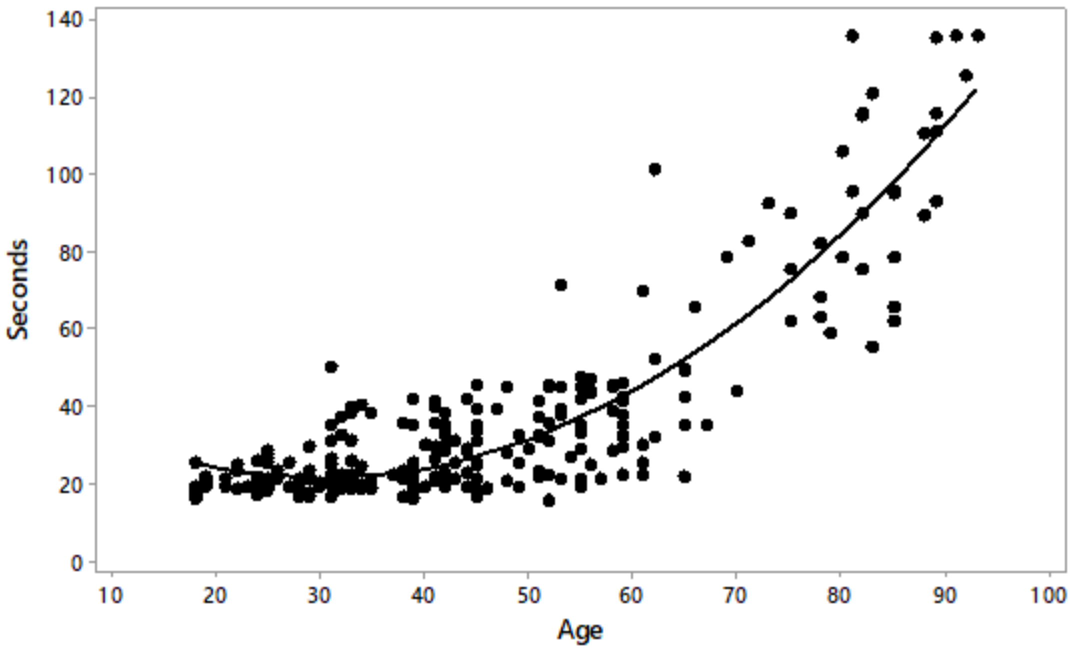


Figure E.25. Scatterplot of Stroop Color Word Part V vs Age

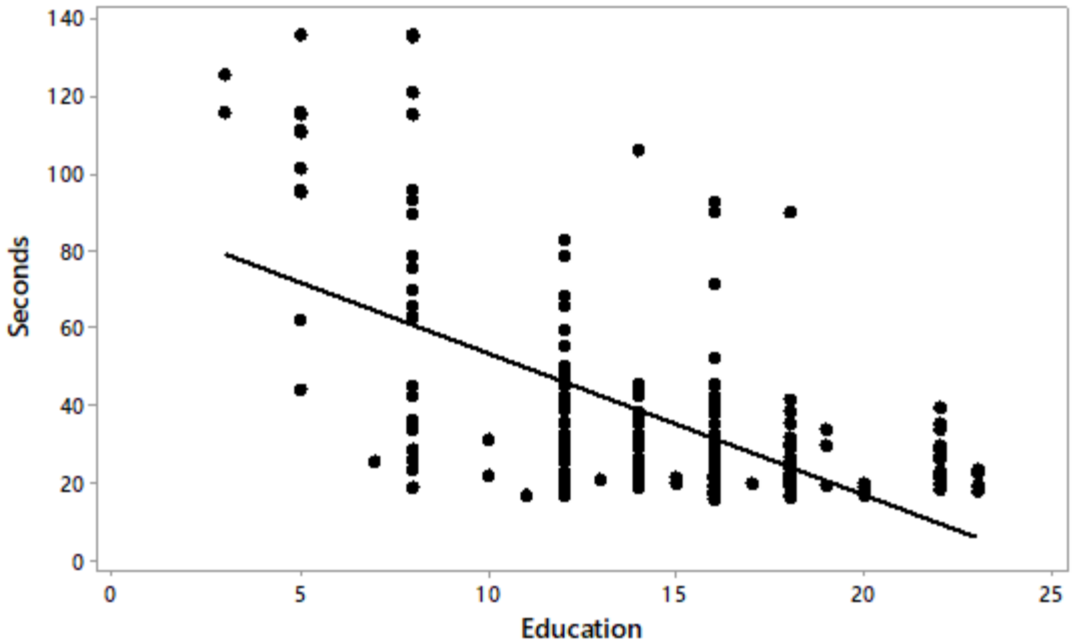


Figure E.26. Scatterplot of Stroop Color Word Part V vs Education

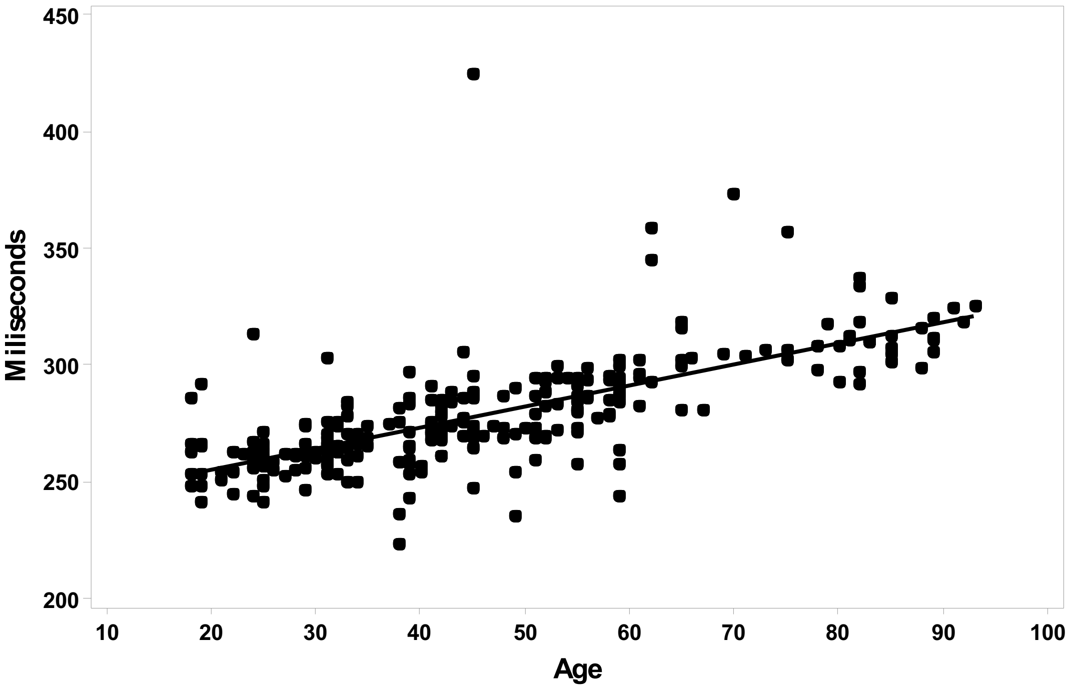


Figure E.27. Scatterplot of Reaction Time Dominant Hand vs Age

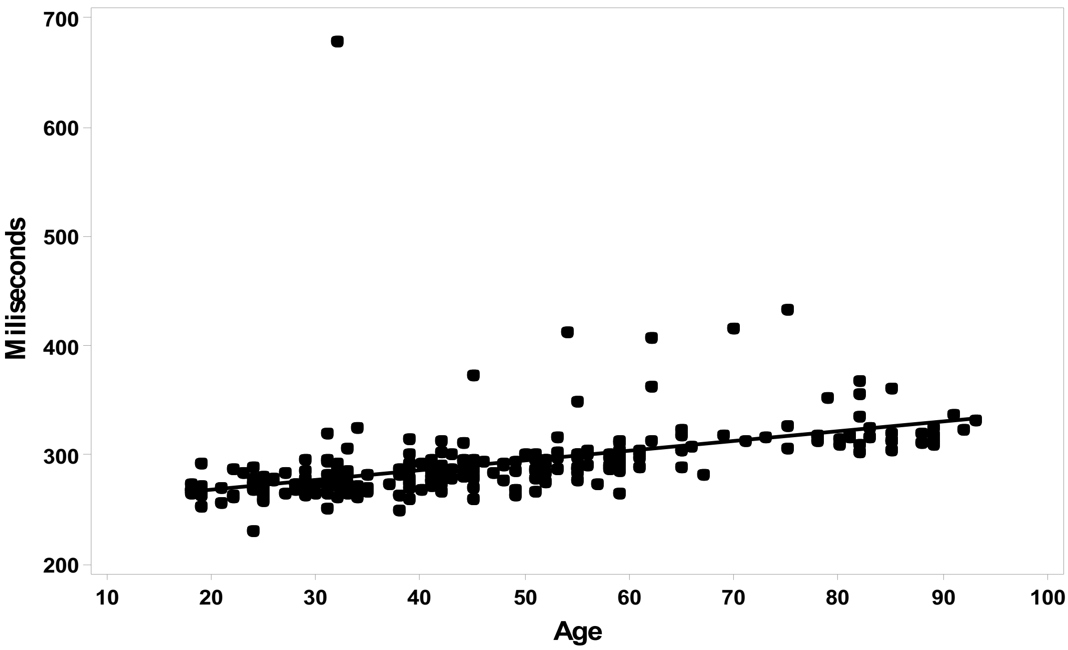


Figure E.28. Scatterplot of Reaction Time Non-Dominant Hand vs Age