

AN ESTIMATION OF NEUROPSYCHOLOGICAL PERFORMANCE OF ADULT FEMALE
POPULATION OF TURKEY

by

Ece Emirleroglu

B.S., Industrial Engineering, Istanbul Technical University, 2012

Submitted to the Institute for Graduate Studies in
Science and Engineering in partial fulfillment of
the requirements for the degree of
Master of Science

Graduate Program in Industrial Engineering
Boğaziçi University
2018

ACKNOWLEDGEMENTS

Firstly, I would like to express my sincere gratitude to my advisor Prof. Dr. Mahmut Ekşiođlu for the continuous support of my study and related research, for his patience, motivation, and immense knowledge. His guidance helped me in all the time of research and writing of this thesis. I could not have imagined having a better advisor and mentor for my study.

Besides my advisor, I would like to thank the rest of my thesis committee: Prof. Dr. Gürkán Kumbarođlu and Asst. Prof. Dr. Hande Küçükaydın, for their insightful comments and encouragement.

I would like to pay my regards to the participants in my survey, who have willingly shared their precious time during the process of testing, especially KASEV Nursing Home. I wish to present my special thanks to Scientific and Technological Research Council of Turkey (TÜBİTAK) for supporting me financially during my graduate education.

ABSTRACT

AN ESTIMATION OF NEUROPSYCHOLOGICAL PERFORMANCES OF ADULT FEMALE POPULATION OF TURKEY

Ergonomic design of human-work and human-technological systems and products requires data of human cognitive and motor performances, in addition to data of physical capabilities. As the published research indicates, these performances may vary across the world populations. Some technologically advanced countries have already developed normative data for their populations. For the case of Turkey, there are only a few limited studies which are far from to satisfy the needs of the designers/engineers. Therefore, this study aims to investigate the cognitive and motor performances of adult female population of Turkey with the following specific objectives: (i) estimate the neuropsychological performances for the adult female population of Turkey in four main areas (attention, concentration and speed, memory and learning, intellectual function and motor function); and (ii) investigate the effects of age, education level, marital status and smoking on the performances. Cognitive and motor performances are measured by the widely accepted these neuropsychological tests: Digit Span, Corsi Span, Stroop-Color, Raven, Reaction Time and Purdue Pegboard. The participants of the study were 251 adult females aged from 18 to 92 with family origins from the seven regions of Turkey. The performance data collected through the application of six neuropsychological tests were statistically analyzed with respect to the objectives. The first objective, the estimations of the neuropsychological performances, was made. The second objective was achieved through the inferential statistics. The results indicate a significant negative effect of age on all performances. On the other, with increasing education most performances were increased. Other factors did not show any significant effect. All six performance measures had strong correlations among themselves. The comparison results with other nationalities show similarities as well as differences. The generated data may serve as a norm for clinical as well as ergonomic design applications.

ÖZET

TÜRKİYE'NİN YETİŞKİN KADIN NÜFUSUNUN NÖROPSİYOLOJİK PERFORMANSININ TAHMİNLEMESİ

Ergonomi insanlar ve sistem arasında uyum olarak tanımlanabilir; cihazlar, ortamlar ve ekipman insan sınırlamalarına uyacak şekilde tasarlanmalıdır. Bilişsel Ergonomi, insanların bilişsel yetenekleri ile cihazları, ekipmanı ve ortamları arasındaki uyuma dayanır. Ergonominin tasarım prensiplerinde önemli bir rolü vardır, bilişsel ergonomi özellikle karmaşık, teknolojik, mobil ve otomatik sistemlerin tasarımı için düşünülür. İnsanın bilişsel yeteneklerine göre ürün ve sistemler tasarlamak için, toplumların normatif verilerine ihtiyaç vardır. Literatürde farklı ülkelerde insanların bilişsel kapasitesini ölçümleyen çalışmalar yer almaktadır. Ancak Türkiye özelinde yeterli çalışmalara rastlanmamıştır, özellikle tek bir çalışmada birden fazla alanda ölçümleme yapılmamıştır. Bu sebeplerden ötürü bu çalışmadaki temel amaçlar şunlardır; (i) Türkiye'nin yetişkin kadın nüfusunun bilişsel işlevlerini ölçerek norm verilerinin dört alanda geliştirilmesi (Dikkat, konsantrasyon, hız; Bellek ve öğrenme; Entelektüel işlev; Motor fonksiyonları) (ii) Yaş, eğitim, gelir düzeyi, sigara alışkanlığı, medeni durum faktörlerinin bilişsel kapasiteye etkilerini araştırmak. Bu amaçlara ulaşılması için, Yaşları 18 ile 92 arasında değişen 251 yetişkin kadına 6 farklı nöropsikolojik test uygulandı. Örnekleme, Türkiye'nin yedi bölgesinde doğan denekler dahil olmak üzere tabakalı bir şekilde yapıldı; kişiler 5 farklı demografik değişkene göre farklı gruplara ayrıldılar (Yaş, eğitim, gelir düzeyi, sigara alışkanlığı, medeni durum. İlk amaç olan nöropsikolojik performansın tahminlemesi gerçekleştirilmiştir. İkinci amaç istatistiksel analiz ile gerçekleştirilmiştir. Sonuçlar, bilişsel yeteneklerin yaşla birlikte azaldığını ve eğitim seviyesi ile belli bir seviyeye kadar arttığını göstermiştir. Test sonuçları arasında pozitif korelasyon bulunmaktadır. Diğer ülkelerle karşılaştırıldığında benzerlikler ve farklılıklar saptanmıştır.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	iii
ABSTRACT.....	iv
ÖZET	v
LIST OF TABLES.....	x
LIST OF FIGURES	xv
LIST OF SYMBOLS	xxvii
LIST OF ACRONYMS/ABBREBIATIONS	xxix
1. INTRODUCTION.....	30
2. LITERATURE REVIEW.....	32
2.1. Test Types	46
2.1.1. The Digit Span Test.....	46
2.1.2. The Corsi Span Test.....	54
2.1.3. Stroop Color and Word Test.....	57
2.1.4. Reaction Time Test.....	78
2.1.5. Purdue Pegboard Test	81
2.1.6. Raven Standard Progressive Matrices	88
2.2. Critiques of Findings.....	93
3. RATIONAL AND OBJECTIVES OF THE STUDY	98
3.1. Rationale of the Study.....	98
3.2. Objectives of the Study.....	98
4. METHODOLOGY	99
4.1. Phases of the Study	99
4.2. Sampling Approach.....	101

4.3.	Tests	103
4.3.1.	Digit Span Test	104
4.3.2.	Corsi Span Test.....	105
4.3.3.	Stroop Color and Word Test.....	107
4.3.4.	Reaction Time.....	111
4.3.5.	Purdue Pegboard Test	113
4.3.6.	The Raven Standard Progressive Test	118
4.4.	Statistical Methods	119
4.4.1.	Statistical Variables	119
4.4.2.	Statistical Analyze	121
4.5.	Pilot Study.....	135
4.6.	Sample Size Determination.....	135
4.7.	Repeatability Study	137
5.	RESULTS.....	141
5.1.	Overview	141
5.2.	Descriptive Statistics.....	141
5.2.1.	Mean, Standard Deviation and Other Values of Response Variables	141
5.2.2.	Percentile Values of Response Variables	155
5.2.3.	Box Plots of Response Variables.....	156
5.2.4.	Independent Variable Groups	208
5.3.	Inferential Statistics.....	209
5.3.1.	Correlation Analysis	209
5.3.2.	ANOVA Results	216
5.3.3.	Post-Hoc Analyses (Pairwise Comparisons)	222
5.3.4.	Paired t Test for Hand Preference Factor.....	234

5.3.5. Regression.....	235
6. DISCUSSION.....	240
6.1. Discussion on the Results.....	240
6.1.1. Age Effect	240
6.1.2. Education Effect	241
6.1.3. Income Level Effect.....	241
6.1.4. Smoking Habit Effect	242
6.1.5. Marital Status Effect	242
6.1.6. Hand Preference Effect.....	242
6.1.7. Relation of Test Results with Each Other.....	242
6.2. Comparison with Other Studies	243
6.2.1. Digit Span Test	252
6.2.2. Corsi Span Test.....	253
6.2.3. Reaction Time Test.....	254
6.2.4. Purdue Pegboard Test	254
6.2.5. Raven Test	255
6.2.6. Stroop Color Word Test.....	255
7. CONCLUSIONS	258
7.1. Contributions and Recommendations to Practitioners	259
7.2. Limitations of the Current Study.....	259
REFERENCES	260
APPENDIX A: FORMS	273
A.1. Health Survey and Personal Consent Form.....	273
A.1.1. Brief Medical History Form	273
A.1.2. Tıbbi Gemiř Formu.....	275

A.1.3. Personal Consent Form.....	277
A.1.4. Kişisel Onay Formu.....	279
A.1.5. Personal Data Form	281
A.1.6. Kişisel Bilgi Formu	282
A.2. Test Record Forms	283
A.2.1. Test Kayıt Formu.....	283
A.2.2. Digit Span Record Form.....	284
A.2.3. Corsi Span Record Form	285
A.2.4. Stroop Color Word Test Record Form	286
A.2.5. Raven’s Standard Progressive Matrices Record Form	287
A.2.6. Purdue Pegboard Record Form.....	288
A.2.7. Reaction Time Record Form	289
A.2.8. Test Procedures in Turkish	290
APPENDIX B: QUESTIONS FOR RAVEN TEST.....	294
APPENDIX C: GRAPHS	309
C.1. Residual plots for Response Variables.....	309
C.2. Scatter Plots of Response Variables	318

LIST OF TABLES

Table 2.1. Summary of studies in the literature.....	36
Table 2.2. Digit Span Test studies in the literature.....	47
Table 2.3. Corsi Span Test studies in the literature.	56
Table 2.4. Stroop Color and Word Test studies in the literature.	59
Table 2.5. Reaction Time Test studies in the literature.	79
Table 2.6. Purdue Pegboard Test studies in the literature.	83
Table 2.7. Raven Standard Progressive Matrices Test studies in the literature.....	90
Table 4.1. Distribution of the subjects' family origins.....	101
Table 4.2. The descriptive statistics of demographic factors of subjects.	102
Table 4.3. The percentage of demographic factors of subjects.	103
Table 4.4. Forward and backward versions of Digit Span test (Hebb, 1961).....	105
Table 4.5. Sequence of Corsi Span test (Milner, 1971).....	107
Table 4.6. Parts of Stroop Color Word Test (Karakas, 2011).	108

Table 4.7. Independent Variables and their levels.....	119
Table 4.8. Tests, response and independent variables.....	120
Table 4.9. Distribution of response variables.....	122
Table 4.10. Levene test results.....	124
Table 4.11. Descriptive statistics of pilot study.....	135
Table 4.12. Minimum sample size of experiments.....	137
Table 4.13. Data of Repeatability study.....	138
Table 4.14. F test results of all test results.....	139
Table 4.15. Paired t test results of all test results.....	140
Table 5.1. Descriptive statistics of response variables.....	142
Table 5.2. Descriptive statistics for Age factor.....	143
Table 5.3. Descriptive statistics for Education factor.....	147
Table 5.4. Descriptive statistics for Income factor.....	150
Table 5.5. Descriptive statistics for Marital Status factor.....	152

Table 5.6. Descriptive statistics for Smoking Habit factor.....	153
Table 5.7. Percentile values of test results.....	155
Table 5.8. Independent Variables Details.....	208
Table 5.9. Pearson correlation matrix.....	210
Table 5.10. Spearman correlation matrix.....	211
Table 5.11. Point Biserial correlation matrix.....	212
Table 5.12. Pearson correlation matrix of response variables.....	214
Table 5.13. ANOVA for Digit Span Forward test.....	217
Table 5.14. ANOVA for Digit Span Backward test.....	217
Table 5.15. ANOVA for Corsi Span Forward test.....	217
Table 5.16. ANOVA for Corsi Span Backward test.....	217
Table 5.17. ANOVA for Raven test.....	218
Table 5.18. ANOVA for Stroop Color Word test part I.....	218
Table 5.19. ANOVA for Stroop Color Word test part II.....	218

Table 5.20. ANOVA for Stroop Color Word test part III.....	218
Table 5.21. ANOVA for Stroop Color Word test part IV.	219
Table 5.22. ANOVA for Stroop Color Word test part V.....	219
Table 5.23. ANOVA for Reaction Time dominant hand test.	219
Table 5.24. ANOVA for Reaction Time nondominant hand test.	219
Table 5.25. ANOVA for Purdue Pegboard dominant hand test.	220
Table 5.26. ANOVA for Purdue Pegboard non dominant hand test	220
Table 5.27. ANOVA for Purdue Pegboard both hand tests.....	220
Table 5.28. ANOVA for Purdue Pegboard total test.	220
Table 5.29. ANOVA for Purdue Pegboard assembly test.	221
Table 5. 30. Tukey’s test results for age group differences.	223
Table 5.31. Tukey’s test results for education group differences.....	229
Table 5.32. Tukey’s test results for marital status group differences.....	230
Table 5.33. Tukey test results for age factor.....	231

Table 5.34. Tukey test results for education factor.....	233
Table 5.35. Tukey test results for marital status factor.....	234
Table 5.36. Descriptive statistics for t test.....	234
Table 6.1. Comparisons between population of Turkey and other nationalities for Digit Span test.....	214
Table 6.2. Comparisons between population of Turkey and other nationalities for Corsi Span test.....	216
Table 6.3. Comparisons between population of Turkey and other nationalities for Reaction Time test	217
Table 6.4. Comparisons between population of Turkey and other nationalities for Purdue Pegboard test.....	218
Table 6.5. Comparisons between population of Turkey and other nationalities for Stroop Color Word test.....	219
Table 6.7. Comparisons between population of Turkey and other nationalities for Raven test.....	221

LIST OF FIGURES

Figure 4.1. Flowchart of the phases of the study.	99
Figure 4.2. The regional distribution of family origin cities.	102
Figure 4.3. The arrangement of blocks on the board shown here from Milner (1971)	107
Figure 4.4. The cards that are used in experiment, taken from Karakaş (2011).	110
Figure 4.5. Position of the subject for reaction time test.	112
Figure 4.6. First screen of computer- based reaction time.	113
Figure 4.7. Purdue Pegboard Test Model 32020 testing board.	114
Figure 4.8. Pins (from left in first and fourth cup), washers (in second cup) and collars (in third cup).	86
Figure 5.4. Boxplot of Corsi Backward test result.	158
Figure 5.5. Boxplot of Raven test result	159
Figure 5.6. Boxplot of Reaction Time Dominant Hand test result.	159
Figure 5.7. Boxplot of Reaction Time Nondominant Hand test result.	160

Figure 5.8. Boxplot of Purdue Pegboard Dominant Hand test result .	160
Figure 5.9. Boxplot of Purdue Pegboard Nondominant Hand test result.	161
Figure 5.10. Boxplot of Purdue Pegboard Both Hand test result.	161
Figure 5.11. Boxplot of Purdue Pegboard Total test result .	162
Figure 5.12. Boxplot of Purdue Pegboard Assembly test result.	162
Figure 5.13. Boxplot of Stroop Color Word Test Part I result.	163
Figure 5.14. Boxplot of Stroop Color Word Test Part II result .	163
Figure 5.15. Boxplot of Stroop Color Word Test Part III result.	164
Figure 5.16. Boxplot of Stroop Color Word Test Part IV result.	164
Figure 5.17. Boxplot of Stroop Color Word Test Part V result.	165
Figure 5.18. Box plot of Reaction Time Test (Dominant Hand).	165
Figure 5.19. Box plot of Reaction Time Test (Nondominant Hand).	166
Figure 5.20. Box plot Purdue Pegboard Test (Dominant Hand).	166
Figure 5.21. Box plot Purdue Pegboard Test (Nondominant Hand).	167

Figure 5.22. Box plot Purdue Pegboard Test (Both Hand)..... 167

Figure 5.23. Box plot Purdue Pegboard Test (Total)..... 168

Figure 5.24. Box plot Purdue Pegboard Test (Assembly). 168

Figure 5.25. Box plot Raven Test. 169

Figure 5.26. Box plot (SCWT Part I)..... 169

Figure 5.27. Box plot (SCWT Part II). 170

Figure 5.28. Box plot (SCWT Part III)..... 170

Figure 5.29. Box plot (SCWT Part IV)..... 171

Figure 5.30. Box plot (SCWT Part V). 171

Figure 5.31. Box plot Digit Span Forward Test. 172

Figure 5.32. Box plot Digit Span Backward Test..... 172

Figure 5.33. Box plot Corsi Span Forward Test. 173

Figure 5.34. Box plot Corsi Span Backward Test. 173

Figure 5.35 Box plot Reaction Time Test (Dominant Hand). 174

Figure 5.36. Box plot Reaction Time Test (Nondominant Hand).	174
Figure 5.37. Box plot Purdue Pegboard Test (Dominant Hand).	175
Figure 5.38. Box plot Purdue Pegboard Test (Nondominant Hand).	175
Figure 5.39. Box plot Purdue Pegboard Test (Both Hand).	176
Figure 5.40. Box plot Purdue Pegboard Test (Total).	176
Figure 5.41. Box plot Purdue Pegboard Test (Assembly).	177
Figure 5.42. Box plot Purdue Raven Test.	177
Figure 5.43. Box plot SCWT (Part I) Test.	178
Figure 5.44. Box plot SCWT (Part II) Test.	178
Figure 5.45. Box plot SCWT (Part III) Test.	179
Figure 5.46. Box plot SCWT (Part IV) Test.	179
Figure 5.47. Box plot SCWT (Part V) Test.	180
Figure 5.48. Box plot Digit Span Forward Test.	180
Figure 5.49. Box plot Digit Span Backward Test.	181

Figure 5.50. Box plot Corsi Span Forward Test.	181
Figure 5.51. Box plot Corsi Span Backward Test.	182
Figure 5.52. Box plot Reaction Time Test (Dominant Hand).	182
Figure 5.53. Box plot Reaction Time Test (Nondominant Hand).	183
Figure 5.54. Box plot Purdue Pegboard Test (Dominant Hand).	183
Figure 5.55. Box plot Purdue Pegboard Test (Nondominant Hand).	184
Figure 5.56. Box plot Purdue Pegboard Test (Both Hand).	184
Figure 5.57. Box plot Purdue Pegboard Test (Total).	185
Figure 5.58. Box plot Purdue Pegboard Test (Assembly).	185
Figure 5.59. Box plot Raven Test.	186
Figure 5.60. Box plot SCWT (Part I) Test.	186
Figure 5.61. Box plot SCWT (Part II) Test.	187
Figure 5.62. Box plot SCWT (Part III) Test.	187
Figure 5.63. Box plot SCWT (Part IV) Test.	188

Figure 5.64. Box plot SCWT (Part V) Test.	188
Figure 5.65. Box plot Digit Span Forward Test.	189
Figure 5.66. Box plot Digit Span Backward Test.	189
Figure 5.67. Box plot Corsi Span Forward Test.	190
Figure 5.68. Box plot Corsi Span Backward Test.	190
Figure 5.69. Box plot Reaction Time Test (Dominant Hand).	191
Figure 5.70. Box plot Reaction Time Test (Nondominant Hand).	191
Figure 5.71. Box plot Purdue Pegboard Test (Dominant Hand).	192
Figure 5.72. Box plot Purdue Pegboard Test (Nondominant Hand).	192
Figure 5.73. Box plot Purdue Pegboard Test (Both Hand).	193
Figure 5.74. Box plot Purdue Pegboard Test (Total).	193
Figure 5.75. Box plot Purdue Pegboard Test (Assembly).	194
Figure 5.76. Box plot Raven Test.	194
Figure 5.77. Box plot SCWT (Part I) Test.	195

Figure 5.78. Box plot SCWT (Part II) Test.	195
Figure 5.79. Box plot SCWT (Part III) Test.	196
Figure 5.80. Box plot SCWT (Part IV) Test.	196
Figure 5.81. Box plot SCWT (Part V) Test.	197
Figure 5.82. Box plot Digit Span Forward Test.	197
Figure 5.83. Box plot Digit Span Backward Test.	198
Figure 5.84. Box plot Corsi Span Forward Test	198
Figure 5.85. Box plot Corsi Span Backward Test.	199
Figure 5.86. Box plot of Reaction Time Test (Dominant Hand).	200
Figure 5.87. Box plot of Reaction Time Test (Nondominant Hand).	200
Figure 5.88. Box plot of Purdue Pegboard Test (Dominant Hand).	201
Figure 5.89. Box plot of Purdue Pegboard Test (Both Hand).	201
Figure 5.90. Box plot of Purdue Pegboard Test (Total).	202
Figure 5.91. Box plot of Purdue Pegboard Assembly Test.	202

Figure 5.92. Box plot of Raven Test.....	203
Figure 5.93. Box plot of SCWT (Part I) Test.	203
Figure 5.94. Box plot of SCWT (Part II) Test.	204
Figure 5.95. Box plot of SCWT (Part III) Test.....	204
Figure 5.96. Box plot of SCWT (Part IV) Test.	205
Figure 5.97. Box plot of SCWT (Part V) Test.....	205
Figure 5.98. Box plot of Digit Span Forward Test.	206
Figure 5.99. Box plot of Digit Span Backward Test.	206
Figure 5.100. Box plot of Corsi Span Forward Test.....	207
Figure 5.101. Box plot of Corsi Span Backward Test.	207
Figure B 1. Questions of Raven Test.	294
Figure C.1. Residual plots for Digit forward result.	309
Figure C.2. Residual plots for Digit backward result.	310
Figure C.3. Residual plots for Corsi forward result.....	310

Figure C.4. Residual plots for Corsi backward result.....	311
Figure C.5. Residual plots for Reaction time dominant hand result.....	311
Figure C.6. Residual plots for Reaction time nondominant hand result.....	312
Figure C.7. Residual plots for Purdue Pegboard dominant hand result.....	312
Figure C.8. Residual plots for Purdue Pegboard nondominant hand result.....	313
Figure C.9. Residual plots for Purdue Pegboard both hand result.....	313
Figure C.10. Residual plots for Purdue Pegboard total result.	314
Figure C.11. Residual plots for Purdue Pegboard assembly result.....	314
Figure C.12. Residual plots for Stroop Color part I result.....	315
Figure C.13. Residual plots for Stroop Color part II result.	315
Figure C.14. Residual plots for Stroop Color part III result.....	316
Figure C.15. Residual plots for Stroop Color part IV result.....	316
Figure C.16. Residual plots for Stroop Color part V result.	317
Figure C.17. Residual plots for Raven test result.	317

Figure C.18. Scatter plot of Digit Span forward test vs age factor.....	318
Figure C.19. Scatter plot of Digit Span forward test vs education factor.....	318
Figure C.20. Scatter plot of Digit Span backward test vs age factor.	319
Figure C.21. Scatter plot of Digit Span backward test vs education factor.	319
Figure C.22. Scatter plot of Corsi Span forward test vs age factor.	320
Figure C.23. Scatter plot of Corsi Span forward test vs education factor.	320
Figure C.24. Scatter plot of Corsi Span backward test vs age factor.	321
Figure C.25. Scatter plot of Corsi Span backward test vs education factor.	321
Figure C.26. Scatter plot of Raven test vs age factor.	322
Figure C.27. Scatter plot of Raven test vs education factor	322
Figure C.28. Scatter plot of Stroop Color Word test part I vs age factor.	323
Figure C.29. Scatter plot of Stroop Color Word test part I vs education factor.	323
Figure C.30. Scatter plot of Stroop Color Word test part II vs age factor.....	324
Figure C.31. Scatter plot of Stroop Color Word test part II vs education factor.....	324

Figure C.32. Scatter plot of Stroop Color Word test part III vs age factor.....	325
Figure C.33. Scatter plot of Stroop Color Word test part IV vs age factor.	325
Figure C.34. Scatter plot of Stroop Color Word test part V vs age factor.....	326
Figure C.35. Scatter plot of Purdue Pegboard dominant hand test vs age factor.	326
Figure C.36. Scatter plot of Purdue Pegboard dominant hand test vs education factor.	327
Figure C.37. Scatter plot of Purdue Pegboard nondominant hand test vs age factor.	327
Figure C.38. Scatter plot of Purdue Pegboard nondominant hand test vs education factor. ...	328
Figure C.39. Scatter plot of Purdue Pegboard both hand test vs age factor.	328
Figure C.40. Scatter plot of Purdue Pegboard both hand test vs education factor.	329
Figure C.41. Scatter plot of Purdue Pegboard total test vs age factor.	329
Figure C.42. Scatter plot of Purdue Pegboard total test vs education factor.	330
Figure C.43. Scatter plot of Purdue Pegboard assembly test vs age factor.	330
Figure C.44. Scatter plot of Purdue Pegboard assembly test vs education factor.	331
Figure C.45. Scatter plot of Reaction Time dominant hand test vs age factor	331

Figure C.46. Scatter plot of Reaction Time nondominant hand test vs age factor. 332

Figure C.47. Scatter plot of Reaction Time nondominant hand test vs Education factor. 332

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
M_p	Mean for categorical group 1
M_q	Mean for categorical group 2
N	Sample size
o	Subjects
p	Proportion of subjects that in group 1
q	Proportion of subjects that in group 2
R^2_{adj}	Adjusted coefficient of determination

r_{pbi}	Point-biserial correlation coefficient
s	Standard deviation of sample
t_{obs}	t observation value
t_{crit}	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
β_j	The effect of the j th level of education
β_v	Parameters of regression analysis
ε	Random error component $(0, \sigma^2)$
μ	Overall mean
σ^2	Variance of sample
γ_l	The effect of the l th level of marital status

LIST OF ACRONYMS/ABBREVIATIONS

ANOVA	Analysis of Variance
CV	Coefficient of Variation
DH	Dominant Hand
Max	Maximum
Min	Minimum
NDH	Non-Dominant Hand
Peg	Pegboard
SCWT	Stroop Color Word Test
Std Er	Standard Error
TOEFL	Test of English as a Foreign Language
USA	United States of America

1. INTRODUCTION

Universal design refers to a process that takes into account the abilities and limitations of all potential users when developing a product or building an environment. The design of the user interface and functionality takes the cognitive and physical abilities of people into account. Especially for designing cognitive work systems and human computer interface systems, cognitive capacities of populations are essential (Chan *et al.*, 2009). Therefore, for designing product, user interface or functionality, normative data on cognitive and physical abilities of people are needed. Cognitive capacities are assessed by neuropsychological tests (Arancivaa *et al.*, 2012).

Generally speaking, normative neuropsychological studies are performed on English-speaking Europeans or Americans (e.g., Moering *et al.*, 2004; Monaco *et al.*, 2012; Elst *et al.*, 2006, and Regla *et al.*, 2013). There are also some studies with Chinese and Spanish speaking participants (e.g., Chan *et al.*, 2009; Lee *et al.*, 2010; and Choi *et al.*, 2013.). In Turkey, there are several studies about neuropsychological performances. In one of the studies, Cangoz *et al.* (2009) studied trail making test with 484 participants (238 female and 246 male) with age of 50 years old and above. Age, gender and education were found as affecting factors. Another study is performed with 64 participants (34 female and 30 male) from Boğaziçi University students with at least 55 TOEFL score. They again used the trail making test and also the Stroop color word test (Dugbartey *et al.*, 2000). The study by Aslan and Kudaki (2007) used the Three Words–Three Shapes Test for people of Turkey. However, putting it all together, these studies do not provide a cognitive performance database for population of Turkey.

As the literature review shows, the cognitive abilities may vary among populations: Japanese, American, Chinese, Spanish data are different from each other. So it could be said that normative data from other nations may not be valid for population of Turkey. This study is an attempt to develop normative data on cognitive abilities of adult female population of

Turkey and compare the results with available data. In the literature studies also reported the significant effect of age, gender, and education level on cognitive and motor abilities.

This study considers the female population of Turkey with age 18 and above. Women from different education levels are selected to participate to the study. This study aims to develop normative data on cognitive capabilities and motor functions of adult female population of Turkey in four areas by using neuropsychological tests and investigate the effects of age, education, income, marital status and smoking habit on the performances. These four main areas are (Mitrushina, *et al.*, 2005):

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

These four main areas are the cognitive abilities of the most frequent concern to professionals in cognitive Ergonomics (Monaco, *et al.*, 2012). For developing norm data the most frequently used neuropsychological tests in these areas will be used.

Results of this study will form a database for cognitive capacities and motor functions of female population of Turkey, so further studies can use this data as a reference for designing more user friendly products, more functional user interface systems for population of Turkey. Moreover products and designs that are used by people could be evaluated for accordance of people's use in Turkey.

2. LITERATURE REVIEW

Human behavior has three dimensions; cognition, emotionality and executive functions (Lezak *et al.*, 2004). Cognitive functions mostly concern about the information processing as feature of human behavior, emotionality means the feelings that affect the human behavior and finally executive functions enable a person to engage successfully in autonomous, purposive, self-serving behavior (Lezak, 1995).

The cognitive functions have greater impact than the other two dimensions in neuropsychology, since problems of cognitive functions affect humans' daily life activities and also these functions are measurable (Lezak *et al.*, 2004). Also cognitive functions like memory and visuospatial ability have an important impact on people's ability conducting a variety of activities ranging from daily living activities to challenging tasks (Grigsby *et al.*, 1998).

Neuropsychological tests are mostly used for assessing cognitive domains; attention, memory, language, visual perception and visuospatial ability, motor functions (Hofgren, 2009). Attention is a very important aspect of neuropsychological assessment (Lezak *et al.*, 2004). It is a selective process that aids the brain for concentrating the most critical information for further processing (Milham, 2003). Tests that are used for measuring attention generally measure more than attention since attentional tasks extend along with other cognitive functions like motor functions, memory, speed of information processing and verbal ability (Strauss *et al.*, 2006).

Memory means system of understanding, saving and recalling the information. It has several forms like long term (permanent storage of information) and short term memory (working memory) (Buckner *et al.*, 2000). Working memory means the cognitive function underlying transient maintenance and online processing of information (Monaco *et al.*, 2012). In clinical neuropsychology, the most popular tests for assessing verbal and visual-spatial working memory are the Digit span and Corsi block span tests (Monaco *et al.*, 2012).

Motor function abilities mean the identification and localization of any stimuli, such as locating an object or more complex motor function tasks like assembling or drawing objects (Hofgren, 2009).

These functions are affected by demographic variables like any other cognitive abilities (Martins *et al.*, 2012). Neuropsychology tries to explain the relationship between brain and behavior (Kolb and Whishaw, 2003). So for assessing cognitive functions neuropsychological tests are used.

Findings of the literature review show that different kind of neuropsychological tests have been used to provide normative data of different populations in order to achieve functional design. For example, in a study on Chinese sample an automated teller machine (ATM) is designed by taking into account needs of older adults. Self-Constructed Memory of Digit Test, Digit Span Test, Visual Span Test, Strop-Color Word Test, Token Test, Symbol Digit Modalities Test, Purdue Pegboard Test and Pinch Strength Test have been applied to 53 men and 38 female aged above 65 from different education levels. Based on the results, design principles of modified ATM prototype have been determined (Chan *et al.*, 2009).

In a study of US population, performance of computer mouse tasks was investigated as a function of age and motor control. Trail Making Test, Digit Span Test, Grooves Pegboard Test and Block Design Test have been applied to older people to reach design principles. This study became a reference for design interface to encourage accessibility for older people (Smith *et al.*, 1999).

In another study of US populations, researchers examined workload as a variable dependent on individuals' cognitive abilities by using Raven Standard Progressive Matrices which measures ability of problem solving and intellectual function. Workload during dynamic decision making in terms of its dependence on both task and cognitive abilities has been investigated in this study. The results show that high workload is more detrimental in individuals with low cognitive abilities than in individuals with high cognitive abilities (Gonzalez, 2005).

Gonzalez's study about dynamic decision making and influences of cognitive abilities on dynamic decision making uses Raven Standard Progressive Matrices for measuring human cognitive capacity (2005). The study also tries to show effects of cognitive abilities on time constraints in dynamic decision making situations (Gonzalez, 2005). Also Carpenter *et al.* (1990) advice using Raven Standard Progressive Matrices to forecast the capacity to perform dynamic tasks since this test is used for measuring people's ability of adjusting new situations, solving problems and conducting objectives in their working memory. Yu and Gonzalez (2013) measured working memory and show the effect of working memory on decision making by using data from Corsi Block Tapping Test.

Stroop Color-Word test is used for measuring peoples' selective attention, control, information processing speed, cognitive flexibility and short administration time, in a study in US the results from this test is used for modifying automatic processes for older adults (Rogers and Fisk, 1991). Also, there is a study that gives design advices for virtual keyboards by using data from cognitive tests like Reaction time, Reverse Digit Span, Digit Symbol Substitution, Digit Symbol Substitution Recall tests (O'Brien *et al.*, 2008).

In a study by McBride *et al.* (2011), digit Span test is used for measuring short term working memory. The results of the test provide information about how individuals, younger and older, interacted with an imperfect automated system like the impact of workload on performance and automation use. According to digit span test results design principles have been determined in Atlanta.

In conclusion, from these studies it could be assumed that while developing new technologies, designing ergonomic products, human computer interfaces and also new software (e.g., decision making tools), information on cognitive capabilities and motor functions of people have an important role to play.

In Table 2.1, there is a list of studies that provides normative data for different cognitive tests from different countries. The list also includes detail 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 and dependent and independent variables which are used for statistical analysis are given too.

Table 2.1. Summary of studies in the literature.

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Shiao-Ling and Tori (2007)	Chinese	Total: 324 Male: 180 Female: 144	Five Digit Test Fuld Object Memory Symbol Digit Modalities Test Trail Making Test Color Trails Verbal Fluency Test (Animal Naming) WAISRC Digit Span	<ul style="list-style-type: none"> • Time+ number of errors • Number of true recall • Total number of correct responses • Time to complete test • Time to complete test • Number of animals • Length of digits 	<ul style="list-style-type: none"> • Age • Gender • Education
Chan <i>et al.</i> (2009)	Chinese	Total: 91 Male: 53 Female: 38	Self-Constructed Memory of Digit Test Digit Span Test Visual Span Test Stroop-Color Word Test Token Test Symbol Digit Modalities Test Purdue Pegboard Test	<ul style="list-style-type: none"> • Number of digits recall • Length of digits • Length of sequence • Error, response time • Correct answers • Total number of correct responses • Number of pins 	<ul style="list-style-type: none"> • Age • Education
Moering <i>et al.</i> (2004)	Afro-American	Total: 236 Male: 108 Female: 128	Stroop Color and Word Test (Golden)	<ul style="list-style-type: none"> • Error • Response time 	<ul style="list-style-type: none"> • Age • Gender • Education

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Elst <i>et al.</i> (2006)	Dutch	Total: 1856	Stroop Color-Word Test	<ul style="list-style-type: none"> • Error • Response time 	<ul style="list-style-type: none"> • Age • Gender • Education
Rognonia <i>et al.</i> (2013)	Spanish	Total: 179	Stroop Color Word Test (Golden) Tower Of London-Drexel University Test Problem Solving	<ul style="list-style-type: none"> • Error • Response time • Total moves and latency time 	<ul style="list-style-type: none"> • Age • Gender • Education
Dugbartey <i>et al.</i> (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 Intelligence Scale For Children Controlled Oral Word Association Test Symbol Subtest From The Wechsler Adult Intelligence Scale-Revised	<ul style="list-style-type: none"> • Time to complete test • Time to complete test • Error • Response time • IQ score • number of words produced • IQ score 	
Karakas <i>et al.</i> (1999)	Turkish	Total: 395	Stroop test TBAG Form	<ul style="list-style-type: none"> • Error • Response time 	

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Jorm <i>et al.</i> (2004)	Australian	Total: 7485	California Verbal Learning Test Digit Span Backwards Symbol-Digit Modalities Test Spot-The-Word Reaction Time	<ul style="list-style-type: none"> • Correct answers • Length of digits • Correct responses • Correct answers • Average time 	<ul style="list-style-type: none"> • Gender • Mediated effects
Mccury <i>et al.</i> (2001)	Japanese American	Total: 201	Wais-R Digit Span Trail Making Test Purdue Pegboard Test Finger Tapping	<ul style="list-style-type: none"> • Length of digits • Time to complete test • Number of pins • Total number of taps for the six ten-second periods for each hand 	<ul style="list-style-type: none"> • Gender • Language • Age
Lee <i>et al.</i> (2010)	Chinese	Total: 475 341 adoles. 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)	<ul style="list-style-type: none"> • Length of digits • Correct responses • Error, Response time • Time to complete test • Correct answers • Correct answers • Number of words produced • Number of design produced 	<ul style="list-style-type: none"> • Gender • Education • Age

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Monaco <i>et al.</i> (2013)	Italian	Total: 362 Male: 187 Female: 175	The Digit Span Corsi Span Both Forward And Backward Version	<ul style="list-style-type: none"> •Length of digits •Maximum number of blocks 	<ul style="list-style-type: none"> •Gender •Education •Age
Llina`s-Regla <i>et al.</i> (2013)	Spanish	Total: 2151	The Stroop Color And Word Test (Scwt) Golden Version	<ul style="list-style-type: none"> •Error •Response time 	<ul style="list-style-type: none"> •Age •Education •Gender •Main language
Lynn and Irwing (2008)			The Digit Span Test Mental Arithmetic (Wechsler Intelligence Tests For Adults And For Children)	<ul style="list-style-type: none"> •Number of digits 	<ul style="list-style-type: none"> •Age •Education •Race
Ludwig, <i>et al.</i> (2010)	French	Total: 228	Stroop Color Test (Comparison Of Two Version -A Standard Blocked Paper-And-Pencil Version And A Computerized Item-By-Item One.	<ul style="list-style-type: none"> •Error •Response time 	<ul style="list-style-type: none"> •Gender •Age •Types of test
Letie <i>et al.</i> (1999)	Brazilian	Total: 92 Male: 39 Female: 53	The Video-Recorded Stroop Color-Word Test	<ul style="list-style-type: none"> •Error •Response time 	<ul style="list-style-type: none"> •Gender •State-trait anxiety score

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Tomaszewska <i>et al.</i> (2008)	Polish	Total: 200 Female: 100 Male: 100	Stroop Color Test Trail Making Test N-Back Test	• Response time	• Education • Age • Gender
Bayard <i>et al.</i> (2011)	French	Total: 244	The Stroop Color-Word Test-Victoria version (VST)	• Error • Response time	• Age • Education
Choi <i>et al.</i> (2013)	Korean	Total: 784 Male: 266 Female: 518	Digit Span Test	• Length of digits	• Age • Education • Gender
Fine <i>et al.</i> (2012)	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. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Woods <i>et al.</i> (2010)	USA New Zealand	Total: 31 Male: 16 Female: 15 Total: 763	Digit Span Test Hopkins Verbal Learning Test Benton Visual Retention Test Digit Symbol Test National Adult Reading Test	<ul style="list-style-type: none"> • Length of digits • Correct items • Correct items • Correct answers • Correct pronunciation 	
Yang <i>et al.</i> (2012)	Taiwan	Total: 888	Digit Span Test	<ul style="list-style-type: none"> • Length of digits 	<ul style="list-style-type: none"> • Age • Gender • Education
Wechsler (1997)	USA	Total: 2450	Digit Span Test	<ul style="list-style-type: none"> • Length of digits 	<ul style="list-style-type: none"> • Age • Gender
Kessels <i>et al.</i> (2008)	Dutch	Total: 246 Male: 112 Female: 134	Corsi block-tapping task Digit Span Test	<ul style="list-style-type: none"> • Length of sequence • Length of digits 	<ul style="list-style-type: none"> • Age

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Piccardi <i>et al.</i> (2008)	Italian	Total: 75 Male: 40 Female: 35	Standard Corsi Span Modified Corsi Span	•Length of sequence •Length of sequence and correct recall	•Gender
Pagulayan <i>et al.</i> (2007)	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
Postma <i>et al.</i> (2004)	Holland	Total: 64 Male: 32 Female: 32	Corsi block-tapping task	•Length of sequence	•Gender

Table 2.1 Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Martins <i>et al.</i> (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	<ul style="list-style-type: none"> • Correct responses • Length of digits • Correct answers • Time to complete test • Correct answers • The maximum number of items 	<ul style="list-style-type: none"> • Age • Education

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Nissan <i>et al.</i> (2013)	Scottish	total: 150	Simple Reaction time test	<ul style="list-style-type: none"> Time Number of errors 	<ul style="list-style-type: none"> Age
Van Dyck <i>et al.</i> (2008)	USA	total:36	Simple reaction time	<ul style="list-style-type: none"> Time 	<ul style="list-style-type: none"> Age Education level
Cinaz <i>et al.</i> (2012)	German	total: 20	Simple reaction time Wearable reaction time test	<ul style="list-style-type: none"> Time 	<ul style="list-style-type: none"> Age Hand Load
Ritesh and Tejas (2012)	Indian	total:50	Simple Reaction time test	<ul style="list-style-type: none"> Time Number of errors 	
Padilla-Medina <i>et al.</i> (2013)	Mexican	total:28	Simple Reaction time test	<ul style="list-style-type: none"> Time Number of errors 	<ul style="list-style-type: none"> Age Diabetes
Gentier <i>et al.</i> (2013)	Belgian	total:37	Simple reaction time	<ul style="list-style-type: none"> Time Number of errors 	<ul style="list-style-type: none"> Age Gender Obese/healthy
Jakobsen <i>et al.</i> (2010)	Danish	total:200	Simple reaction time	<ul style="list-style-type: none"> Time Number of errors 	<ul style="list-style-type: none"> Age Gender Patient/healthy
Anstey <i>et al.</i> (2007)	Australian	total: 489	Simple reaction time	<ul style="list-style-type: none"> Time Number of errors 	<ul style="list-style-type: none"> Age Gender Patient/healthy
Howley <i>et al.</i> (2012)	Irish	total:57	Simple reaction time	<ul style="list-style-type: none"> Time 	<ul style="list-style-type: none"> Age Gender Genetic disorder/healthy

Table 2.1. Summary of studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST(S)	RESPONSE VARIABLE(S)	INDEPENDENT VARIABLE(S)
Mackintosh and Bennett (2005)	English	total:97	Raven Test	<ul style="list-style-type: none"> • Number of correct answers 	<ul style="list-style-type: none"> • Gender
Dobrean <i>et al.</i> (2005)	Romanian	total: 2755	Raven Test	<ul style="list-style-type: none"> • Number of correct answers 	<ul style="list-style-type: none"> • Age
Bass (2000)	Africa	total :380	Raven's Color	<ul style="list-style-type: none"> • Number of correct answers 	<ul style="list-style-type: none"> • Age • Grade
Raven (2000)	USA	total: 3464	Raven's Progressive Matrices	<ul style="list-style-type: none"> • Number of correct answers 	<ul style="list-style-type: none"> • Age • Ethnicity
Tiffin and Asher (1948)	USA	total:7814	Purdue Pegboard Test	<ul style="list-style-type: none"> • Number of pins 	<ul style="list-style-type: none"> • Gender
Garner and Broman (1979)	USA	total:1334	Purdue Pegboard Test	<ul style="list-style-type: none"> • Number of pins 	<ul style="list-style-type: none"> • Age • Gender
Hamm and Curtis (1980)	USA	total :340	Purdue Pegboard Test	<ul style="list-style-type: none"> • Number of pins 	<ul style="list-style-type: none"> • Age • Gender

2.1. Test Types

2.1.1. The Digit Span Test

The Digit Span test is most popular test for determining the span of immediate recall (Casanova, *et al.*, 2009). Digit Span is used for determining attention, concentration, and short-term memory of subjects (Hsieh and Tori, 2007). Digit span includes both attention and memory task (Casonova, 2009).

Backward version of the digit span test consists of working memory task, mental tracking task and verbal, visual processes (Larrabee and Kane, 1986). The result of the test is a single number, and this number refers to the subject's Digit Span (Casanova, *et al.*, 2009).

In Table 2.2., the Digit Span test results of different populations are listed. The independent and response variable values (number of digits) of both Digit span forward and backward tests are given.

Normative data on neuropsychological tests for Chinese people is rare (Lee *et al.*, 2002). Chinese researchers believe Chinese population has different cognitive capabilities from the Western societies (Lee *et al.*, 2002). All variables age, gender and education are considered at the studies. But only age and education are importantly related to cognitive performance, gender has a medium effect on elderly group's cognitive performance (Hsieh and Tori, 2007). Age, gender and education do not have an interaction in all studies. Education is related to digit span results (Lee *et al.*, 2002).

In a study of US sample, age and education had a significant effect on Digit Span test performance. On the other hand gender did not have any significant effect (Fine *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	mean:69.27 years	7.49	1.29
			backward	gender	male	3.82	1.29
		43	forward	age	mean:69.27 years	7.4	1.03
			backward	gender	female	3.42	1.45
Chan <i>et al.</i> (2009)	Chinese	90	forward	education	total	7.28	1.3
		38			high	7.92	1.12
		52			low	6.81	1.22
Jorm <i>et al.</i> (2004)	Australian	2404	backward	age gender	20-25 male years	5.47	2.31
					20-25 female years	5.23	2.26
		2530	backward	age gender	40-44 male years	5.33	2.36
					40-44 female years	5.1	2.23
		2551	backward	age gender	60-64 male years	5	2.26
					60-64 female years	4.75	2.22
McCurry <i>et al.</i> (2001)	Japanese American	120	forward and backward	age	70 -79 years	11.8	3.5
		81	forward and backward	age	80 + years	10.4	2.3
Monaco <i>et al.</i> (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 <i>et al.</i> (2010)	Chinese	28	forward	age	mean :12.33	8.89	0.88
			backward	education	7 years	6.14	1.86
		29	forward	age	mean :12.43	8.17	1.4
			backward	education	7 years	6.38	1.28
		23	forward	age	mean :12.50	9.14	1.48
			backward	education	7 years	5.48	1.81
		21	forward	age	mean :12.71	8	1.22
			backward	education	7 years	5.05	1.32
		32	forward	age	mean :14.15	9.03	0.97
			backward	education	9 years	6.91	1.78
		27	forward	age	mean :14.17	9.15	1.17
			backward	education	9 years	6.44	1.5
		18	forward	age	mean :14.58	8.78	0.81
			backward	education	9 years	5.38	1.62
		38	forward	age	mean :14.95	8.24	1.2
			backward	education	9 years	5.03	1.55
		36	forward	age	mean :16.03	9.44	1.25
			backward	education	11 years	7.53	1.68
		31	forward	age	mean :16.06	8.97	0.87
			backward	education	11 years	6.52	1.57
27	forward	age	mean :16.72	8.78	1.55		
	backward	education	11 years	6.3	1.66		
31	forward	age	mean:16.38	8.58	1.54		
	backward	education	11 years	5.45	1.81		
134	forward	age	total	8.86	1.24		
	backward	education		6.39	1.73		
14	forward	age	20-46 years	7.86	1.29		
	backward	education	<9 years	5.15	1.14		
50	forward	age	20-46 years	8.92	1.21		
	backward	education	9-13 years	6.2	1.7		
69	forward	age	20-46 years	9.12	1.16		
	backward	education	>13 years	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 <i>et al.</i> (2013)	Koreans	9	forward	age	60-74 years	3.89	2.15
			backward	education	0-3 years	3.56	0.88
		60	forward	gender	male	5.52	2.48
			backward	age	4-9 years	4.47	1.56
		109	forward	education	male	7.58	2.49
			backward	gender	>10 years	5.42	1.55
		101	forward	age	60-74 years	3.66	1.73
			backward	education	0-3 years	2.86	1.43
		167	forward	gender	female	4.93	2.02
			backward	age	60-74 years	4.12	1.46
		116	forward	education	4-9 years	6.86	2.02
			backward	gender	>10 years	5.05	1.54
		8	forward	age	60-74 years	4.13	1.13
			backward	education	0-3 years	3.13	1.46
		41	forward	gender	male	5.2	2.1
			backward	age	75-90 years	4.27	1.38
39	forward	education	4-9 years	6.28	1.96		
	backward	gender	male	5.23	1.75		
53	forward	age	75-90 years	3.04	1.21		
	backward	education	0-3 years	2.55	1.15		
53	forward	gender	female	4.58	2.17		
	backward	age	75-90 years	3.94	1.46		
28	forward	education	4-9 years	6.25	2.84		
	backward	gender	female	4.94	1.88		
Woods <i>et al.</i> (2010)	New Zealand	763	forward	age	mean:46.5 years	6.35	1.15
			backward	education	mean:12.5 years	4.61	1.22
Yang <i>et al.</i> (2012)	Taiwan	1658	forward	total		7.63	1.44
			backward	education	6-16 years	5.21	1.8
Woods <i>et al.</i> (2010)	American (USA)	31	forward	age	mean:26 years	7.36	0.88
			backward	education	mean:14.8 years	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 <i>et al.</i> (2012)	American (USA)	260	forward	age	85-86 years	7.6	2.1
			backward	gender	female	6.1	2
		143	forward	age	85-86years	7.6	2
			backward	education	<12 years	6.1	1.9
		117	forward	gender	female	7.6	2.2
			backward	age	85-86 years	6.1	2.1
		279	forward	education	>12 years	7.4	1.9
			backward	gender	female	6	2
		148	forward	age	87-89 years	7.3	2
			backward	education	<12 years	5.8	2
		131	forward	gender	female	7.5	1.9
			backward	age	87-89 years	6.4	2
141	forward	education	>12 years	7.5	2.2		
	backward	gender	female	5.9	2.8		
89	forward	age	90-95 years	7.4	2.2		
	backward	education	<12 years	5.6	1.7		
52	forward	gender	female	7.8	2.3		
	backward	age	90-95 years	6.2	2		
Kessels <i>et al.</i> (2008)	Dutch	37	forward	age	50-59 years	6.1	1.3
			backward	age	50-59 years	4.8	1.3
		112	forward	age	60-69 years	5.7	1.2
			backward	age	60-69 years	4.3	1.2
		81	forward	age	70-79 years	5.5	1.1
			backward	age	70-79 years	4	1.2
16	forward	age	80 + years	5.6	1.1		
	backward	age	80 + years	4.3	1.1		
Wechsler (1997)	American (USA)	2450	forward	age	16-89 years	6.43	1.36
backward	age		16-89 years	4.7	1.43		
Martins <i>et al.</i> (2013)	Portuguese	12	forward	age	60-65 years	4	1
			backward	education	0-3 years	3	1
		77	forward	age	60-65 years	5	1
			backward	education	4 years	3	1
		72	forward	age	60-65 years	6	1
			backward	education	5-9 years	4	1
		71	forward	age	60-65 years	6	1
			backward	education	>9 years	4	1
		36	forward	age	>65 years	4	1
			backward	education	0-3 years	3	1
		108	forward	age	>65 years	5	1
			backward	education	4 years	3	1
59	forward	age	>65 years	5	1		
	backward	education	5-9 years	4	1		
44	forward	age	>65 years	5	1		
	backward	education	>9 years	4	1		

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 <i>et al.</i> (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		

A comparative study of 1658 Chinese of Taiwan with 16 to 84 years had found that the digit span scores of Chinese of Taiwan differ from US population; Taiwan sample has better results in the longest forward span than the USA sample (Yang *et al.*, 2012).

Studies in Korean population are limited. Basically they aim to explore the effect of demographic variables on Digit Span test scores of Korean population (Choi *et al.*, 2013). A large sample of elderly people is used for research, only healthy participants are included (Choi *et al.*, 2013). The study shows that age, gender and education have an important effect on performance of digit span test for both forward and backward versions. The results indicate that working memory capacity and attention are affected by age, gender and education.

In Europe, there are studies on different populations. For example, Monaco *et al.* (2012) developed Italian population norms for digit span forward and backward tests, conducting tests on a large sample from different age groups. The results of the study shows that age is negatively related to performance of both forward and backward digit span test, education has positive effect on performance of subjects and finally gender does not affect digit span scores (Monaco *et al.*, 2012).

Elderly Dutch population was investigated for digit span backward and forward tests with 246 participants (Kessels *et al.*, 2008). As a result of this study no gender effect was found on the forward and backward Digit Span performance, negative correlation between age and digit span performance is found and education has positive correlation. However according to the study gender differences on this type of spatial memory task can only be shown in very large sample sizes. This study compared also Digit Span backward and forward tests; and it could be said that the Digit Span backward is more difficult than the forward task. Because the forward and backward Digit Span might include different cognitive operations (Kessels *et al.*, 2008).

Most of the studies about digit span performance focus on older age groups. In Portugal, Martins *et al.* (2013) tested old and low educational (64% female, mean age 66.4 years) 479 Portuguese subjects for developing norms for Digit Span Test. 13 measures of cognitive

function (Trail Making Test, Symbol Search, Matrix reasoning; Semantic and phonemic verbal fluencies, Stroop test, and digit span) are conducted on a sample of 479 adults. Independent variables as age, gender, and education were examined within each age group; age shows less variance than education (Martins *et al.*, 2013). Gender has different effect on performance of Digit Span Test; women had an importantly better performance on Digits Span forward and backwards.

In Australia, gender differences in cognitive abilities were investigated with a very large sample of Australian subjects from different age groups from 20 to 64 (Jorm *et al.*, 2004). They only conducted Digit Span backward test and considered gender and age effect on cognitive performance. According to this study, males performed better on Digit Span Backward, but they also focus on a range of socio demographic, health state, and health habit variables as possible mediators of these gender differences, like education, non-English speaking background, depression, alcohol use or 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 (Jorm *et al.*, 2004).

Mccury *et al.* (2001) conducted a study to investigate the influence of age, education, gender and spoken language on cognitive abilities in a moderate sample of elderly Japanese-American adults. The population of the study consisted of persons with age 65 or older, who were at least 50% Japanese. As a result, older age was correlated to lower Digit Span scores. Moreover, female subjects showed better performance on Digit span test. Education and spoken language did not have a significant effect on performance of digit span test.

In Turkey, Karakas *et al.* (2002) studied Visual Aural Digit Span Test–Revised, with 1856 subjects from different age. Age and education were found significant factors for Digit Span test performances.

- Both in Eastern and Western society's normative data for Digit Span Forward and Backward test are developed. They have different norm values. Generally speaking, Eastern Societies' Digit Span test performances were better than Western societies.
- Age, Gender, Education factors are considered as independent factors. In general, age and education have effect on results. Age has a negative effect, education has a positive effect. In case of gender, the results are conflicting.
- In Turkey there is only one study and this study used only visual aural digit span test. Age and education were found significant for result, age has shown a negative effect but education has shown a positive effect on the test performance.

2.1.2. The Corsi Span Test

Spatial memory is described as the ability of storing information about spatial features of the environment, and recalls this information, this type of memory is essential for everyday tasks, because it helps us remembering the locations of objects (Postma *et al.*, 2004).

Corsi Span Test is also called as Location Memory Test in literature. The Corsi span test is often used for determining verbal and visual-spatial short-term memory and learning, differently from the digit span test, the Corsi span test measures the ability of reproducing a sequence of locations (Monaco *et al.*, 2012). Like the digit span test Corsi span test has backward and forward versions, the response variable of the tests is the maximum length of sequence that subject recall (Kessels *et al.*, 2008). Forward versions of Corsi Span, in which sequences of items of increasing length have to be reproduced in the order they were presented, is used for determining operating of the working memory material-specific slave systems, the backward Corsi Span, in which sequences of items have to be reproduced in the reverse order, is used for evaluating Central Executive resources (Monaco *et al.*, 2012).

There are some studies for providing normative data for Italian, USA and Dutch people. One of the studies researched how the order in which information is presented affects when a

person decides to stop performing a task by using the Corsi Span test results (Yu and Gonzalez, 2013).

In Table 2.3, The Corsi Span test results of different populations are listed. The independent variables and response variable values (length of sequence) of both Corsi span forward and backward tests are given.

A study about Italian population included, 362 healthy Italian subjects with age 20 to 90 years. Both forward and backward version of the test are conducted, and the results of the tests shows that with increasing age performance in all tasks decrease, but education has a positive effect on the performance of Corsi span backward test (Monaco *et al.*,2012). This study also compared The Digit Span test and Corsi Span test. According to results of the study, subjects' forward span was larger in the Digit Span task than the Corsi task and backward span was smaller on the Digit task than the Corsi backward span (Monaco *et al.*,2012).

In Dutch population, the author conducts a standardized backward test with 246 healthy older adults from age 50 to 92 (Kessels *et al.*, 2008). They also compare the results with the Digit test results. The effects of independent variables examined and it shows that there is no gender effect on Corsi Span forward and backward tests, but age has small negative effect on the results of Corsi backward test. Education level had positive effect on Corsi forward task performance (Kessels *et al.*, 2008). When authors compared Corsi forward and backward test results, it seems the forward and backward conditions were equally difficult, scores are not different and according to this they claim that the Corsi forward and backward conditions rely on the same cognitive process (Kessels *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 <i>et al.</i> (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 <i>et al.</i> (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 <i>et al.</i> (2008)	Italian	40	forward	age education gender	mean:23.1 13 male	years years	5.28	0.88
		35	forward	age education gender	mean:23.26 13 female	years years	4.38	0.82
Pagulayan <i>et al.</i> (2007)	American (USA)	26	forward	education age	Grade mean:7 years	1	5	0.8
		27	forward	education age	Grade mean:8.1 years	2	5.2	1
		24	forward	education age	Grade mean:9 years	3	5.5	1
		24	forward	education age	Grade mean:10 years	4	6	1.1
		26	forward	education age	Grade mean:11 years	5	6.3	0.9
		47	forward	education age	Grade mean:12.2 years	6	6.3	0.9
		32	forward	education age	Grade mean:12.9 years	7	6.4	0.9
		40	forward	education age	Grade mean:13.9 years	8	6.9	1.1
		91	forward	education age	Grade mean:21.7 years	13+	7.1	1
Postma <i>et al.</i> (2004)	Netherland	32	forward	age gender	mean: 21.4 male	years	6.22	1.1
		32	backward	age gender	mean: 21.5 female	years	5.75	0.98

Another study on Dutch population showed that males have better performance than females in an object location memory task (Corsi Block Tapping test) (Postma *et al.*, 2004).

An Italian study investigated gender difference and for that purpose Corsi Block-Tapping test (CBT) is used for test locations and route memories. Their results showed that males have better performance for both forward and backward task, females have a more homogeneous pattern of memory (Piccardi *et al.*, 2008).

- Age, education and gender affects are investigated. Age generally has negative effect on results. But education has positive correlation. Gender factor has conflicting results.
- In Turkey, there is no study about Corsi Span Test.

2.1.3. Stroop Color and Word Test

The Stroop Color and Word Test (SCWT) is commonly used in neuropsychological assessment to evaluate the cognitive functions of attention control, information processing speed, selective attention and cognitive flexibility (Llina`s-Regla *et al.*, 2013). Generally this test is preferred for its short administration time and sensitivity for evaluating cognitive functions (Rregard, 1981).

Most of the clinical studies prove that subjects who have diseases like schizophrenia, depression, attention deficit with hyperactivity disorder, Parkinson's disease, chronic alcoholism, head trauma, child focal benign epilepsy, and dementia, among others, do not perform well on the Stroop Color Word Test (Lezak *et al.*, 2004).

There are a number of versions of Stroop test. These versions differs in the number of cards, items on the cards, in the size and presentation of stimuli cards, applying procedure, the method of scoring, and the normative data calculation. Some studies collect and show

normative data for errors scores of items and only some of the versions correct for generalized slowing on the interference condition (Bayard *et al.*, 2011).

Although there are different versions of the Stroop test, the basic paradigm has not changed (Elst *et al.*, 2006). The basic paradigm of the test is performance of an individual on a simple task and its comparison with his or her performance on an analogous task in which a habitual response needs to be suppressed in support of an unusual one (Elst *et al.*, 2006). In this paradigm the time difference between first task and latter task is defined as “the Stroop interference effect” and this effect is generally used for determining cognitive flexibility and mental control (Davidson *et al.*, 2003). The interference effect can be explained as the reading of words printed in a different color is slower than the reading of the word or the color naming separately (Strauss *et al.*, 2006). So despite of the version Stroop test consists of an interference task and control tasks.

In all versions, the Stroop test provides data about the reading of words, colors, and words–colors (Llina`s-Regla *et al.*, 2013). In the most widely used version of test, Golden’s version of the Stroop test, the interference score is measured by using the assumption of the time for naming a color printed in a word of a different color is a function that is additive to the time necessary for reading the word plus the time necessary for naming the color (Llina`s-Regla *et al.*, 2013). This version includes 3 cards that have 50 items on (Karakas *et al.*, 1999). The other popular version of the test is the Victoria version, in this version there are 3 cards each consist of 24 items, on cards three conditions that consist in naming the color of dots, of neutral words, and of color words printed in incongruent colors are showed (Bayard *et al.*, 2011).

In Table 2.4, The Stroop test results of different populations are listed. The independent and response variables (duration and errors) and versions of the test are given.

Table 2.4. Stroop Color and 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	gender		21.11	6.24
		57	Word	age	60-71 years	79.02	11.94
			Color	gender	female	38.33	13.55
			Color-Word	gender		24.02	5.66
54	Word	age	72-84 years	56.52	17.31		
	Color	gender	male	28.28	10.96		
	Color-Word	gender		20.28	4.52		
71	Word	age	72-84 years	69.04	14.94		
	Color	gender	female	30.69	11.01		
	Color-Word	gender		21.7	5.46		
171	Word			65.5	16.28		
	Color	education	<12 years	29.94	11.18		
	Color-Word	education		20.63	5.02		
42	Word			75.95	12.84		
	Color	education	12 years	33.05	6.86		
	Color-Word	education		23.36	4.72		
23	Word			85.74	11.81		
	Color	education	>12 years	48.83	17.2		
	Color-Word	education		27.7	7.13		
236	Word			69.33	16.69		
	Color	total		32.33	12.54		
	Color-Word	total		21.8	5.63		

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

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Lee et al. (2010) cont.	Chinese	31	Dot subtask (time)	age	mean :16.06 years	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	mean :16.72 years	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	mean :16.38 years	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			31.6	9.2
		334	Word	age	55-61 years	94.9	15.3
			Word-Color			37.9	9.5
		227	Word	age	55-61 years	98.8	14.7
			Word-Color			40.3	9.1
		513	Word	age	62-64 years	79.5	17.6
			Word-Color			30.9	9.3
		300	Word	age	62-64 years	94.4	15.9
			Word-Color			37.2	9.4
		202	Word	age	62-64 years	97.5	15.2
			Word-Color			39.7	8.9
		521	Word	age	65-67 years	77.4	18.3
			Word-Color			30.4	9.9
		249	Word	age	65-67 years	92.6	15.9
			Word-Color			35.9	9.5
		176	Word	age	65-67 years	97.5	15.2
			Word-Color			38.2	9.7
		515	Word	age	68-70 years	74	18.6
			Word-Color			28.9	10.1
		193	Word	age	68-70 years	89.5	16.1
			Word-Color			33.9	9.3
		137	Word	age	68-70 years	96	0
			Word-Color			36	11.1
		469	Word	age	71-73 years	71.2	18.8
			Word-Color			28.3	10.5
		139	Word	age	71-73 years	85.3	16.8
			Word-Color			32.2	9.2
		109	Word	age	71-73 years	92.3	15.4
			Word-Color			33	10.6
444	Word	age	74-76 years	68.9	19.4		
	Word-Color			26.7	9.3		
115	Word	age	74-76 years	81	16		
	Word-Color			29.8	8.8		
91	Word	age	74-76 years	87.4	15.1		
	Word-Color			30.8	11.6		
401	Word	age	77-79 years	66	19.2		
	Word-Color			25.3	9.1		

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

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

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

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst et al. (2006) cont.	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 and Word Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst et al. (2006) cont.	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 and Word Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst et al. (2006) cont.	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 and Word Test studies in the literature (cont.).

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst et al. (2006) cont.	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 and Word Test studies in the literature (cont.).

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

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

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

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

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

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

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

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

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULT (seconds)	
						MEAN	SD
Elst et al. (2006) cont.	Dutch	17	Stroop V (Interference)	gender age education	female 44-46 years high education	29.84	9.6
		18	Stroop V (Interference)	gender age education	female 49-51 years high education	38.85	11.53
		6	Stroop V (Interference)	gender age education	female 54-56 years high education	35.03	11.81
		7	Stroop V (Interference)	gender age education	female 59-61 years high education	37.94	7.35
		5	Stroop V (Interference)	gender age education	female 64-66 years high education	40.88	7.85
		6	Stroop V (Interference)	gender age education	female 69-71 years high education	47.16	7.68
		6	Stroop V (Interference)	gender age education	female 74-76 years high education	58.03	25.88
		6	Stroop V (Interference)	gender age education	female 79-81 years high education	69.91	27.93
Karakas 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 a study of 244 elderly French populations with age 50 to 59 years, the effect of age and education on cognitive function is studied by using the Victoria version of Stroop test (Bayard, *et al.*, 2011). Age has shown negative effect on test performance.

In French-speaking communities of North America, the Stroop Test is one of the most widely used tests for measuring cognitive functioning (Ivnik *et al.*, 1996). In one study the French adaptation of the Victoria Stroop test was used (Bayard *et al.*, 2011). As a result of the study, normative data for the VST for an elderly francophone population is provided. Gender was not found to be significantly associated with performance. Also consistent with literature education factor has positive effect on the performance of the test (Bayard *et al.*, 2011).

In Spain for creating normative data for the Stroop Color and Word test and seeing the effect of age, sex, and educational level, Stroop test was applied to a population based sample of 2,151 participants aged 55 or older. For determining the effect of sex, age, and educational level, linear regression models are used (Llina`s-Regla *et al.*, 2013). There are some studies for normative data for different languages and versions of Stroop test (Lezak *et al.*, 2004). Most of these studies provide normative data of the SCWT in elderly populations were from Anglo-Saxon countries and with subjects of a relatively high educational level (Ivnik *et al.*, 1996).

The results of Llinas-Reglas et al (2013) study prove that demographic variables such as age, sex, and level of education affect Stroop Test scores of subjects. According to the study age is the most effective variable and explains most of the variance for all scores. This study does not provide an effect of age because the age range was restricted by 55 years or more and also, education level had a significant effect on performance of subject (Llina`s-Regla *et al.*, 2013).

A study in the Netherlands with large sample of 1856 subjects with age range 24 to 81 showed effects of age, education and gender on Stroop Color Word test performance (Elst *et al.*, 2006). According to the results, it could be said that the demographic variables effect the speed-dependent Stroop scores (time to complete a subtest), rather than the accuracy measures (the errors made per Stroop subtask), besides main effect of these variables, interactions

between age and was detected for the Error III and the Stroop Interference scores (Elst *et al.*, 2006). So as a result, it is obvious that executive functioning declines with age especially in people with a low level of education (Elst *et al.*, 2006).

For African-American population, the effect of demographic characteristics on Stroop Color Word test and cognitive functioning is measured by testing 236 elderly African American adults (60–84 years of age), as a result normative data of Stroop test scores and age, education, gender, and the education by gender interaction were determined to influence the Stroop Color and Word Test tasks scores (Moering *et al.*, 2004).

For Chinese population there are some studies which investigated effects of demographic variables and provide normative data both Victoria version and Golden version of Stroop Color Word Tests. Like the study that provide norms on several tests including Stroop test using a sample of 475 Cantonese-speaking Chinese aged from 13 to 46 (Lee *et al.*, 2002). And study of Chinese version of Stroop Color and Word test to search effect of education and provide normative data by using 174 Chinese speaking subjects (Chan *et al.*, 2009).

In Turkey, there is only one study that used Turkish version of Stroop Color and Word test. Aim of the study was only the standardization of the Stroop Test and determining the scoring method for this standardization, named as the Stroop Test TBAG version not providing normative data for executive functioning. 395 subjects aged from 20 to 74 are administered to this version (Karakaş, *et al.*, 1999).

- There are studies all around the world which used Stroop Color and Word Test.
- Most of them searched demographic variables (age, gender, education) effect on test responses. Especially age factor seems to have a negative effect.
- In Turkey, there is only one study. Aim of the study was only the standardization of the Stroop Test and determining the scoring method for this standardization, named as the Stroop Test TBAG version, but not providing normative data for cognitive

functioning. 395 subjects aged from 20 to 74 participated in this version. Age factor has shown negative effect on test performance and also education has shown positive effect on test performance.

- In general, only gender factor had conflicted results in the studies.

2.1.4. Reaction Time Test

The reaction time is useful for determining the processing speed of Central Nervous System. It is also used for analyzing the co-ordination between the sensory and motor systems (Ritesh and Tejas, 2012).

For measuring peoples' motor function performance, reaction time test could be used. Nissan et al., (2013) studied the effect of age on cognitive and motor function performance by using reaction time test.

There are two types of reaction time which are simple reaction and choice reaction time. In simple reaction time there is only one stimulus and response variable is time average of five trials. In choice reaction time there are more than one stimulus and multiple response variables which 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 response variables are given too.

Table 2.5. Reaction Time Test studies in the literature.

SOURCE	POPULATION	SAMPLE SIZE	TEST TYPE	INDEPENDENT VARIABLES		RESULTS (ms)	
						mean	S.D
Nissan <i>et al.</i> (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 <i>et al.</i> (2008)	American (USA)	36	simple reaction time	age education	68-88 years 9-20 years	217.3	34
Cinaz <i>et al.</i> (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)	Indian	50	Simple reaction time	gender	male	165.9	26.8
			Choice reaction time			308.6	74.9
Padilla-Medina <i>et al.</i> (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 <i>et al.</i> (2013)	Belgian	19	Simple reaction time	age	6-12 years	460.69	49.87
			Choice reaction time			560.48	66.56
Jakobsen <i>et al.</i> (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 <i>et al.</i> (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 <i>et al.</i> (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 a study of Scottish people, reaction time test is applied to 150 people from different age groups. For analyzing effect of age on test results, subjects are divided in three age groups. The results of the study pointed out that age has a significant effect on the reaction time test performance, and older people are slower (Nissan *et al.*, 2013).

There are some comparative studies of simple and choice reaction time tests. For example in India there is a study that used 50 male students as subjects and this study provides that younger people has better results in simple reaction time than choice reaction time (Ritesh and Tejas, 2012).

In a study of Belgian people, reaction time test provided information about effect of obesity on controlling functions and movement execution (Gentier *et al.*, 2013). The study conducted on 19 obese children and 19 healthy children. As a result it was concluded that children with normal weight have shorter reaction time for the both simple and choice reaction time test. In conclusion, it is assumed that obesity has a negative impact on motor functions, since it has a negative impact on reaction time test (Gentier *et al.*, 2013).

- There are some studies about Simple Reaction Time Test. Age factor has negative effect on test performance in general. Also obesity and health problems have negative effect too. No education and gender effect have found in studies.
- In Turkey there is not normative data on this test.

2.1.5. Purdue Pegboard Test

One of the neuropsychological tests for measuring gross movements of fingers, hands and arms and fine motor dexterity is Purdue Pegboard Test (Tiffin and Asher, 1948). The first version of Purdue Pegboard Test was developed by Tiffin in 1948 (Tiffin and Asher, 1948).

In Table 2.6, the results of Purdue Pegboard Test for different populations are listed. The independent variables, sample information, sample size and response variable are given as well.

In a study of US population Purdue Pegboard test is used for selecting new employees for industrial jobs; such as packing and assembly by assessing finger dexterity (Tiffin and Asher, 1948). The researchers divided their sample (7814 subjects) in five groups as college men, college women, veterans (men), industrial applicants (men) and industrial applicants (women). The results of the test suggested that there is no significant difference between industrial women and college women. Women are better than men for finger dexterity and gender has an effect on the motor function and finger dexterity.

Another study of US school children (663 girls, 671 boys) aged between 5 and 15 showed that gender has an influence on motor functions like movements of fingers, hands and arms (Garner and Broman, 1979).

For the normative data study of older Japanese American population, McCurry *et al.* (2001) investigated the effects of age, education, gender, and primary spoken language on motor functions by using Purdue Pegboard Test. The subjects' age was 65 or older who were at least % 50 Japanese heritages. From the results of this study, it was stated that age and education have significant effect on motor function ability and speed. In addition, gender had an effect; female subjects had better results than male.

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 males	<35 years	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 females	<35 years	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 males	≥35 years	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 females	≥35 years	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 Men	Applicants	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 Women	Applicants	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	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	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)	5.0-5.5 years	Right Hand	10	1.53	
				Left Hand	8.5	1.36	
				Both Hand	13.94	2.5	
				Assembly	14.7	2.55	
			5.6-5.11 years	Right Hand	9.3	1.73	
				Left Hand	9.13	1.59	
				Both Hand	13.54	2.56	
				Assembly	14.37	4.02	
			6.0-6.5 years	Right Hand	11.43	1.33	
				Left Hand	10.23	1.52	
				Both Hand	17.06	2.92	
				Assembly	18.03	3.54	
			6.5-6.11 years	Right Hand	11.87	1.68	
				Left Hand	10.47	1.38	
				Both Hand	17.34	3.58	
				Assembly	20.63	4.27	
			7.0-7.5 years	Right Hand	12.03	1.65	
				Left Hand	10.47	2.08	
				Both Hand	17.66	3.6	
				Assembly	19.77	4.49	
		7.6-7.11 years	Right Hand	12.47	1.53		
			Left Hand	11.5	1.8		
			Both Hand	19	3.4		
			Assembly	20.2	4.61		
		8.0-8.5 years	Right Hand	13.07	1.78		
			Left Hand	12.03	1.4		
			Both Hand	20.2	3.62		
			Assembly	21.93	4.31		
		8.6-8.11 years	Right Hand	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 <i>et al.</i> (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

- There are studies in Eastern and Western countries but in Turkey no study is conducted.
- In general, gender has an effect on results. Female shows better performance than males.
- Also Age and education level is investigated. Age has a significant negative effect on results. Education factor effects are conflicting.

2.1.6. Raven Standard Progressive Matrices

Raven's Standard Progressive Matrices could mostly be used for design and decision making since it examines the effects of human cognitive capacity and its relationship to time constraints (Raven, 2000).

The most popular and widely used intelligence test of all time is Raven's Progressive Matrices Test (Raven *et al.*, 2005). This test is easy to conduct both as an individual and group test. It could be applied to a wide age range that's why this test is very popular among intelligence tests (Raven *et al.*, 2005). This test is a non-verbal test so it can be conducted in diverse languages and cultures and in different settings as schools, organizations etc. (Raven, 2000).

In Table 2.7, the results of Raven Progressive Matrices for different populations are listed. The independent variables, sample information, sample size and response variable are given as well.

John Raven applied this test to 2000 subjects who has summarized norms of different cultural, ethnic, and socioeconomic groups (Raven, 2000). Raven claims that this test is useful for assessing two different abilities first educative ability and second reproductive ability (2000). Also results of the study developed normative data for British children aged from 6.5 to 15.5. (Raven, 2000).

Table 2.7. Raven Standard Progressive Matrices 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
				Raven (2000)	USA	2924
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					
Dobrea <i>et al.</i> (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					

A study in England aimed to determine the effects of gender on Raven Test score and this study presents normative data for 17 and 18 years of girls and boys (Mackintosh and Bennett, 2005). They applied subjects the short version of Raven Progressive Matrices that includes 36 questions and has been applied to 34 male and 95 female English sixth-grade students, aged 17–18. As a result the study claimed that males are better than females.

In Romania, The Raven's Standard Progressive Matrices has been conducted to 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 (Dobrea *et al.*, 2005).

In Poland this test is conducted to 977 subjects aged between 15 and 55 for obtaining normative data (Dobrea *et al.*, 2005). This study shows no relationship between exam scores of subjects and test results, also Poland's norms are better than USA norms (Dobrea *et al.*, 2005).

In Ankara (Turkey), Duzen and Sahin (1944) performed Raven Progressive Matrices for children. 2458 children aged between 6.5 and 15, from 15 different primary schools had been selected. Age is found as the main factor affecting the performance but education level of parents, rural background, and income were also effective. The results showed that the differences between life in rural and urban areas have a significant effects on test scores. Mother's education levels of subjects have more significant effects on scores. The normative data from this study have been compared to 1979 British norms, and it shows that British norms are higher than Turkish norms.

- In Turkey, Raven Test was conducted to children. Education factor was investigated and found insignificant. Age factor was the main factor affecting the performance. No normative data on adult population of Turkey exists.
- Some studies claims that males performing better than female participants. Also age factor has shown negative effect on Raven performance. Education factor has conflicting results.

2.2.Critiques of Findings

For Digit Span Test:

- There are few studies for Far East countries like China, Japan, and Hong Kong for Digit Span Test. Most of the studies provide normative data for Western Countries and aim to provide normative data for digit span test and investigate effect of demographic variables like age, education and gender.
- Effects of demographic variables are similar between China and Western countries. For both age and education where significantly related to neuropsychological performance; in older ages subjects tend to show loss of psychomotor speed, memory functions, and certain executive abilities (Hsieh

and Tori (2007). In China, education factor is the most important variable with digit span score (Lee *et al.*, 2002). Education level of subjects has conflicting effects in the literature; it has a positive impact on digit span test in some studies; for population of Portuguese, again education is the variable that explains most of the variance (Martins *et al.*, 2013). But for example Japanese-American population show no relation between digit score and education (Mccury *et al.*, 2001).

- Generally speaking, these studies focus on only digit span test. Few studies apply series of cognitive test to develop norms for general cognitive abilities including attention, concentration, speed, memory and learning, motor function and intellectual function.
- In Turkey, Karakas *et al.* (2002) performed a study for Visual Aural Digit Span Test–Revised with 1856 subjects from different age. Effect of age and education had an effect on subjects’ digit span scores. They used aural stimuli–oral response (A–O), visual stimuli –oral response (V–O), aural stimuli –written response (A–W) and visual stimuli –written response (V–W) types of digit span. But they excluded aural stimuli-aural response (A–A). And during their study subjects were only administrated to digit span forward version of the test.

So in Turkey there is not a normative data for both Digit Span Forward and Backward test.

For Corsi Span Test:

- Normative data on Corsi Span test is not many. In Europe there are some studies for measuring location memory, this test is preferable for its easy and short administration procedure (Kessels *et al.*, 2008).
- These studies generally used large sample of participants so norms for Western countries can be found in the literature. Also in these articles influence of demographic variables; age, gender and education on location memory of participants were studied.
- Older age leads lower Corsi span scores, but high education leads high span scores in general. For gender affect, studies shows different results; in some

there is no significant difference but some studies showed males perform better results than females.

- For other populations normative data is scarce, especially in Turkey there is not a significant study that provided norms and determining effects of demographic variables on Corsi Span task performance.

For Reaction Time Test:

- There are studies that provide normative data for reaction time test in Scotland, Germany, India, Mexico, Belgium, Australia and Ireland. These studies mostly investigated age effect on results. Older people were slower in general. Gender mostly does not affect reaction time; however, in some studies males performed better.
- Disorders, health problems have a negative impact on reaction time. Some studies reveal that people who score highly on intelligence tests also tend to have faster and less variable reaction times.
- Most of these studies do not cover all considered populations and they have small sample sizes.
- In literature, there is no extensive study that provides normative data for the population in Turkey.

For The Raven Progressive Matrices:

- In different populations the Raven Progressive Matrices norms are established and impact of age, gender, culture and education factors on test results were examined.
- In these studies, sample size mostly covers different age groups, but most of the studies only focus on normative data and relation between Raven and other neuropsychological tests were not assessed.
- Results of these studies shows that gender have conflicting effect on the results; in some populations (e.g., British) there was no significant difference between male and female scores but in some other populations (e.g., South African) males performing better than female participants.

- Generally speaking, age is the main affecting factor; but education level of parents, rural background, and income examined for children in Turkey showed that the differences between life in rural and urban areas have significant effects on test scores.
- In Turkey a few studies provide information about The Raven Progressive Matrices test scores; however, there is not a comprehensive study that provides normative data for all age groups.

For Purdue Pegboard Test:

- In general, it could be said that for Purdue Pegboard Test women are better than men at finger dexterity and gender has an effect on the motor functions. Also age and education have significant effect on motor function ability and speed too.
- In Turkey, there are several studies with Purdue Pegboard Test. One of these studies investigated the effect of class ranks of nursing students. In literature there are no extensive studies that provide normative data for population in Turkey.

For Stroop Color and Word Test:

- This test is the most popular test for evaluating the executive functions of attention control, information processing speed, selective attention and cognitive flexibility since it has short administration time and sensitivity for evaluating cognitive functions (Lee *et al.*, 2002). So there are many researches in the literature for different populations and age range. There are norms for Spanish, French, Dutch, American (USA), Chinese, and so on. These studies use different versions of Stroop test, develop normative data for all tasks of test and generally study the influence of demographic variables on test performance.
- Some of the studies use only Stroop test and provide data on executive functions of attention control, information processing speed, selective attention and cognitive flexibility, but some of them use Stroop test among other cognitive test and provide general overview of cognitive abilities of subjects. They apply series of test and develop norms for different type of cognitive ability.

- Age, education and gender factors were investigated for Stroop Color Word test consistent with studies of Caucasian samples, for East, it is found that age and education are related to performance of subjects. Also gender was also found to be significantly associated with performance, a result that has been inconsistently reported in the literature for Caucasians.
- Some studies suggests that sex only has a limited influence on Stroop test performance or only has impact after certain age level or for only a certain age group.
- Although there is a study in Turkey, it aims only standardization of Stroop test for Turkish speakers. It provided a Turkish form of Strop Color and Word Test. Again this study focuses on only Stroop test and mental flexibility (Karakaş *et al.*, 1999).

3. RATIONAL AND OBJECTIVES OF THE STUDY

3.1.Rationale of the Study

The cognitive and motor performance data of populations are needed to design safe, user friendly and efficient product, work and technological systems. Such performance data exist for some developed countries; however, there are variations among populations. For example, Eastern and South Eastern Asians, in general, have higher performances compared to the populations of the some Western countries. This shows that, the available performance data of one population may not be applied to the designs of other populations. For the case of Turkey, such normative data does not exist, except several limited studies.

Since there is not a study that includes the most important cognitive and motor capabilities such as attention, concentration, speed, memory, learning, intellectual and motor functions for adult female population of Turkey with all ages, this study will be important resource for ergonomic designs and clinical applications and other related fields that may need this type of data for population of Turkey.

3.2.Objectives of the Study

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

- (i) Establish the cognitive and motor capability database of adult female population of Turkey in four main areas (attention, concentration and speed; memory and learning; intellectual function; motor function) by using neuropsychological tests
- (ii) Investigate the effects of education and income levels, age, marital status and smoking on the test performances.
- (iii) Examine the correlations among the considered neuropsychological tests results.
- (iv) Compare the test performance results of this study with the previous study results.

4. METHODOLOGY

To accomplish the stated objectives the methodology followed is covered in this chapter.

4.1. Phases of the Study

The following chart summarizes the main phases of this study (Figure 4.1):

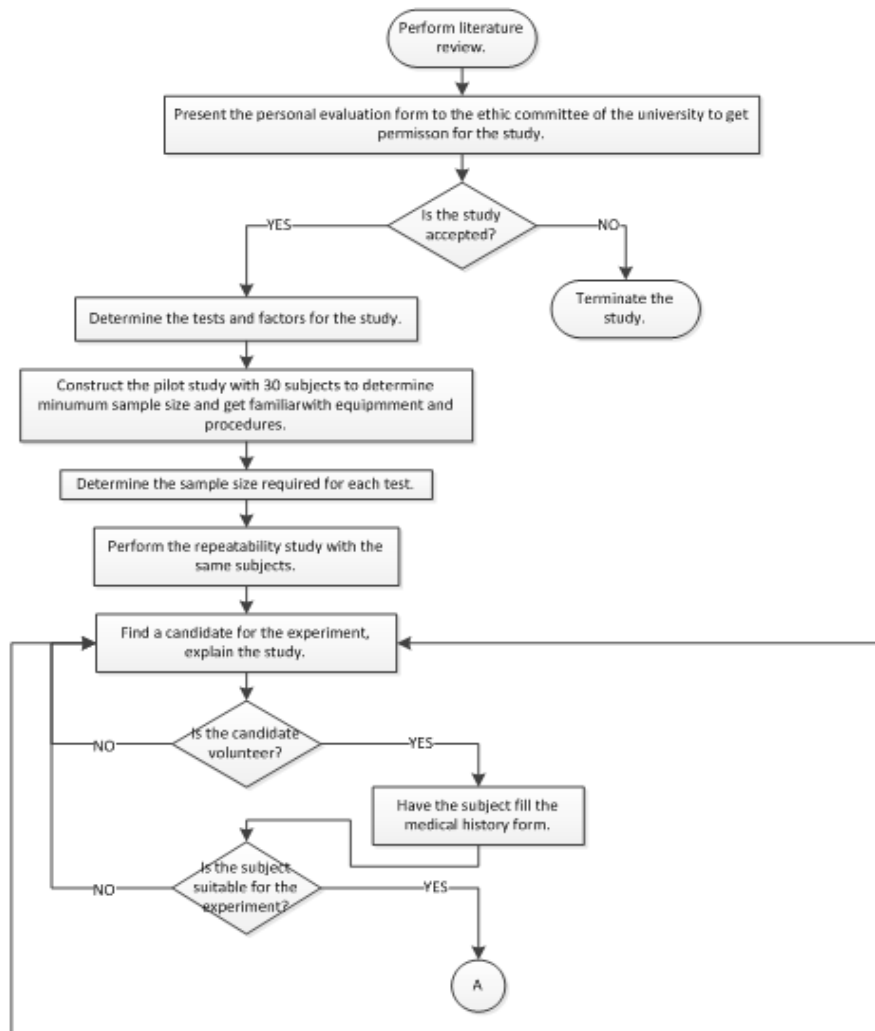


Figure 4.1. Flowchart of the phases of the study.

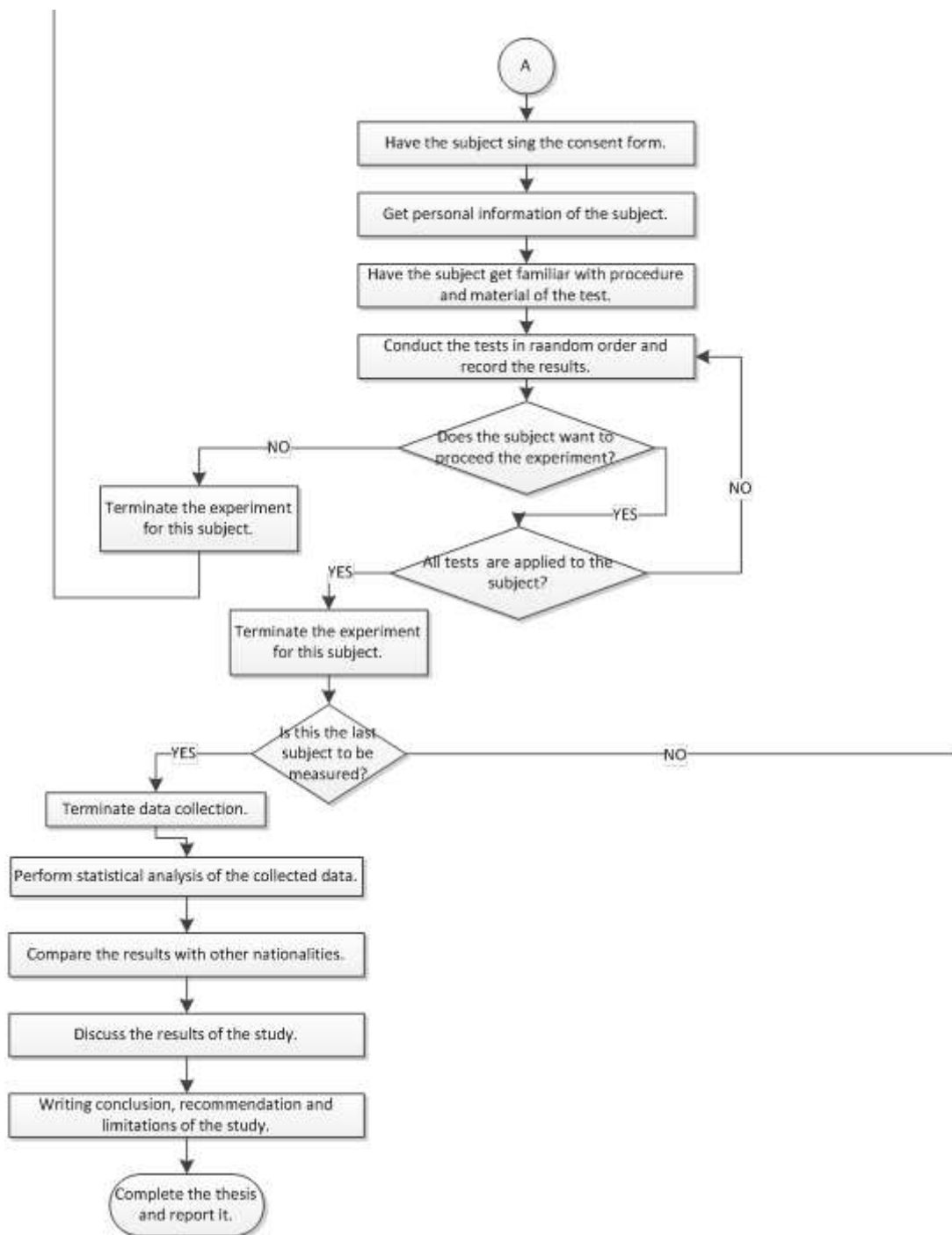


Figure 4.1. Flowchart of the phases of the study (cont.).

4.2.Sampling Approach

A stratified sampling approach was used for the study to represent the whole adult females of Turkey. Healthy females with family origins from seven regions of Turkey, age of 18 to 92 years, different education and income levels participated in the study. Total sample size was 251. The population of Istanbul approximately represents the population of Turkey since people from the seven regions of Turkey live in İstanbul so the subjects were mainly chosen from İstanbul, and its surrounding areas.

At the beginning of the experiment, Personal Consent Form, Health Survey and Personal Data Form are presented to the participants (Appendix A.1 to A.5). With Personal Data form, the demographic data of subjects are collected: birthplace, city of family origin, age, education level, education level of subjects' parents, income level, marital status, dominant / nondominant hand and smoking habits.

For gathering data for developing normative data of populations, all subjects must be free from neurological and psychiatric illnesses, drugs and diseases like hypertension, heart disease, diabetes (Chan *et al.*, 2009). For ensuring this situation, a medical history form was applied to the subjects before accepting them for the study. Only the healthy subjects were accepted for the study.

The regional distribution of the family origin of the subjects is shown in Table 4.1 and Figure 4.2

Table 4.1. Distribution of the subjects' family origins.

Regions	Subjects
Mediterranean	53
Eastern Anatolia	16
Aegean	38
Southeastern Anatolia	28
Central Anatolia	42
Black Sea	27
Marmara	47
Total	251

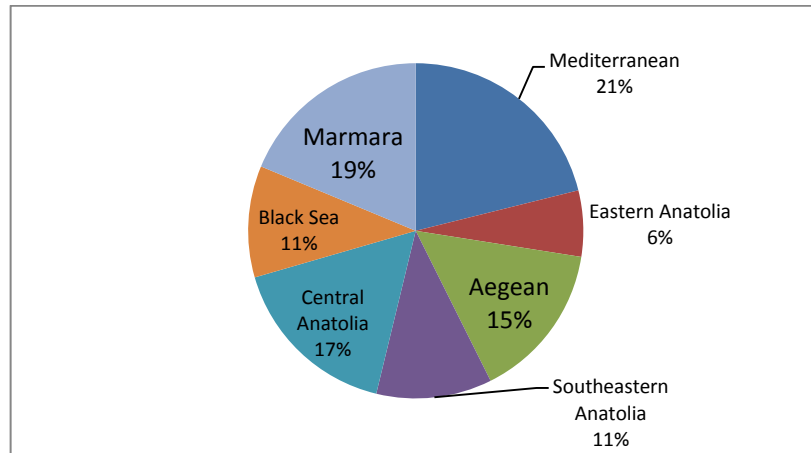


Figure 4.2. The regional distribution of family origin cities.

The participants are divided into 6 age groups (18-30, 31-40, 41-50, 51-60, 61-70, and 71-92) and 4 education groups. The mean and standard deviations of demographic factors of subjects are shown in Table 4.2 and Table 4.3.

Table 4.2. The descriptive statistics of demographic factors of subjects.

Factors		Age (years)		Education (years)		Education of Mother (years)		Education of Father (years)	
						Mean	SD	Mean	SD
Age Groups	N	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Total	251	46.97	17.24	13.11	4.45	8.92	4.68	10.95	4.76
18 – 30	50	24.52	3.13	14.56	3.82	11.48	4.62	12.80	4.84
31 – 40	50	35.40	2.49	13.64	4.08	8.58	4.69	10.92	4.93
41 - 50	50	46.56	3.03	12.88	4.75	9.24	4.47	11.38	4.80
51 – 60	50	54.14	2.13	14.32	3.52	9.2	4.23	10.92	4.30
61 - 70	18	66.83	2.64	9.00	5.43	6.00	4.98	7.22	4.37
71 - 92	33	77.42	5.32	9.03	4.57	5.00	2.95	6.66	3.26

Table 4.3. The percentage of demographic factors of subjects.

Demographic Factor	Level	n (%)	n
Education (years)	0 - 5 years	18%	45
	6 - 12 years	52%	130
	13 - 16 years	23%	58
	17 + years	7%	18
Income	Low	24%	59
	Medium	58%	145
	High	19%	47
Marital Status	Married	69%	204
	Single	31%	47
Smoking Habit	Smoking	29%	72
	Non smoking	71%	179
Hand Preference	Right Handed	90%	227
	Left Handed	10%	24

Income status was divided into three groups: low, medium, high.

4.3. Tests

In this study, six different neuropsychological tests have been applied to the subjects. These tests are;

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

The necessary conditions required for all 6 tests are; Subjects should be seated comfortably in a quiet place. The subject should not be hungry or thirsty. The tester should sit opposite to the participants. The test could be conducted at any time of the day. Rest break can be taken every 30 minute sessions (or as needed). Drinking water is made

available during experiment. All instructions are given in Turkish because of the population; although here they are explained in English.

4.3.1. Digit Span Test

Digit span test is used for measuring and short-term verbal memory. There are two version of the test: Forward and Backward, two versions are applied separately.

For Digit Span Forward Test, the steps involved are as follows;

- (i) Test starts with informing subjects by reading that “You will be read list of digits, and that you will try to repeat the digits in the order in which they were read out.”
- (ii) The sequences of digits are pronounced and recorded with a voice recorder by the experimenter and the subjects are listened a list of digits in an even tone, at approximately the rate of one digit per second, and subjects repeats the list in the same order immediately after.
- (iii) If they repeat the list correctly, a list one digit longer is presented to the subjects but if they fail to repeat the list, then a second list of the same length is presented. If they repeat the second list correctly, a list one digit longer is presented. But, if subjects fail to repeat the second list, the test is finished. The number of digits in the longest list repeated correctly is determined as subject’s span (Hebb, 1961).
- (iv) The length of the digit sequences start with three digits and sequences increase one by one to maximum ten digits.

Before performing the test, a trial test is conducted to subject, for understanding the process. Digit Span Backward Test; The same procedure is applied, but in this version subjects are required to repeat the sequence of digits in reverse order (Hebb, 1961).

First the following instruction was given to the subjects: “I am going to read you list of digits, and you should repeat the digits in the reverse order in which they were read out.” Then, an example, the list: 4, 7, 1 was read to the subject. First a trial test is conducted and then the procedure was followed. Table 4.4 shows the sequences used for the forward and backward versions of the Digit span tests.

Table 4.4. Forward and backward versions of Digit Span test (Hebb, 1961).

List (forward)	Result	List (backward)	Result
	(√ or ×)		(√ 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	

4.3.2. Corsi Span Test

The Corsi span test is often used for determining visual-spatial short-term memory and learning. It is different from the digit span test because the Corsi span test measures the ability of reproducing a sequence of locations (Monaco *et al.*,2012). It has two versions; forward and backward. The two versions are applied separately.

The apparatus and procedure used for the Corsi Span Test were developed by Philip Corsi (Milner, 1971). The equipment used for The Corsi Span test is consisted of nine white cardboard blocks fixed to 30 cm × 35 cm white cardboard. The blocks are 4 cm cubes placed as shown in Figure 4.3 (Milner, 1971). Exact locations for the cubes are not specified, so placement of the cubes is near the locations shown in Figure 4.3. Each cube has a number on one side of it and the numbers are only visible to the examiner. The experimenter points the sequence by using her index finger (Milner, 1971). Corsi Span Forward Test has the following procedure:

- (i) The experimenter starts the test by tapping a sequence of a three blocks, at the rate of one block per second and asks subjects to reproduce this sequence instantly.
- (ii) Two trials were applied to the subject for each sequence. And if the subject fails to repeat two trials, test ends.
- (iii) But if the subject can pass at least one of the two trials, a sequence of a length that is one higher than previous one is presented to the subject (Postma *et al.*, 2004).

The sequences were created in a random order and no block was repeated in any sequence (Pagulayan *et al.*, 2006). The specific sequences are listed in Table 4.5. The degree of difficulty is determined by the number of blocks in a sequence, so degree of difficulty ranged from 3 to 9. For backward tests sequence length of 9 is not used. Before the actual test, the subject conducted a trail test.

Corsi Span Backward test; Degree of difficulty of this version is ranged from 3 to 8 (Monaco *et al.*, 2012). One less length is used for backward test. Same procedure is applied but subjects are asked to reproduce sequence in backward.

Corsi Block Tapping span is determined as the longest sequence level at which the subject successfully repeat at least one sequence (Pagulayan *et al.*, 2006).

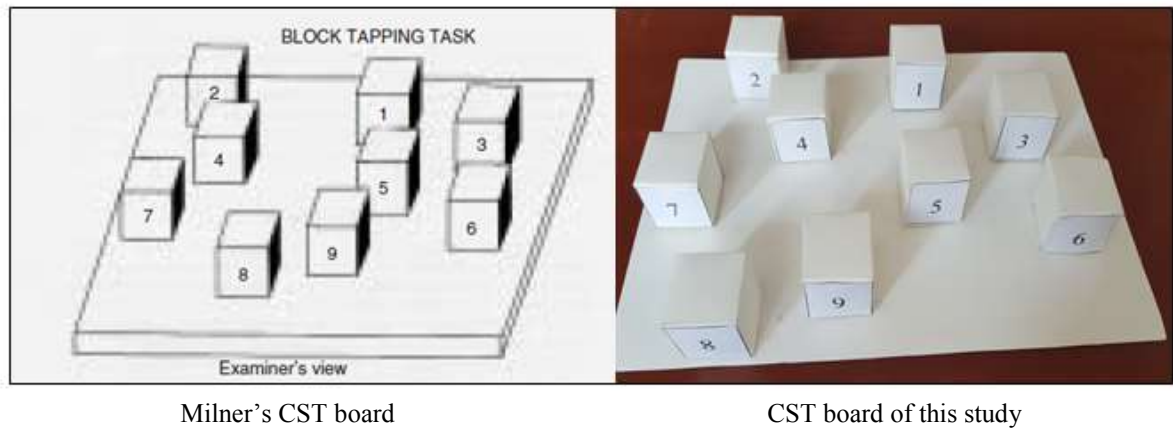


Figure 4.3. The arrangement of blocks on the board shown here from Milner (1971) (on left side of the picture) is similar to that used in our study (on right side of the picture).

Table 4.5. 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	5,3,9,4,1,8	7,2,4,8,5,6
7	5,9,1,7,4,2,8	4,1,7,9,,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		

For this study, the Corsi Span Test versions were applied separately to the subjects. First the following instruction was given to the subjects; “I am going to touch a sequence of three blocks at a rate of approximately one block per second, and you should to touch the blocks in the reverse order immediately.” Then, an example was shown to the subject and after that the procedure was followed.

4.3.3. Stroop Color and Word Test

This test evaluates functions of attention control, information processing speed, selective attention and cognitive flexibility (Llina`s-Regla *et al.*, 2013). For this study

Stroop Test TBAG version used, since it is a standardized version of the Stroop Color and Word test for Turkish language. Like Victoria version this form consist of 4 white card in dimensions of 14.0 x 21.5 cm and each card consist of randomly ordered 4 items at 6 lines, total 24 items. This version is developed by merging Golden Version and Victoria version of the Stroop test (Karakaş, 2011).

Test consists of five parts. Four cards are used in the test and these cards are used as stimuli. The subjects' reactions to these stimuli form the parts of the test, total score of the test is determined by scoring individually each part of the test (Karakaş, 2011). Also the colors of blue, green, red and yellow are used in items like Victoria version. The parts of the test are shown in Table 4.6. (Karakaş, 2011).

Table 4.6. Parts of Stroop Color Word Test (Karakaş, 2011).

Parts	Stimuli	Content	Task
I	Card 1	Color names in Black	Reading color names, reading items
II	Card 2	Color names in different colors	Reading color names, reading items
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

- (i) On Card 1, the color names are written in black ink on white board.
- (ii) On Card 2 the color names are written in different color ink but each word is written in different color from itself; for example word “red” is printed with “yellow” ink, this card is the basic stimuli for the test (Karakaş, 2011).
- (iii) On card 3, there are circles in colors with 0.4 cm diameter.
- (iv) On Card 4, there are neutral words in colors. For choosing neutral words grammar structure of words in original Stroop test is considered and ratio of total number of letters in neutral words to total number of letters in color names is fixed as 17/20 (Karakaş, *et al.*, 1999).

For administering procedure, test consists of 5 parts and details of parts can be seen in Table 4.6. and it can be seen from table that card 2 is used twice both in part 2 and part

5. All of these cards and parts cover tasks and factors for Stroop Interference effect (Karakaş *et al.*, 1999).

There are three factors for Stroop Color Word test, first naming colors (in card 1 and 3), second factor interference effect (in card 2 and 3) and final factor speed (in card 1) (Karakaş *et al.*, 1999). From all of these cards 5 different scores are measured. These scores are the completion time for each of 5 tasks.

A standard record form and stopwatch is used for data collection (Appendix A.6). The test is applied to the subjects individually by using the following instructions (Karakaş, 2011).

The test consists of 5 parts: in each part, stopwatch starts with the command of “Start” and stops when subject read the last item on the card. Total completion time is recorded on the record form. Also in each part wrong answers are counted and recorded on the form too. Before performing the test, no trial test is conducted to subject, for understanding the process.

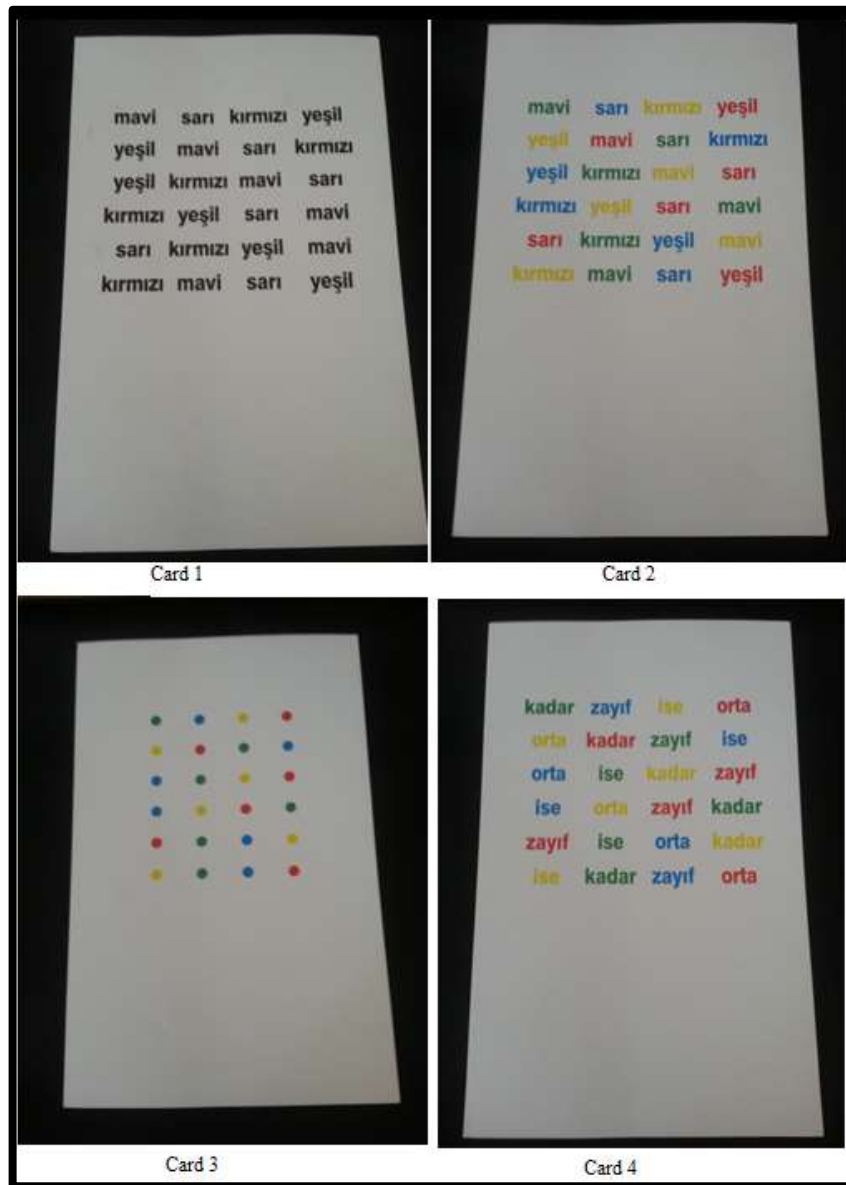


Figure 4.4. The cards that are used in experiment, taken from Karakaş (2011).

- (i) At the start of the experiment following instruction is given to the participant. “I am going to show you some cards by holding my hand and after I tell you to start I want you to read the words or the color of the words on the cards. You should try to read as fast as possible. If you make a mistake do not correct it and move on reading.”
- (ii) Part I: Card 1 is replaced in front of the subject and further instructions are given: “Now I want you to read words on the card as quick as possible, from starting

(Show the beginning of the row by pointing finger on the first line and cover the other lines with one hand) this and move on” is said.

- (iii) Part II: Second part is started with Card 2 and the instruction “Now I want you to read name of colors of on the card as quick as possible, the color of the Word is not important you should read the words, from starting (Show the beginning of the row by pointing finger on the first line and cover the other lines with one hand) this and move on”.
- (iv) Part III: Card 3 is showed to the subject and subject is informed with “Now I want you to say the name of the color of circles on the card as quick as possible, from starting at the beginning of the row.”
- (v) Part IV: Card 4 is showed to the subject and subject is informed with “Now I want you to read name of colors of words on the card as quick as possible, from starting at the beginning of the row.”
- (vi) Part V: Card 2 is showed to the subject and subject is informed with “Now I want you to read the name of colors of words on the card as quick as possible, from starting at the beginning of the row. Do not read the words tell the color of the ink of the word.” For each part the score is determined as recorded time and number of errors. So the response variable of Stroop test is consists of the scores of 5 parts (Karakas, 2011).

4.3.4. Reaction Time

Reaction time test is used for analyzing the co-ordination between the sensory and motor systems (Ritesh and Tejas, 2012). Simple reaction time test has one stimulus and one response. In this research a computer-based program has been used for recording simple reaction time (Shadmehr and Amiri, 2012). The website is used for the study. The testing procedure is as follows;

- (i) First the subjects sit in front of the computer screen with test link is open; the subjects should be seated comfortably (Figure 4.5.).

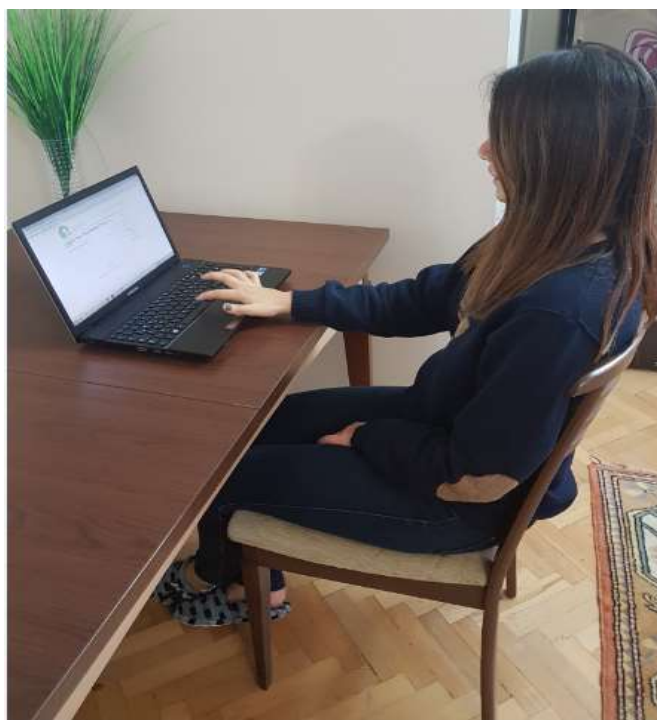


Figure 4.5. Position of the subject for reaction time test.

- (ii) The visual stimulus of the test is a green circle, the participant is asked to press any button on the keyboard with hand (right handed subjects used their right hand, left handed used their left hand) when red circle turns big green circle on the screen. Subject can choose any of her finger for experiment, put her finger on space button of the keyboard and wait for the stimulus.
- (iii) They are informed that they can use any of their fingers for pressing any button.
- (iv) After that the trial test is conducted, then the test starts, the subject sees a red circle on the screen. When circle turns into green, the program starts counting time until the subject presses any button, then program stops counting and give the reaction time result.
- (v) For calculating normative data in this test, a visual stimulus has been given five times and average of five trials has been taken as the final reaction time result (Ritesh and Tejas, 2012).

In Figure 4.6, at first screen; first screen of the computer-based test could be seen (Ritesh and Tejas, 2012). First instruction to the participant is: “Press SPACE or click here to start”. Then in picture the red circle could be seen, which turns green for measuring reaction time of subjects. In third picture big green circle which appears on the screen and

the program starts counting reaction time automatically when the subjects press button, program stops counting. The last picture shows the screen which show reaction time after subject presses the button.

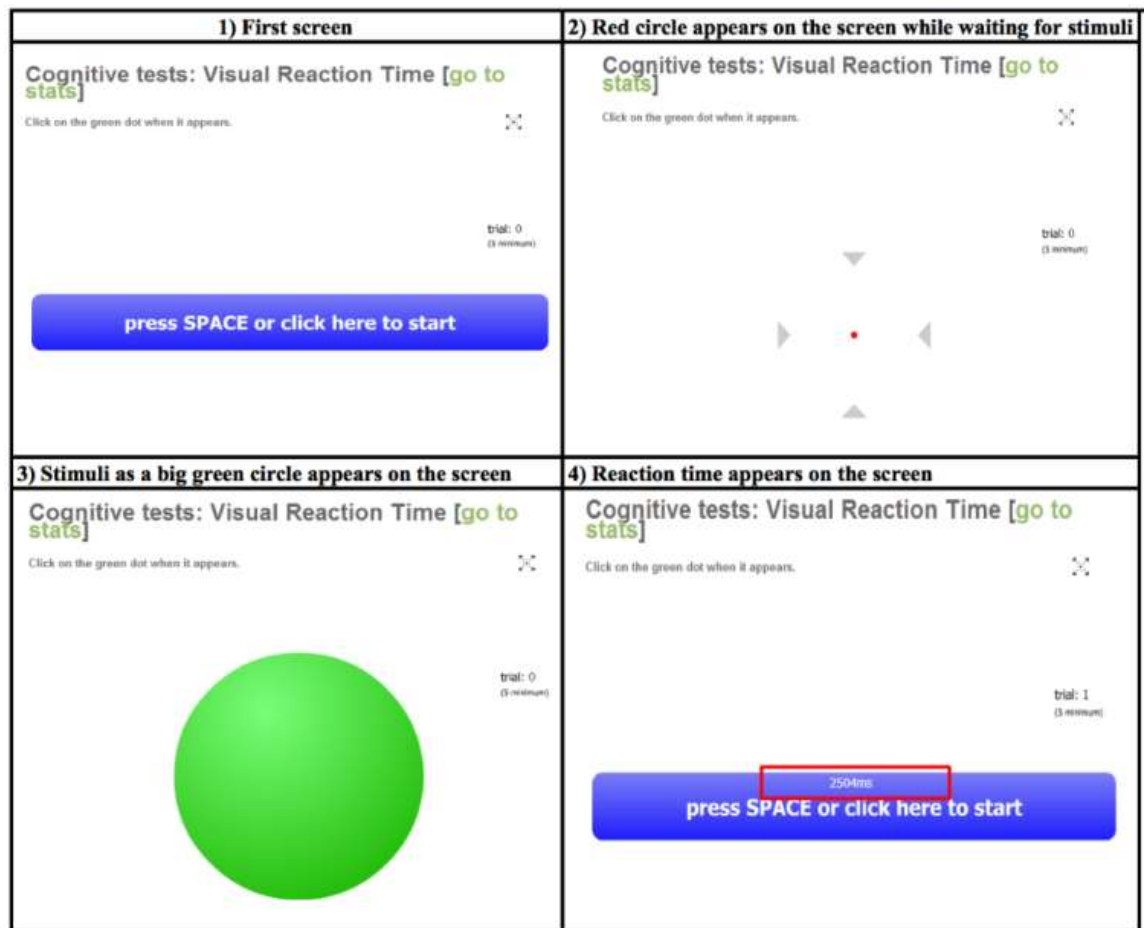


Figure 4.6. First screen of computer- based reaction time.

The subjects make 5 trials for both hands and average of 5 trials is seen as a final reaction time.

4.3.5. Purdue Pegboard Test

This test is used for measuring gross movements of fingers, hands and arms and fine motor dexterity. The materials of Purdue Pegboard Test Model 32020 from Lafayette Instrument Company contains 1 test board, 50 pins, 40 collars, 40 washers

and score sheets; also a stopwatch has been used to measure elapsed time. There are 4 cups and two vertical columns with 25 small holes on the testing board. 50 pins are placed in two cups: first and fourth cups contain 25 pins. Second cup from left contains 40 washers and the third one contains 20 collars. Figure 4.7 and Figure 4.8 show the material called testing board, pins, washers and collars that used in this test.

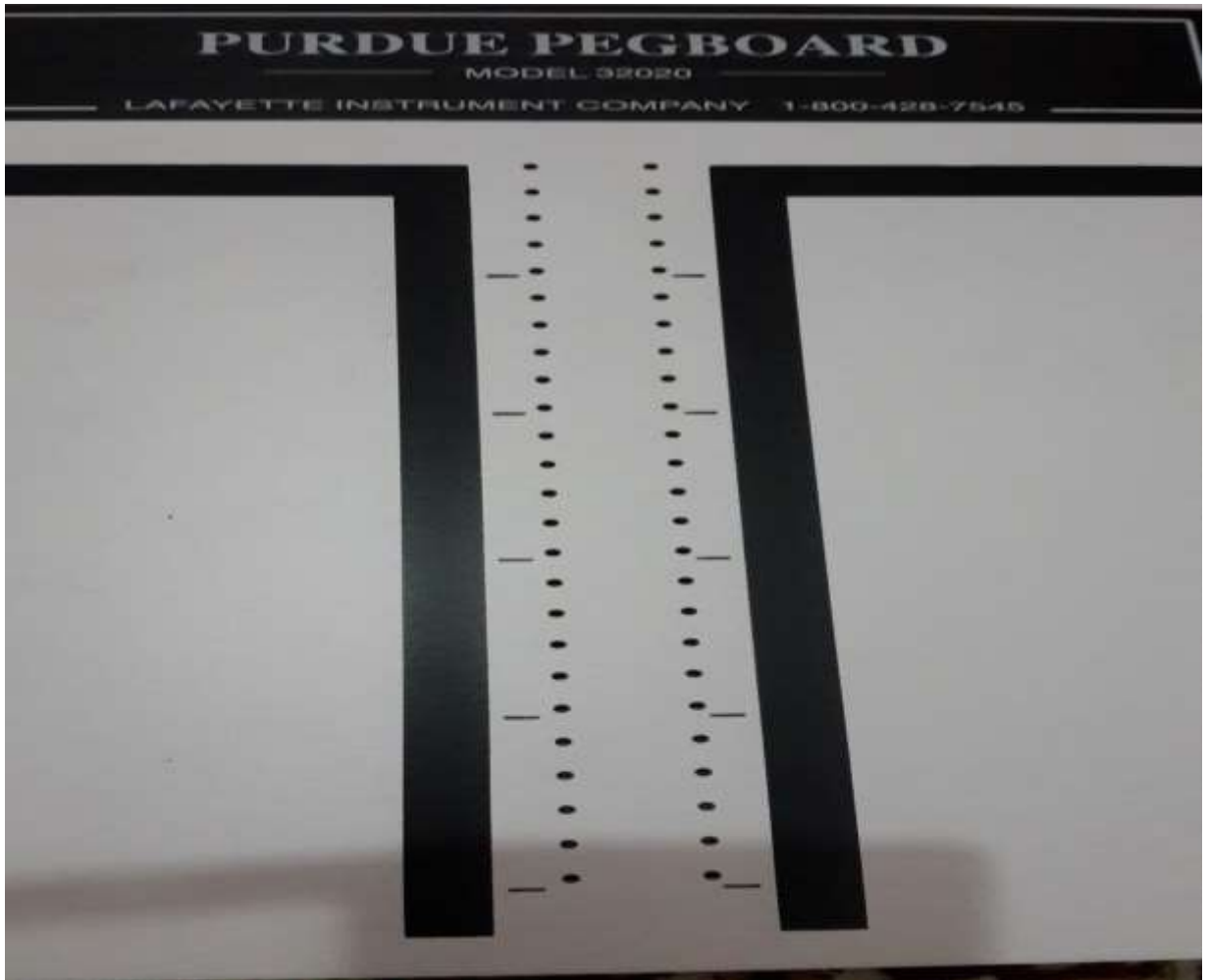


Figure 4.7. Purdue Pegboard Test Model 32020 testing board.



Figure 4.8. Pins (from left in first and fourth cup), washers (in second cup) and collars (in third cup).

Before the test starts, the participants should be seated comfortably at a table with the Purdue Pegboard on the table in front of her. The Purdue Pegboard Test consists of five parts (Tiffin and Asher, 1948). For each part the subjects can practice until they feel comfortable with the test. Each part must 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 by using the dominant hand in 30 seconds (Tiffin and Asher, 1948).

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

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

Subtest 4: This task is not an actual task; it is the total number of previous three tasks which are dominant hand, non-dominant hand and both hands (Tiffin and Asher, 1948).

Subtest 5: Last task is called assembly task; it takes 60 seconds. The score is the average number of pins, washers and collars assembled in an order 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). The steps are as follows;

- (i) First, subject is seated comfortably and asked if he/she is ready to begin. After that the short explanation about the test is given to the participant. Before subject begins the each subtest, an opportunity is given to practice and ensure the subject understands what to do (Tiffin and Asher, 1948).
- (ii) The experimenter should inform the subject about the first part of the test so he/she should said "Pick one pin at a time with your dominant hand from the cup at the direction of your dominant hand. Starting from the top of test board, place each pin in a hole of the column at the direction of your dominant hand. You can practice if you want. Do not pick up the pin if you drop it. You can continue by taking another pin" (Tiffin and Asher, 1948).
- (iii) Experimenter asks subject to make some practice. When subject completes practice and ready to go real test, experimenter gives following instructions: "With my 'Begin' command place pins in the column as quickly as you can until time is over. You have 30 seconds for this part and I will inform you when time is over" (Tiffin and Asher, 1948). The subjects have 30 seconds for this task, if all pins are placed then experiment is stopped.
- (iv) After time is up, the experimenter counts the number of pins and records the results. Participants leave the pins in the holes. The test is repeated one more time average of two trials is recorded as final result (Tiffin and Asher, 1948).

- (v) Same instructions for non-dominant hand are given to subjects. After completion of second part, third test contains both hands starts with the commands: "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 fast as you can. You have 30 seconds for this part and I will inform you when time is over" (Tiffin and Asher, 1948). Again the subject makes two trials; the score is the average number of pair of the pins not the total number of pins (Tiffin and Asher, 1948). If all pins are placed then the experiment is stopped.
- (vii) Forth test is not a real test, it is only calculated by summing of three previous scores (Tiffin and Asher, 1948).
- (viii) Fifth test occurs assembling of pins, washers and collars (Tiffin and Asher, 1948). Again experimenter gives following instructors. "Pick up one pin with your right hand from the right cup and while putting it in a hole pick up a washer with your left hand. Drop the washer over the pin as soon as the pin has been placed pick up a collar with the right hand while the washer is being placed over the pin with the left hand. While the collar is being dropped over the pin, pick up another washer with the left hand and drop it over the collar. This placement called as assembly (Tiffin and Asher, 1948).
- (ix) The score of assembly part is the total number of pins, washers and collars. Subject completes two trials and average time of them recorded as a final score (Instrument,2002).

So as a summary the Purdue Pegboard test includes 5 subtests, result of first one is the average number of pins placed in the dominant hand column using the dominant hand in 30 seconds. The result of second subtest is average number of pins placed in the nondominant hand column using the nondominant hand in 30 seconds (Tiffin and Asher, 1948). The score of third task is the average number of pairs of pins placed in both columns using both hands in 30 seconds, Forth is the total number of previous three tasks which are dominant hand, nondominant hand and both hands. And the fifth task's score is

the average number of pins, washer and collars assembled in 60 seconds (Tiffin and Asher, 1948).

4.3.6. The Raven Standard Progressive Test

Raven's Progressive Matrices Test is used as intelligence test. In this study Classical Raven Progressive Matrices Test is used. The Raven Progressive Matrices Test includes 60 multiple choice questions of abstract reasoning (Raven *et al.*, 2005). In each question, subject has to determine the lacking piece required to complete a larger pattern. And testing time is 40 minutes for each subject (Raven *et al.*, 2005).

Firstly the participant is seated comfortably in a quiet place. He / She are given the papers that include 60 questions, pencil, eraser and water. The information about test and test time is given to the subject by the experimenter. A trial question is asked to the subject, and then the correct answer is explained. The following instructions are given by the experimenter to the subject: "This test contains 60 questions. You can start from any questions you want. You have 40 minutes to perform. As soon as time is over, I will gather papers." At the end of 40 minutes, the experimenter gathers papers from the subject. The questions are given at Appendix B.

All tests have been conducted in a place where subjects felt comfortable. The place must be silent to let subjects concentrate on test. First of all, necessary information about test like objective of this study etc. is given to the participant. After that Health Survey and Personal Consent Form (Appendix A.1) which includes questions about subject's brief medical history, personal consent form and personal data form that has questions about demographic information of subjects. Then tests are applied to the subjects in a random order, individually. During the experiment subject is seated in a neutral position across the experimenter. When subject needs a break, experiment stops until the time that subject gets ready. A record form is used for data collection (Appendix A.6).

4.4. Statistical Methods

4.4.1. Statistical Variables

The classification factors are presented in Table 4.7. The dependent (response) variables for the current study are different for each test. Response variables and classification factors can be seen in Table 4.8, for each 6 tests.

Table 4.7. Independent Variables and their levels.

Classification Factor	Number of Levels	Levels
Age	6	(1) 18 – 30 years
		(2) 31 – 40 years
		(3) 41 – 50 years
		(4) 51 – 60 years
		(5) 61 – 70 years
		(6) 71 – 92 years
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

Table 4.8. Tests, response and independent variables.

Test		Response (Dependent) Variable	Type	Classification Factor	Number of Levels
Digit Span	Forward	Number of Digits (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Backward	Number of Digits (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Corsi Span	Forward	Length of Sequence (longer is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Backward	Length of Sequence (longer is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Stroop Color and Word	Part 1	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 2	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 3	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Part 4	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Part 5	Completion Time (lower is better)	Continuous	Age	6	
			Education	4	
			Income	3	
			Smoking	2	
			Marital Status	2	
Raven Test	Raven Test	Number of Correct Answers (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2

Table 4.8. Tests, response and independent variables (cont.).

Test		Response (Dependent) Variables	Type	Classification Factor	Number of Levels
Purdue Pegboard Test	Dominant Hand	Number of Pins (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Nondominant Hand	Number of Pins (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Both Hand	Number of Pins (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Total	Number of Pins (higher is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
Assembly	Number of Assembled Parts (higher is better)	Continuous	Age	6	
			Education	4	
			Income	3	
			Smoking	2	
			Marital Status	2	
Reaction Time Test	Dominant Hand	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2
	Nondominant Hand	Completion Time (lower is better)	Continuous	Age	6
				Education	4
				Income	3
				Smoking	2
				Marital Status	2

4.4.2. Statistical Analyze

4.4.2.1.Descriptive Statistics. For descriptive statistics of test results; mean, standard error of the mean, standard deviation, and coefficient of variation, minimum value, maximum value and median values were calculated. Also percentile values of test results were calculated and boxplots for every test result were drawn.

4.4.2.2. Inferential Statistics. For statistical analysis the distributions of the continuous response variables were studied for determining that parametric statistical analyses could be applied or not. Assumptions for inferential statistics are listed below.

Normality assumption (For correlation, ANOVA and regression analysis); according to Razali and Wah (2011) Anderson Darling normality test is used for normality assumption. Also normality of data can be checked by normal probability plots (Villanueva *et al.*, 2000). In this assumption the hypotheses below is checked:

Ho: The sampled population is normally distributed

H1: The sampled population is not normally distributed

If $p \geq 0.05$ normal

In this study for each test result Anderson Darling test is conducted for testing normality of the data. Normality is checked also by normal probability plots (Table 4.9; Appendix C.1). Since ANOVA is a method that relatively robust to minor violation of normality assumption (Rayner and Best, 2013); some result variables; Corsi span backward test, Stroop Color and Word test parts, part 1, Reaction time test are considered normally distributed.

Table 4.9. Distribution of response variables.

Test	Result Variable	Type	P Value	Distribution
Digit Span Forward	Number of digits	Continuous	0.19	Normal
Digit Span Backward	Number of digits	Continuous	0.088	Normal
Corsi Span Forward	Length of sequence	Continuous	0.068	Normal
Corsi Span Backward	Length of sequence	Continuous	0.019	Non Normal
Stroop Color and Word - Part 1	Seconds	Continuous	<0.01	Non Normal
Stroop Color and Word - Part 2	Seconds	Continuous	<0.01	Non Normal
Stroop Color and Word - Part 3	Seconds	Continuous	<0.01	Non Normal
Stroop Color and Word - Part 4	Seconds	Continuous	<0.01	Non Normal
Stroop Color and Word Part 5	Seconds	Continuous	<0.01	Non Normal

Table 4.9. Distribution of response variables (cont.).

Test	Result Variable	Type	P Value	Distribution
Reaction Time Test - Dominant Hand	Milliseconds	Continuous	<0.01	Non Normal
Reaction Time Test - Nondominant Hand	Milliseconds	Continuous	0.028	Non Normal
Raven Test	Number of correct answers	Continuous	0.306	Normal
Purdue Pegboard Test - Dominant Hand	Number of pins	Continuous	<0.01	Non Normal
Purdue Pegboard Test - Nondominant Hand	Number of pins	Continuous	<0.01	Non Normal
Purdue Pegboard Test - Both Hand	Number of pins	Continuous	0.035	Non Normal
Purdue Pegboard Test - Total	Number of pins	Continuous	0.014	Non Normal
Purdue Pegboard Test - Assembly	Number of washers, collars and pins	Continuous	0.445	Normal

Homogeneity of Variance Assumption (For ANOVA and regression analysis); this assumption can be evaluated by using Levene Test (Villanueva *et al.*, 2000). The null hypothesis is as follows:

$$H_0 = \sigma^2_1 = \sigma^2_2 = \dots = \sigma^2_n$$

$$H_1 = \sigma^2_1 \neq \sigma^2_2 \neq \dots \neq \sigma^2_n$$

In addition, plots of the residuals versus the fitted values are a simple way to check homogeneity of variance. Moderate deviations from the assumption of equal variances do not seriously affect the results in the ANOVA, and ANOVA is robust to small deviations from this assumption. Evidence of a large heterogeneity of variance problem is easy to detect in residual plots (Villanueva *et al.*, 2000).

Levene (1960) presents a test of homogeneity (equal variance). The Levene test is recommended when the normality assumption is not fulfilled (Nordstokke and Zumbo, 2010). Levene Test Hypothesis: P-value ≤ 0.05 this means the differences between variances are statistically significant. If Intervals overlap this means sample has equal variance status. The results of Levene test is shown in Table 4.10.

Table 4.10. Levene test results.

Factor	Test	p value	Graph Result	Equal Variance Status
Age Factor	Digit Forward	0.02	Intervals overlap	Yes
	Digit Backward	<0.001	Do not overlap	No
	Corsi Forward	0.05	Intervals overlap	Yes
	Corsi Backward	0.03	Intervals overlap	Yes
	Reaction Time - Dominant Hand	<0.001	Do not overlap	No
	Reaction Time -Nondominant Hand	<0.001	Do not overlap	No
	Purdue Pegboard - Dominant Hand	0.45	Intervals overlap	Yes
	Purdue Pegboard -Nondominant Hand	0.25	Intervals overlap	Yes
	Purdue Pegboard - BH	<0.001	Do not overlap	No
	Purdue Pegboard - Total	0.01	Intervals overlap	Yes
	Purdue Pegboard - Assembly	0.18	Intervals overlap	Yes
	Raven Test	<0.001	Do not overlap	No
	Stroop Color Word Test - Part I	<0.001	Do not overlap	No
	Stroop Color Word Test - Part II	<0.001	Intervals overlap	Yes
	Stroop Color Word Test - Part III	<0.001	Do not overlap	No
	Stroop Color Word Test - Part IV	<0.001	Intervals overlap	Yes
Stroop Color Word Test - Part V	<0.001	Do not overlap	No	
Education Factor	Digit Forward	0.05	Intervals overlap	Yes
	Digit Backward	<0.001	Do not overlap	No
	Corsi Forward	<0.001	Intervals overlap	Yes
	Corsi Backward	<0.001	Do not overlap	No
	Reaction Time - Dominant Hand	<0.001	Intervals overlap	Yes
	Reaction Time - Nondominant Hand	<0.001	Intervals overlap	Yes
	Purdue Pegboard - Dominant Hand	<0.001	Do not overlap	No
	Purdue Pegboard - Nondominant Hand	0.01	Do not overlap	No
	Purdue Pegboard - BH	0.21	Intervals overlap	Yes
	Purdue Pegboard - Total	0.01	Do not overlap	No
	Purdue Pegboard - Assembly	0.04	Intervals overlap	Yes
	Raven Test	<0.001	Do not overlap	No
	Stroop Color Word Test - Part I	<0.001	Do not overlap	No
	Stroop Color Word Test -Part II	0.08	Intervals overlap	Yes
	Stroop Color Word Test -Part III	0.2	Intervals overlap	Yes
	Stroop Color Word Test -Part IV	0.4	Intervals overlap	Yes
Stroop Color Word Test -Part V	0.01	Do not overlap	No	
Income Level	Digit Forward	0.51	Intervals overlap	Yes
	Digit Backward	0.16	Intervals overlap	Yes
	Corsi Forward	0.07	Intervals overlap	Yes
	Corsi Backward	0.04	Intervals overlap	Yes

Table 4.10. Levene test results (cont.).

Factor	Test	p value	Graph Result	Equal Variance Status
Income Level	Reaction Time - Dominant Hand	0.01	Intervals overlap	Yes
	Reaction Time - Nondominant Hand	0.02	Intervals overlap	Yes
	Purdue Pegboard - Dominant Hand	0.03	Intervals overlap	Yes
	Purdue Pegboard - Nondominant Hand	0.07	Intervals overlap	Yes
	Purdue Pegboard – BH	0.52	Intervals overlap	Yes
	Purdue Pegboard – Total	0.42	Intervals overlap	Yes
	Purdue Pegboard - Assembly	0.19	Intervals overlap	Yes
	Raven Test	0.02	Intervals overlap	Yes
	Stroop Color Word Test - Part I	0.07	Intervals overlap	Yes
	Stroop Color Word Test - Part II	0.01	Do not overlap	No
	Stroop Color Word Test - Part III	0.01	Do not overlap	No
	Stroop Color Word Test - Part IV	<0.001	Intervals overlap	Yes
	Stroop Color Word Test - Part V	0.01	Do not overlap	No
Smoking Habit	Digit Forward	0.21	Intervals overlap	Yes
	Digit Backward	0.28	Intervals overlap	Yes
	Corsi Forward	0.53	Intervals overlap	Yes
	Corsi Backward	0.81	Intervals overlap	Yes
	Reaction Time - Dominant Hand	0.8	Intervals overlap	Yes
	Reaction Time - Nondominant Hand	0.16	Intervals overlap	Yes
Smoking Habit	Purdue Pegboard -Dominant Hand	0.3	Intervals overlap	Yes
	Purdue Pegboard -Nondominant Hand	0.38	Intervals overlap	Yes
	Purdue Pegboard -BH	0.051	Intervals overlap	Yes
	Purdue Pegboard -Total	0.19	Intervals overlap	Yes
	Purdue Pegboard -Assembly	0.08	Intervals overlap	Yes
	Raven Test	0.18	Intervals overlap	Yes
	Stroop Color Word Test -Part I	0.63	Intervals overlap	Yes
	Stroop Color Word Test -Part II	0.36	Intervals overlap	Yes
	Stroop Color Word Test - Part III	0.96	Intervals overlap	Yes
	Stroop Color Word Test - Part IV	0.25	Intervals overlap	Yes
	Stroop Color Word Test -Part V	0.22	Intervals overlap	Yes
Marital Status	Digit Forward	0.43	Intervals overlap	Yes
	Digit Backward	0.61	Intervals overlap	Yes
	Corsi Forward	0.61	Intervals overlap	Yes
	Corsi Backward	0.77	Intervals overlap	Yes
	Reaction Time -Dominant Hand	0.11	Intervals overlap	Yes
	Reaction Time -Nondominant Hand	0.1	Intervals overlap	Yes
	Purdue Pegboard -Dominant Hand	0.85	Intervals overlap	Yes
	Purdue Pegboard -Nondominant Hand	0.94	Intervals overlap	Yes
	Purdue Pegboard -BH	0.74	Intervals overlap	Yes
	Purdue Pegboard -Total	0.95	Intervals overlap	Yes
	Purdue Pegboard -Assembly	<0.001	Intervals overlap	Yes
	Raven Test	0.92	Intervals overlap	Yes
	Stroop Color Word Test - Part I	0.05	Intervals overlap	Yes
	Stroop Color Word Test - Part II	0.39	Intervals overlap	Yes
	Stroop Color Word Test - Part III	0.74	Intervals overlap	Yes
	Stroop Color Word Test - Part IV	0.06	Intervals overlap	Yes
Stroop Color Word Test - Part V	0.08	Intervals overlap	Yes	

Independence Assumption (For ANOVA); Independence assumption requires no correlation between error terms and no correlation between independent variables and error terms (Montgomery, 2005). According to Montgomery (2005) for gaining independence, randomization is an important factor; tests are applied to the subjects in random order for randomization (2005).

So in this study Independence is fulfilled by randomness in selection and assignment, for example subjects are chosen randomly and are not dependent upon the selection of another subject. Also each subject is tested only once.

Also for determining whether there is any correlation between residuals, the plots of the residuals versus observation orders for female are examined (Appendix C.2.). They showed that there is no correlation between residuals.

Linearity (For correlation and regression analysis); The relationship between the dependent and independent variables must be linear (Williams *et al.*, 2013). In other words the model that relates the response to the predictors like X_1, X_2, \dots, X_n is assumed to be linear for regression analysis (Montgomery, 2005). That is the response variable is assumed to be a linear function of the parameters ($\beta_1, \beta_2, \dots, \beta_n$), but not necessarily a linear function of the predictor variables X_1, X_2, \dots, X_n (Osborne and Waters, 2002). So if relationship between response variable and independent variables is nonlinear still linear regression modelling could be used. If there is a quadratic relationship between response variable (Y) and independent variables (X_1, X_2, \dots, X_n), regression equation could include both X and X^2 as predictors and the equation still would be a linear regression equation if Y is modeled as a linear function of parameters (Montgomery, 2005).

Linearity assumption can be checked by using residual and scatter plots (Appendix C1 and C2) showing the standardized residuals vs. the predicted values (Stevens, 2009). Only the factors that have significant effect on the test results according to ANOVA tests are checked for regression assumptions. The results are as follows:

- Digit Span Forward and Backward Test responses vs subjects' age in years have quadratic relationship but subjects' education levels in years have linear relationship.
- Corsi Span Forward and Backward Test responses vs subjects' age in years have quadratic relationship but subjects' education levels in years have linear relationship.
- Raven Test vs subjects' age in years and but subjects' education levels in years have linear relationship.
- Stroop Color Word Test Part I vs subjects' education levels in years and Stroop Color Word Test Part II vs subjects' education levels in years have quadratic relationship so in regression equations for these tests Education level of the subject should be used as quadratic variable (Education^2). Relations of these two tests with subjects' age in years are linear.
- Stroop Color Word Test Part III vs subjects' age in years and Stroop Color Word Test Part IV vs subjects' age in years have quadratic relationship so in regression equations for these tests subjects' age variable should be used as quadratic variable (Age^2).
- All Purdue Pegboard task results have linear relationships with subjects' age in years and subjects' education levels in years.
- Reaction Time Dominant Hand test result vs subjects' age in years has quadratic relationship so age of subject should be used as quadratic variable (Age^2) in regression equation.
- Reaction Time Non Dominant Hand test result have linear relationships with subjects' age in years and subjects' education levels in years.

Multicollinearity (For regression analysis); Multicollinearity assumption means that the independent variables are not correlated, so if multicollinearity exists, it means that there are redundant variables in the regression (Keith, 2006). This can be checked by looking at the variance inflation factor (VIF). The Variance inflation factor is an index of the amount that the variance of each regression coefficient is increased over that with uncorrelated independent variables (Keith, 2006). The rule of thumb for a large VIF value is 10 (Keith, 2006). When the result of regression is checked, all VIF values are checked and since they are less than 10 this assumption is fulfilled too.

Autocorrelation (For regression analysis); There must not be a correlation between the errors because correlation affects the estimation of coefficients for the regression (Montgomery, 2005). Durbin-Watson statistic is used to verify this assumption. It is desired to be between 1.5 and 2.5. (Montgomery, 2005). So for every regression model first of all Durbin Watson test statistic is checked for autocorrelation. Durbin Watson test is conducted on Minitab Software too. All tests fulfilled this assumption too.

In this study only Pearson Correlation Coefficient is used for calculating correlations between independent variables and response variables. Also correlations between response variables are calculated by using Pearson correlation formula.

Since this study only has classification factors, Completely Randomized Design (CRD) is used. For determining the effects of independent factors and their relations on response variables, ANOVA were conducted. According to ANOVA results, no interaction effect is found significantly important, only main effects were observed. The statistical models corresponding to each test are provided below.

Digit Span Forward and Backward Tests; According to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.1)$$

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

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

where

Y_{ij} : ij^{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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_{24}$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Corsi Span Forward and Backward Test; According to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.2)$$

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

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

where

Y_{ij} : ij^{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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_{24}$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Raven Test; according to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.3)$$

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

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

where

Y_{ij} : ij^{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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_{24}$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair } (i,j)$$

Reaction Time Dominant Hand and Non-dominant Hand Tests; for Reaction Time Dominant Hand according to ANOVA results there is no interaction effect on test result and only age factor has also effect. The statistical model of no interaction one - factor CRD is:

$$Y_{ij} = \mu + \alpha_i + \varepsilon_{ij} \quad (4.4)$$

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

where

Y_{ij} : ij^{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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_6$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Reaction Time Non dominant Hand; according to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.5)$$

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

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

where

Y_{ij} : i^{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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_{24}$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Stroop Color and Word Test (Part I, Part II, Part III, Part IV and Part V); Part I and Part II: According to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.6)$$

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

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

where

Y_{ij} : i_j^{th} time in seconds

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

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

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_4$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Part III; according to ANOVA results there is no interaction effect and Education, Income level and Smoking habit have no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{il} = \mu + \alpha_i + \gamma_l + \varepsilon_{il} \quad (4.7)$$

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

$l = 1, 2$ (Marital Status Levels)

where

Y_{il} : i_l^{th} time in seconds

μ : The overall response mean (mean time in seconds)

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

γ_l : the effect of the l^{th} level of marital status

ε_{il} : random error component ($0, \sigma^2$)

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_4$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Part IV and Part V: According to ANOVA results there is no interaction effect and only age factor has an effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_i = \mu + \alpha_i + \varepsilon_i \quad (4.8)$$

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

where

Y_i : i^{th} time in seconds

μ : the overall response mean (mean time in seconds)

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

ε_i : random error component ($0, \sigma^2$)

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_6$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

Purdue Pegboard (Dominant Hand, Nondominant Hand, Both Hand, Total and Assembly) Tests; according to ANOVA results there is no interaction effect and Income level, Marital Status and Smoking habit have also no effect on test result. The statistical model of no interaction two - factors CRD is:

$$Y_{ij} = \mu + \alpha_i + \beta_j + \varepsilon_{ij} \quad (4.9)$$

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

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

where

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

μ : the overall response mean (mean of number of pins or 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 $(0, \sigma^2)$

The hypothesis of interest is:

$$H_0 = \mu_1 = \mu_2 = \dots = \mu_4$$

$$H_1 = \mu_i \neq \mu_j \text{ for at least one pair (i,j)}$$

For post hoc analysis Tukey's test was used. Tukey's test is recommended by Hochberg and Tamhane (1987) for pairwise comparisons because this test is a simple method which gives almost correct control of the error rate. There are some conditions to be satisfied before using parametric ANOVA, if homogeneity of variance assumption is not fulfilled non parametric ANOVA (Welch's ANOVA) could be used (Gastwirth *et al.*, 2009) (For this study for the factors and test results that has violation of ANOVA assumptions of homogeneity of variance both non parametric and parametric ANOVA tests were used. Since the same results obtained from both tests, the study is continued with parametric ANOVA and Tukey test).

Regression Analysis; stepwise regression approach is used. It is a method which systematically adds the most significant variable to the model and removes the least significant variable in each step.

Statistical Analysis was performed using Minitab 18.0. For all the inferential statistical analyses, a p value <0.05 was used to indicate significance.

4.5.Pilot Study

For the pilot study, randomly selected 30 female subjects from different age and education groups performed the tests before the actual tests. The pilot study is used for calculating average time for completion of six experiments, getting accustomed to the equipment and test procedures, observing subject reactions during experiments and obtaining the necessary statistical parameter values (mean, standard deviation) in order to determine the required minimum sample size.

Table 4.11. Descriptive statistics of pilot study.

Test	n	\bar{x}	sd	CV
Digit Forward Result (number of digits)	30	5.67	1.15	20.38
Digit Backward Result (number of digits)	30	4.8	1.16	24.1
Corsi Forward Result (length of sequence)	30	5.1	1.42	27.9
Corsi Backward Result (length of sequence)	30	4.57	1.19	26.15
Reaction Time - Dominant Hand Result (milliseconds)	30	368.55	112.27	30.46
Reaction Time - Nondominant Hand Result (milliseconds)	30	359.65	81.4	22.63
Purdue Pegboard - Dominant Hand (number of pins)	30	13.13	2.76	21.04
Purdue Pegboard - Nondominant Hand (number of pins)	30	11.82	2.56	21.7
Purdue Pegboard - Both Hand (number of pins)	30	11.3	2.81	24.86
Purdue Pegboard - Total (number of pins)	30	36.52	7.8	21.35
Purdue Pegboard - Assembly Result (number of pins, colors, washers)	30	33.07	11.38	34.41
Raven Test Result (number of correct answers)	30	38.93	14.74	37.87
Stroop Color Word Test - Part I (seconds)	30	10.85	3.97	36.59
Stroop Color Word Test - Part II (seconds)	30	13.69	6.82	49.78
Stroop Color Word Test - Part III (seconds)	30	13.29	4.63	34.86
Stroop Color Word Test - Part IV (seconds)	30	19.14	8.29	43.33
Stroop Color Word Test - Part V (seconds)	30	32.03	15.05	47

4.6.Sample Size Determination

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

$$N = ((1.96 \times CV) / a)^2 \times (1.5342)^2 \quad (4.18)$$

where, 1.96 is the critical Z value from a standard normal distribution for a 95% confidence interval, CV is the coefficient of variation and a is the percentage of relative

accuracy desired (CI is to be no larger than \pm some percentage of the mean). CV is defined as the following:

$$CV=(SD/\bar{x})\times 100 \quad (4.18)$$

where, \bar{x} is the sample mean and SD is the sample standard deviation.

In the current study, true mean and standard deviation of the population are unknown, so these values are estimated by using the results of the pilot study. Relative accuracy is decided to be at least 5%. The sample size determined by using both results of the pilot study and once again for the total results.

In this study, only 251 female subjects are tested. So accuracy of the test results is given at the Table 4.10. Accuracy is calculated by using the same formula with known $n=251$ and calculating alpha value. Desired alpha value is decided to be at least 5%. Some tests are more than this value but some of them are below

Table 4.12. Minimum sample size of experiments.

Test	Calculated sample size by pilot study (n=30)	Calculated minimum sample size by measure of actual study (n=251)	Accuracy of the Actual Study (α) (%)
Digit Forward	150	208	4.55
Digit Backward	210	253	5.02
Corsi Forward	281	308	5.53
Corsi Backward	247	327	5.71
Reaction Time - Dominant Hand	336	178	4.21
Reaction Time - Nondominant Hand	185	139	3.72
Purdue Pegboard - Dominant Hand	160	165	4.06
Purdue Pegboard - Nondominant Hand	170	187	4.31
Purdue Pegboard - Both Hand	223	147	3.82
Purdue Pegboard - Total	165	153	3.90
Purdue Pegboard - Assembly	428	227	4.75
Raven Test	519	655	8.08
Stroop Color and Word Test - Part I	484	364	6.02
Stroop Color and Word Test - Part II	896	578	7.59
Stroop Color and Word Test - Part III	439	371	6.08
Stroop Color and Word Test - Part IV	679	526	7.24
Stroop Color and Word Test - Part V	799	646	8.02

4.7.Repeatability Study

Repeatability or test-retest reliability is another significant issue for an experiment. For determining repeatability the maximum deviation between measurements under the same conditions and with the same measuring instrument should be calculated.

In this study, 30 female subjects from pilot study conducted the tests once more at least a week later from the first trail. Table 4.13 includes mean, standard deviation and coefficient of variation values of both first and second trial for repeatability.

Table 4.13. Data of Repeatability study.

Test	Mean (n=30)		SD		CV	
	Trial 1	Trial 2	Trial 1	Trial 2	Trial 1	Trial 2
Digit Forward	5.67	5.74	1.15	1.12	20.38	19.51
Digit Backward	4.8	4.87	1.16	1.14	24.1	23.41
Corsi Forward	5.1	5.1	1.42	1.35	27.9	26.47
Corsi Backward	4.57	4.57	1.19	1.11	26.15	24.29
Reaction Time Dominant Hand	38.93	39	14.74	14.63	37.87	37.51
Reaction Time Nondominant Hand	10.85	10.81	3.97	3.88	36.59	35.89
Purdue Pegboard Dominant Hand	12.5	12.6	2.64	2.47	0.22	19.60
Purdue Pegboard Nondominant Hand	11.82	11.92	2.57	2.37	0.22	19.88
Purdue Pegboard Both Hand	11.3	11.42	2.81	2.63	0.25	23.03
Purdue Pegboard Total (Righ+Left+Both)	35.62	35.59	7.3	6.87	0.21	19.30
Purdue Pegboard Assembly	33.07	32.92	11.38	11.2	0.35	34.02
Raven Test	0.27	0.24	0.78	0.78	294.3	325
Stroop Color and Word Test Part I	0.57	0.5	0.9	0.83	158.4	166
Stroop Color and Word Test Part II	1.2	1.2	2.04	1.92	170.1	160
Stroop Color and Word Test Part III	2.7	2.77	3.37	3.52	125	127.08
Stroop Color and Word Test Part IV	368.55	370.78	112.27	111.36	30.46	30.03
Stroop Color and Word Test Part V	359.65	355.29	81.4	82	22.63	23.08

For testing repeatability, the difference between the means of first and second trails should be observed. So at first F-Test is used to determine if the variances of two populations are equal (Table 4.14). After F test, paired t-test is used to comparing two samples means.

The hypotheses for the t-test are:

$$H_0: \mu_1 - \mu_2 = 0$$

$$H_1: \mu_1 - \mu_2 \neq 0$$

For each test results, paired t tests are conducted (Table 4.15). According to F test results, variances of samples assumed equal or not for paired t test. At the results if $F < F$ critical variances assumed equal, but if $F > F$ critical t test variances assumed unequal.

Table 4.14. F test results of all test results.

Test	F Critical	F	P value
Digit Span Forward Test	1.86	1.08	0.42
Digit Span Backward Test	1.86	1.04	0.46
Corsi Span Forward Test	0.54	0.95	0.44
Corsi Span Backward Test	1.86	1.17	0.34
Reaction Time - Dominant Hand	1.86	1.05	0.45
Reaction Time - Nondominant Hand	1.86	1.09	0.4
Purdue Pegboard - Dominant Hand	1.86	1.14	0.36
Purdue Pegboard - Nondominant Hand	1.86	1.18	0.33
Purdue Pegboard - Both Hand	1.86	1.15	0.36
Purdue Pegboard - Total	1.86	1.13	0.37
Purdue Pegboard - Assembly	1.86	1.03	0.47
Raven Test	1.86	1.02	0.48
Stroop Color and Word Test - Part I	1.86	1.05	0.45
Stroop Color and Word Test - Part II	0.54	1	0.5
Stroop Color and Word Test - Part III	1.86	1	0.5
Stroop Color and Word Test - Part IV	0.54	0.94	0.44
Stroop Color and Word Test - Part V	1.86	1.02	0.48

After F test, at Table 4.15 paired t test results could be seen. So we accept the null hypothesis; there is no significant difference between two sample means for all tests.

Table 4.15. Paired t test results of all test results.

Test	T Critical	T statistics	P value
Digit Span Forward Test	2	-0.23	0.82
Digit Span Backward Test	2	-0.23	0.82
Corsi Span Forward Test	2	-0.49	0.63
Corsi Span Backward Test	2	0	0.99
Reaction Time - Dominant Hand	2.05	0.82	0.42
Reaction Time - Nondominant Hand	2.05	0.74	0.46
Purdue Pegboard - Dominant Hand	2	-0.15	0.88
Purdue Pegboard - Nondominant Hand	2	-0.16	0.88
Purdue Pegboard - Both Hand	2	-0.17	0.87
Purdue Pegboard - Total	2	0.02	0.99
Purdue Pegboard - Assembly	2	0.05	0.96
Raven Test	2	-0.02	0.99
Stroop Color and Word Test - Part I	2	0.05	0.96
Stroop Color and Word Test - Part II	2.01	-0.3	0.77
Stroop Color and Word Test - Part III	2.05	0.44	0.66
Stroop Color and Word Test - Part IV	2	-3.06	<0.001
Stroop Color and Word Test - Part V	2.05	1.41	0.17

5. RESULTS

5.1.Overview

At this part of the study, the results of the tests were documented. Descriptive statistics of test results, percentile tables and boxplots were presented. After that for inferential statistics correlation analysis, analyses of variance with post hoc analyses and regression analyses results were documented.

5.2.Descriptive Statistics

5.2.1. Mean, Standard Deviation and Other Values of Response Variables

The mean, standard error of the mean, standard deviation, and coefficient of variation, minimum, maximum and median values are calculated (Table 5.1).

Table 5.1. Descriptive statistics of response variables.

Test and Response Variable	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min. - Max.	Median
Digit Forward (number of digits)	251	5.31	1.27	0.08	23.98	3.00 - 8.00	5.00
Digit Backward (number of digits)	251	4.63	1.22	0.08	26.44	3.00 - 8.00	4.00
Corsi Forward (length of sequences)	251	4.70	1.37	0.09	29.16	3.00 - 8.00	4.00
Corsi Backward (length of sequences)	251	4.22	1.27	0.08	30.08	2.00 - 7.00	4.00
Reaction Time -Dominant Hand (millisecond)	251	340.31	75.62	4.77	22.19	261.00 - 610.00	308.60
Reaction Time - Nondominant Hand (millisecond)	251	351.60	68.86	4.35	19.62	268.00 - 589.00	333.20
Purdue Pegboard - Dominant Hand (number of pins)	251	12.60	2.65	0.17	21.38	7.00 - 19.00	12.00
Purdue Pegboard - Nondominant Hand (number of pins)	251	12.00	2.74	0.17	22.73	5.50 - 18.00	11.50
Purdue Pegboard Both - Hand (number of pins)	251	11.06	2.23	0.14	20.13	3.50 - 18.00	10.50
Purdue Pegboard Total - (number of pins)	251	35.98	7.39	0.47	20.55	19.50 - 52.00	35.00
Purdue Pegboard - Assembly (number of pins. collars. washers)	251	33.21	8.32	0.52	25.04	6.5 - 52	35
Raven Test (number of correct answers)	251	32.92	14.01	0.88	42.55	14 - 58	30
Stroop Color - Word Test - Part I (Time) (seconds)	251	12.07	3.83	0.24	31.71	6.43 - 25.45	11.48
Stroop Color - Word Test - Part II (seconds)	251	13.12	5.25	0.33	39.99	5.89 - 35.33	10.46
Stroop Color - Word Test- Part III (seconds)	251	13.81	4.42	0.28	32.01	8.35 - 28.11	12.15
Stroop Color - Word Test - Part IV (seconds)	250	18.95	7.22	0.46	38.12	2.46 - 40.88	17.7
Stroop Color - Word Test- Part V (seconds)	249	32.01	13.52	0.86	42.26	14.07 - 72.16	29.15

Table 5.2. Descriptive statistics for Age factor.

Response	Age Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min. - Max.	Median
Digit Span Forward (number of digits)	18 - 30 years	50	6.47	1.15	0.16	0.18	0.83 - 8.00	6.00
	31 - 40 years	50	6.40	0.86	0.12	0.13	5.00 - 8.00	6.00
	41 - 50 years	50	4.76	0.66	0.09	0.14	4.00 - 6.00	5.00
	51 - 60 years	50	4.74	0.92	0.13	0.19	3.00 - 6.00	4.50
	61 - 70 years	18	4.11	0.58	0.14	0.14	3.00 - 5.00	4.00
	71 - 92 years	33	4.12	0.86	0.15	0.21	3.00 - 6.00	4.00
Digit Span Backward (number of digits)	18 - 30 years	50	5.74	0.66	0.09	0.12	4.00 - 7.00	6.00
	31 - 40 years	50	5.94	0.87	0.12	0.15	4.00 - 8.00	6.00
	41 - 50 years	50	4.14	0.50	0.07	0.12	3.00 - 5.00	4.00
	51 - 60 years	50	4.06	0.74	0.10	0.18	3.00 - 5.00	4.00
	61 - 70 years	18	3.28	0.46	0.11	0.14	3.00 - 4.00	3.00
	71 - 92 years	33	3.30	0.47	0.08	0.14	3.00 - 4.00	3.00
Corsi Span Forward (length of sequence)	18 - 30 years	50	6.12	0.72	0.10	0.12	4.00 - 8.00	6.00
	31 - 40 years	50	5.84	0.89	0.13	0.15	4.00 - 8.00	6.00
	41 - 50 years	50	3.82	0.56	0.08	0.15	3.00 - 5.00	4.00
	51 - 60 years	50	3.94	0.89	0.13	0.23	3.00 - 6.00	4.00
	61 - 70 years	18	3.56	0.86	0.20	0.24	3.00 - 6.00	3.00
	71 - 92 years	33	3.67	0.82	0.14	0.22	3.00 - 6.00	3.00
Corsi Span Backward (length of sequence)	18 - 30 years	50	5.50	0.65	0.09	0.12	4.00 - 7.00	5.50
	31 - 40 years	50	5.52	0.95	0.13	0.17	3.00 - 7.00	5.00
	41 - 50 years	50	3.40	0.53	0.08	0.16	2.00 - 4.00	3.00
	51 - 60 years	50	3.48	0.71	0.10	0.20	2.00 - 5.00	3.00
	61 - 70 years	18	3.17	0.62	0.15	0.20	2.00 - 5.00	3.00
	71 - 92 years	33	3.27	0.72	0.13	0.22	2.00 - 5.00	3.00

Table 5.2. Descriptive statistics for Age factor (cont.).

Response	Age Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Purdue Pegboard - Dominant Hand (number of pins)	18 - 30 years	50	15.02	1.34	0.19	0.09	12.00	-	17.00	15.00
	31 - 40 years	50	15.72	1.55	0.22	0.10	11.00	-	19.00	16.00
	41 - 50 years	50	11.57	1.14	0.16	0.10	9.00	-	14.00	11.50
	51 - 60 years	50	11.15	0.98	0.14	0.09	9.00	-	13.50	11.00
	61 - 70 years	18	9.28	1.11	0.26	0.12	7.00	-	11.50	9.00
	71 - 92 years	33	10.06	1.70	0.30	0.17	7.00	-	15.00	10.00
Purdue Pegboard - Nondominant Hand (number of pins)	18 - 30 years	50	14.34	1.83	0.26	0.13	10.50	-	17.00	15.00
	31 - 40 years	50	14.64	1.64	0.23	0.11	10.00	-	18.00	14.50
	41 - 50 years	50	11.02	1.62	0.23	0.15	8.50	-	15.50	11.00
	51 - 60 years	50	10.85	1.24	0.18	0.11	9.00	-	13.50	10.50
	61 - 70 years	18	8.69	1.49	0.35	0.17	6.00	-	11.00	8.75
	71 - 92 years	33	9.20	1.92	0.33	0.21	5.50	-	15.00	9.00
Purdue Pegboard - Both Hand (number of pins)	18 - 30 years	50	12.89	1.07	0.15	0.08	10.00	-	15.00	13.00
	31 - 40 years	50	13.01	1.37	0.19	0.11	8.00	-	15.00	13.25
	41 - 50 years	50	10.13	0.87	0.12	0.09	8.50	-	12.00	10.00
	51 - 60 years	50	10.09	0.81	0.11	0.08	8.50	-	12.00	10.00
	61 - 70 years	18	8.58	1.37	0.32	0.16	7.00	-	11.00	8.75
	71 - 92 years	33	9.59	3.36	0.59	0.35	3.50	-	18.00	8.50
Purdue Pegboard - Total (number of pins)	18 - 30 years	50	42.25	3.52	0.50	0.08	35.00	-	47.50	43.25
	31 - 40 years	50	43.37	3.96	0.56	0.09	29.00	-	51.00	44.00
	41 - 50 years	50	32.72	3.13	0.44	0.10	27.50	-	40.50	32.75
	51 - 60 years	50	32.09	2.53	0.36	0.08	27.00	-	38.50	31.75
	61 - 70 years	18	26.56	3.47	0.82	0.13	20.00	-	32.00	27.25
	71 - 92 years	33	28.85	6.55	1.14	0.23	19.50	-	47.50	27.00
Purdue Pegboard - Assembly (number of pins, collars, washers)	18 - 30 years	50	41.85	4.99	0.71	0.12	28.00	-	52.00	42.00
	31 - 40 years	50	37.93	4.18	0.59	0.11	25.00	-	45.00	38.25
	41 - 50 years	50	32.11	6.16	0.87	0.19	24.00	-	42.50	29.00
	51 - 60 years	50	30.28	5.95	0.84	0.20	23.00	-	42.00	27.00
	61 - 70 years	18	26.61	5.82	1.37	0.22	20.50	-	38.00	24.00
	71 - 92 years	33	22.67	6.26	1.09	0.28	6.50	-	36.00	23.00

Table 5.2. Descriptive statistics for Age factor (cont.).

Response	Age Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Stroop Color Word Test - Part I (seconds)	18 - 30 years	50	8.47	1.09	0.15	0.13	6.43	-	10.41	8.77
	31 - 40 years	50	9.91	0.77	0.11	0.08	8.71	-	12.36	9.83
	41 - 50 years	50	11.66	1.42	0.20	0.12	9.45	-	14.45	11.85
	51 - 60 years	50	12.41	0.85	0.12	0.07	10.46	-	14.13	12.34
	61 - 70 years	18	17.53	4.26	1.00	0.24	11.98	-	24.45	19.09
	71 - 92 years	33	17.90	4.26	0.74	0.24	12.00	-	25.45	16.28
Stroop Color Word Test - Part II (seconds)	18 - 30 years	50	9.20	1.70	0.24	0.18	5.89	-	12.87	9.35
	31 - 40 years	50	9.60	1.28	0.18	0.13	8.45	-	17.45	9.50
	41 - 50 years	50	12.21	3.05	0.43	0.25	7.97	-	18.65	10.80
	51 - 60 years	50	12.94	3.34	0.47	0.26	8.15	-	19.60	11.44
	61 - 70 years	18	20.80	2.62	0.62	0.13	15.06	-	25.45	21.09
	71 - 92 years	33	21.89	4.01	0.70	0.18	17.15	-	35.33	21.85
Stroop Color Word Test - Part III (seconds)	18 - 30 years	50	10.42	1.20	0.17	0.12	8.35	-	13.45	10.20
	31 - 40 years	50	10.43	1.15	0.16	0.11	9.16	-	16.79	10.15
	41 - 50 years	50	13.94	3.10	0.44	0.22	9.46	-	19.25	12.46
	51 - 60 years	50	13.94	2.44	0.35	0.18	10.15	-	19.45	13.16
	61 - 70 years	18	19.76	3.46	0.81	0.17	13.45	-	25.41	19.96
	71 - 92 years	33	20.45	4.12	0.72	0.20	12.40	-	28.11	21.16
Stroop Color Word Test - Part IV (seconds)	18 - 30 years	50	12.99	2.58	0.36	0.20	9.12	-	18.16	12.85
	31 - 40 years	50	13.24	2.63	0.37	0.20	9.94	-	23.15	13.12
	41 - 50 years	50	18.75	2.30	0.32	0.12	15.00	-	23.45	18.38
	51 - 60 years	50	18.91	2.83	0.40	0.15	2.46	-	22.46	19.25
	61 - 70 years	18	29.58	4.55	1.07	0.15	25.08	-	38.45	27.71
	71 - 92 years	33	32.91	8.92	1.55	0.27	23.40	-	74.54	32.16
Stroop Color Word Test - Part V (seconds)	18 - 30 years	50	21.61	3.63	0.51	0.17	14.07	-	29.41	21.42
	31 - 40 years	50	21.31	3.10	0.44	0.15	16.02	-	34.16	20.71
	41 - 50 years	50	29.14	1.93	0.27	0.07	24.16	-	33.45	29.41
	51 - 60 years	50	32.55	2.76	0.39	0.08	27.45	-	38.85	32.72
	61 - 70 years	18	56.24	8.39	1.98	0.15	42.01	-	72.16	56.12
	71 - 92 years	33	55.91	9.68	1.68	0.17	32.50	-	72.10	55.89

Table 5.2. Descriptive statistics for Age factor (cont.).

Response	Age Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Raven Test (number of correct answers)	18 - 30 years	50	50.92	5.63	0.80	0.11	37.00	-	58.00	52.50
	31 - 40 years	50	43.42	10.54	1.49	0.24	19.00	-	58.00	45.00
	41 - 50 years	50	24.74	6.86	0.97	0.28	15.00	-	38.00	24.50
	51 - 60 years	50	24.44	7.49	1.06	0.31	14.00	-	38.00	23.00
	61 - 70 years	18	23.83	6.26	1.48	0.26	15.00	-	38.00	22.50
	71 - 92 years	33	19.91	4.34	0.76	0.22	15.00	-	33.00	18.00
Reaction Time - Dominant Hand (milliseconds)	18 - 30 years	50	322.87	38.30	5.42	0.12	262.60	-	408.20	320.10
	31 - 40 years	50	287.47	32.11	4.54	0.11	261.00	-	429.00	280.20
	41 - 50 years	50	363.91	67.09	9.49	0.18	285.40	-	488.00	379.70
	51 - 60 years	50	344.42	46.02	6.51	0.13	295.80	-	455.80	327.50
	61 - 70 years	18	353.71	101.51	23.93	0.29	287.80	-	605.00	301.02
	71 - 92 years	33	398.06	125.98	21.93	0.32	290.80	-	610.00	310.40
Reaction Time - Nondominant Hand (milliseconds)	18 - 30 years	50	323.40	37.47	5.30	0.12	276.40	-	426.00	323.30
	31 - 40 years	50	297.18	28.48	4.03	0.10	273.40	-	423.80	289.10
	41 - 50 years	50	370.43	56.55	8.00	0.15	284.20	-	474.00	378.70
	51 - 60 years	50	359.35	43.27	6.12	0.12	308.80	-	441.60	341.40
	61 - 70 years	18	389.58	86.37	20.36	0.22	315.20	-	556.00	346.20
	71 - 92 years	33	415.28	102.58	17.86	0.25	315.20	-	589.00	348.20

Table 5.3. Descriptive statistics for Education factor.

Response	Education Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Digit Forward (number of digits)	0 - 5 years	45	3.95	0.67	0.15	0.17	3	-	5	4
	5 - 12 years	130	4.79	1.05	0.1	0.22	3	-	8	5
	13 - 16 years	58	6.08	1.17	0.13	0.19	4	-	8	6
	17 - + years	18	5.84	1.06	0.15	0.18	4	-	8	6
Digit Backward (number of digits)	0 - 5 years	45	3.1	0.30	0.07	0.1	3	-	4	3
	5 - 12 years	130	4.19	1.00	0.1	0.24	3	-	6	4
	13 - 16 years	58	5.32	1.13	0.13	0.21	3	-	8	5
	17 - + years	18	5.16	1.06	0.15	0.2	3	-	7	5
Corsi Forward (length of sequence)	0 - 5 years	45	3.33	0.73	0.16	0.22	3	-	6	3
	5 - 12 years	130	4.25	1.24	0.12	0.29	3	-	7	4
	13 - 16 years	58	5.31	1.28	0.15	0.24	3	-	8	5
	17 - + years	18	5.14	1.05	0.15	0.2	3	-	8	5
Corsi Backward (length of sequence)	0 - 5 years	45	3	0.32	0.07	0.11	2	-	4	3
	5 - 12 years	130	3.74	1.16	0.11	0.31	2	-	7	3
	13 - 16 years	58	4.91	1.13	0.13	0.23	3	-	7	5
	17 - + years	18	4.72	1.14	0.16	0.24	3	-	7	5
Raven Test (number of correct answers)	0 - 5 years	45	19.48	4.02	0.88	0.21	14	-	29	18
	5 - 12 years	130	24.95	9.49	0.92	0.38	15	-	56	20
	13 - 16 years	58	42.4	12.30	1.41	0.29	20	-	58	48
	17 - + years	18	41.06	12.49	1.75	0.3	18	-	58	36.5
Reaction Time - Dominant Hand (milliseconds)	0 - 5 years	45	381.42	105.05	22.92	0.28	287.8	-	598	365.8
	5 - 12 years	130	354.36	78.09	7.58	0.22	263.4	-	605	327.01
	13 - 16 years	58	316.71	47.48	5.45	0.15	262.6	-	537.25	300.2
	17 - + years	18	329.3	78.35	10.97	0.24	261	-	610	298.6
Reaction Time - Nondominant Hand (milliseconds)	0 - 5 years	45	415.9	87.97	19.2	0.21	328	-	589	397.8
	5 - 12 years	130	364.31	68.80	6.68	0.19	273.4	-	582.16	343.81
	13 - 16 years	58	323.84	46.83	5.37	0.14	276.4	-	553.15	314.2
	17 - + years	18	339.2	65.53	9.18	0.19	275.4	-	584	323.2

Table 5.3. Descriptive statistics for Education factor (cont.).

Response	Education Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min. - Max.	Median
Stroop Color Word Test - Part I (seconds)	0 - 5 years	45	17.91	4.04	0.88	0.23	12 - 24.45	19.15
	5 - 12 years	130	12.91	3.84	0.37	0.3	8.12 - 25.45	12.15
	13 - 16 years	58	10.07	1.85	0.21	0.18	6.48 - 14.05	9.82
	17 - + years	18	10.85	2.79	0.39	0.26	6.43 - 23.18	10.65
Stroop Color Word Test - Part II (seconds)	0 - 5 years	45	20.87	5.34	1.16	0.26	10.25 - 35.33	21.72
	5 - 12 years	130	12.79	4.71	0.46	0.37	7.97 - 23.45	10.46
	13 - 16 years	58	11.29	3.79	0.43	0.34	5.89 - 22.46	9.78
	17 - + years	18	13.33	5.39	0.75	0.4	6.41 - 35.33	12.48
Stroop Color Word Test - Part III (seconds)	0 - 5 years	45	19.65	3.99	0.87	0.2	11.46 - 25.41	20.46
	5 - 12 years	130	13.99	4.65	0.45	0.33	9.46 - 28.11	12.16
	13 - 16 years	58	12.01	2.96	0.34	0.25	8.35 - 18.24	10.85
	17 - + years	18	13.69	3.80	0.53	0.28	8.55 - 25.13	12.28
Stroop Color Word Test - Part IV (seconds)	0 - 5 years	45	29.18	6.54	1.43	0.22	18 - 40.88	27.45
	5 - 12 years	130	20.03	8.80	0.86	0.44	10.12 - 74.54	18.16
	13 - 16 years	58	15.36	4.95	0.57	0.32	2.46 - 29.46	16.15
	17 - + years	18	18.88	6.50	0.91	0.34	9.27 - 40.88	18.34
Stroop Color Word Test - Part V (seconds)	0 - 5 years	45	54.97	12.10	2.64	0.22	31.12 - 72.16	56.78
	5 - 12 years	130	34.27	13.79	1.34	0.4	18.25 - 67.78	29.85
	13 - 16 years	58	25.23	6.79	0.78	0.27	14.07 - 53.15	22.16
	17 - + years	18	28.84	10.26	1.44	0.36	15.26 - 62	27.88
Purdue Pegboard - Dominant Hand (number of pins)	0 - 5 years	45	9.88	1.13	0.25	0.11	8 - 12	10
	5 - 12 years	130	11.97	2.64	0.26	0.22	7 - 18	11
	13 - 16 years	58	13.89	2.28	0.26	0.16	8.5 - 19	14
	17 - + years	18	13.31	2.45	0.34	0.18	9 - 18	13
Purdue Pegboard - Nondominant Hand (number of pins)	0 - 5 years	45	8.9	1.35	0.29	0.15	6.5 - 11.5	9
	5 - 12 years	130	11.31	2.51	0.24	0.22	5.5 - 16.5	11
	13 - 16 years	58	13.45	2.46	0.28	0.18	8.5 - 18	13.5
	17 - + years	18	12.38	2.45	0.34	0.2	9 - 18	11.75

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

Response	Education Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Purdue Pegboard - Total (number of pins)	0 - 5 years	45	27.52	4.03	0.88	0.15	22	-	39	27
	5 - 12 years	130	33.64	6.83	0.66	0.2	19.5	-	47.5	32
	13 - 16 years	58	39.45	5.99	0.69	0.15	26.5	-	51	40.5
	17 - + years	18	37.64	6.48	0.91	0.17	27.5	-	49	36
Purdue Pegboard - Assembly (number of pins, collars, washers)	0 - 5 years	45	23.83	3.99	0.87	0.17	12.5	-	35	23
	5 - 12 years	130	30.61	7.67	0.75	0.25	6.5	-	52	27.5
	13 - 16 years	58	37.35	6.18	0.71	0.17	20	-	49	39
	17 - + years	18	36.38	8.66	1.21	0.24	9.5	-	51	38
Purdue Pegboard - Both Hand (number of pins)	0 - 5 years	45	8.74	1.94	0.42	0.22	7	-	15.5	8
	5 - 12 years	130	10.36	2.05	0.2	0.2	3.5	-	15	10
	13 - 16 years	58	12.11	1.69	0.19	0.14	9.5	-	18	12.5
	17 - + years	18	11.95	2.16	0.3	0.18	8	-	17.5	11.5

Table 5.4. Descriptive statistics for Income factor.

Response	Income Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Digit Forward (number of digits)	Low Level	59	4.63	1.11	0.14	0.24	3	-	7	5
	Medium Level	145	5.48	1.25	0.1	0.23	3	-	8	5
	High Level	47	5.66	1.26	0.18	0.22	3	-	8	6
Digit Backward (number of digits)	Low Level	59	4	1.07	0.14	0.27	3	-	6	4
	Medium Level	145	4.74	1.19	0.1	0.25	3	-	8	5
	High Level	47	5.09	1.23	0.18	0.24	3	-	7	5
Corsi Forward (length of sequence)	Low Level	59	4.05	1.17	0.15	0.29	3	-	6	4
	Medium Level	145	4.79	1.29	0.11	0.27	3	-	7	5
	High Level	47	5.06	1.44	0.21	0.28	3	-	8	5
Corsi Backward (length of sequence)	Low Level	59	3.69	1.13	0.15	0.31	2	-	7	3
	Medium Level	145	4.34	1.27	0.11	0.29	2	-	7	4
	High Level	47	4.51	1.27	0.18	0.28	2	-	7	4
Purdue Pegboard - Dominant Hand (number of pins)	Low Level	59	11.73	2.39	0.31	0.2	9	-	18	11
	Medium Level	145	12.83	2.72	0.23	0.21	7	-	19	12.5
	High Level	47	13.18	2.63	0.38	0.2	7	-	18	13
Purdue Pegboard - Nondominant Hand (number of pins)	Low Level	59	10.97	2.32	0.3	0.21	7	-	18	10.5
	Medium Level	145	12.23	2.81	0.23	0.23	5.5	-	18	12
	High Level	47	12.39	2.63	0.38	0.21	6.5	-	17	12.5
Purdue Pegboard - Both Hand (number of pins)	Low Level	59	10.49	2.64	0.34	0.25	3.5	-	18	10
	Medium Level	145	11.17	2.02	0.17	0.18	6	-	15.5	11
	High Level	47	11.46	2.19	0.32	0.19	7	-	15	11
Purdue Pegboard - Total (number of pins)	Low Level	59	33.19	6.81	0.88	0.21	21	-	49	31.5
	Medium Level	145	36.23	7.19	0.6	0.2	19.5	-	51	35.5
	High Level	47	37.03	7.14	1.03	0.19	20.5	-	49	35
Purdue Pegboard - Assembly (number of pins, collars, washers)	Low Level	59	29.07	8.79	1.13	0.3	6.5	-	50.5	27
	Medium Level	145	34.3	7.97	0.66	0.23	12.5	-	52	36.5
	High Level	47	35.03	7.12	1.03	0.2	14	-	44	37
Raven Test (number of correct answer)	Low Level	59	24.95	12.04	1.55	0.48	14	-	58	20
	Medium Level	145	34.76	13.61	1.13	0.39	15	-	58	33
	High Level	47	37.23	13.88	2	0.37	17	-	56	35

Table 5.4. Descriptive statistics for Income factor (cont.).

Response	Income Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	Max.	Median
Reaction Time - Dominant Hand (milliseconds)	Low Level	59	368.51	93.78	12.11	0.25	262.6	610	328.4
	Medium Level	145	335.02	67.21	5.56	0.2	261.4	605	308.4
	High Level	47	321.62	65.69	9.48	0.2	261	580	299.4
Reaction Time - Nondominant Hand (milliseconds)	Low Level	59	378.94	79.44	10.26	0.21	278.6	589	351
	Medium Level	145	346.46	63.59	5.26	0.18	273.4	582.16	330.2
	High Level	47	332.78	61.87	8.93	0.19	278.6	584	320.4
Stroop Color Word Test - Part I (seconds)	Low Level	59	13.97	4.42	0.57	0.32	7.31	24.45	12.78
	Medium Level	145	11.56	3.55	0.29	0.31	6.43	24.18	10.45
	High Level	47	11.25	3.07	0.44	0.27	6.48	25.45	10.55
Stroop Color Word Test - Part II (seconds)	Low Level	59	15.08	6.22	0.8	0.41	6.41	35.33	12.16
	Medium Level	145	12.5	4.93	0.41	0.39	5.89	35.33	10.16
	High Level	47	12.59	4.3	0.62	0.34	6.44	23.41	10.85
Stroop Color Word Test - Part III (seconds)	Low Level	59	15.79	5.24	0.68	0.33	9.44	28.11	14.45
	Medium Level	145	13.03	3.9	0.32	0.3	8.35	26.13	11.46
	High Level	47	13.74	4.15	0.6	0.3	8.44	27.49	12.45
Stroop Color Word Test - Part IV (seconds)	Low Level	59	23.93	10.41	1.34	0.44	11.16	74.54	20.15
	Medium Level	145	17.78	6.85	0.57	0.39	2.46	40.88	17.1
	High Level	47	17.5	5.28	0.76	0.3	9.27	35.15	18.16
Stroop Color Word Test - Part V (seconds)	Low Level	59	39.6	15.6	2.01	0.39	18.25	72.1	33.45
	Medium Level	145	30.42	12.77	1.06	0.42	14.07	72.16	27.89
	High Level	47	28.52	10.34	1.49	0.36	16.02	62.15	28.36

Table 5.5. Descriptive statistics for Marital Status factor.

Response	Marital Status	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Digit Forward (number of digits)	Married	204	5,66	1,26	0,18	0,22	3	-	8	6
	Single	47	5,24	1,27	0,09	0,24	3	-	8	5
Digit Backward (number of digits)	Married	204	5,09	1,23	0,18	0,24	3	-	7	5
	Single	47	4,52	1,2	0,08	0,27	3	-	8	4
Corsi Forward (length of sequence)	Married	204	5,06	1,44	0,21	0,28	3	-	8	5
	Single	47	4,57	1,29	0,09	0,28	3	-	7	4
Corsi Backward (length of sequence)	Married	204	4,51	1,27	0,18	0,28	2	-	7	4
	Single	47	4,16	1,27	0,09	0,31	2	-	7	4
Purdue Pegboard - Dominant Hand (number of pins)	Married	204	13,18	2,63	0,38	0,2	7	-	18	13
	Single	47	12,51	2,67	0,19	0,21	7	-	19	12
Purdue Pegboard - Nondominant Hand (number of pins)	Married	204	12,39	2,63	0,38	0,21	6,5	-	17	12,5
	Single	47	11,86	2,73	0,19	0,23	5,5	-	18	11,5
Purdue Pegboard - Both Hand (number of pins)	Married	204	11,46	2,19	0,32	0,19	7	-	15	11
	Single	47	10,97	2,23	0,16	0,2	3,5	-	18	10,5
Purdue Pegboard - Total (number of pins)	Married	204	37,03	7,14	1,03	0,19	20,5	-	49	35
	Single	47	35,35	7,2	0,5	0,2	19,5	-	51	34,5
Purdue Pegboard - Assembly (number of pins, collars, washers)	Married	204	35,03	7,12	1,03	0,2	14	-	44	37
	Single	47	32,79	8,53	0,6	0,26	6,5	-	52	33
Raven Test (number of correct answer)	Married	204	37,23	13,88	2	0,37	17	-	56	35
	Single	47	31,92	13,88	0,97	0,43	14	-	58	29
Reaction Time - Dominant Hand (milliseconds)	Married	204	321,62	65,69	9,48	0,2	261	-	580	299,4
	Single	47	344,71	77,13	5,39	0,22	261,4	-	610	317,1
Reaction Time - Nondominant Hand (milliseconds)	Married	204	332,78	61,87	8,93	0,19	278,6	-	584	320,4
	Single	47	355,85	69,92	4,88	0,2	273,4	-	589	335,4
Stroop Color Word Test - Part I (seconds)	Married	204	11,25	3,07	0,44	0,27	6,48	-	25,45	10,55
	Single	47	12,26	3,96	0,28	0,32	6,43	-	24,45	11,79
Stroop Color Word Test - Part II (seconds)	Married	204	12,59	4,3	0,62	0,34	6,44	-	23,41	10,85
	Single	47	13,25	5,45	0,38	0,41	5,89	-	35,33	10,45
Stroop Color Word Test - Part III (seconds)	Married	204	13,74	4,15	0,6	0,3	8,44	-	27,49	12,45
	Single	47	13,83	4,49	0,31	0,32	8,35	-	28,11	12,15

Table 5.5. Descriptive statistics for Marital Status factor (cont.).

Response	Marital Status	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min. - Max.	Median
Stroop Color Word Test - Part IV (seconds)	Married	204	17,5	5,28	0,76	0,3	9,27 - 35,15	18,16
	Single	47	19,56	8,49	0,59	0,43	2,46 - 74,54	17,71
Stroop Color Word Test - Part V (seconds)	Married	204	28,52	10,34	1,49	0,36	16,02 - 62,15	28,36
	Single	47	33,08	14,23	0,99	0,43	14,07 - 72,16	29,41

Table 5.6. Descriptive statistics for Smoking Habit factor.

Response	Smoking Habit Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min. - Max.	Median
Digit Forward (number of digits)	Smoking	72	5.35	1.21	0.09	0.23	3 - 8	5
	Non Smoking	179	5.22	1.43	0.17	0.27	3 - 8	5
Digit Backward (number of digits)	Smoking	72	4.66	1.23	0.09	0.26	3 - 8	5
	Non Smoking	179	4.54	1.22	0.14	0.27	3 - 8	4
Corsi Forward (length of sequence)	Smoking	72	4.68	1.33	0.1	0.28	3 - 8	5
	Non Smoking	179	4.63	1.35	0.16	0.29	3 - 8	4
Corsi Backward (length of sequence)	Smoking	72	4.24	1.26	0.09	0.3	2 - 7	4
	Non Smoking	179	4.18	1.31	0.15	0.31	2 - 7	4
Purdue Pegboard - Dominant Hand (number of pins)	Smoking	72	12.53	2.52	0.3	0.2	7 - 17	12
	Non Smoking	179	12.68	2.73	0.2	0.22	7 - 19	12
Purdue Pegboard - Nondominant Hand (number of pins)	Smoking	72	11.83	2.61	0.31	0.22	6.5 - 17	11.75
	Non Smoking	179	12.01	2.77	0.21	0.23	5.5 - 18	11.5
Purdue Pegboard - Both Hand (number of pins)	Smoking	72	10.92	1.9	0.22	0.17	7 - 15	11
	Non Smoking	179	11.12	2.35	0.18	0.21	3.5 - 18	10.5
Purdue Pegboard - Total (number of pins)	Smoking	72	35.29	6.72	0.79	0.19	20.5 - 48	34.25
	Non Smoking	179	35.81	7.4	0.55	0.21	19.5 - 51	35
Purdue Pegboard - Assembly (number of pins, collars, washers)	Smoking	72	33.65	7.18	0.85	0.21	21 - 49	35.5
	Non Smoking	179	33.03	8.74	0.65	0.26	6.5 - 52	35

Table 5.6. Descriptive statistics for Smoking Habit factor (cont.).

Response	Smoking Habit Group	n	\bar{x}	s	Std. Error of \bar{x}	CV (s/ \bar{x})	Min.	-	Max.	Median
Reaction Time - Dominant Hand (milliseconds)	Smoking	72	330.71	55.74	6.57	0.17	262.6	-	482.8	305.9
	Non Smoking	179	344.28	81.99	6.11	0.24	261	-	610	310.4
Reaction Time - Nondominant Hand (milliseconds)	Smoking	72	345.04	53.55	6.31	0.16	276.4	-	514.6	330.6
	Non Smoking	179	354.14	74.24	5.53	0.21	273.4	-	589	333.4
Stroop Color Word Test - Part I (seconds)	Smoking	72	12.11	3.54	0.42	0.29	6.43	-	25.45	11.53
	Non Smoking	179	12.05	3.94	0.29	0.33	6.48	-	24.45	11.48
Stroop Color Word Test - Part II (seconds)	Smoking	72	12.91	4.46	0.53	0.35	6.46	-	23.41	10.46
	Non Smoking	179	13.21	5.54	0.41	0.42	5.89	-	35.33	10.48
Stroop Color Word Test - Part III (seconds)	Smoking	72	13.99	4.23	0.5	0.3	8.84	-	27.49	12.29
	Non Smoking	179	13.74	4.51	0.34	0.33	8.35	-	28.11	12.15
Stroop Color Word Test - Part IV (seconds)	Smoking	72	18.57	6.44	0.76	0.35	9.12	-	37.89	18.14
	Non Smoking	179	19.11	7.53	0.56	0.39	2.46	-	40.88	17.27
Stroop Color Word Test - Part V (seconds)	Smoking	72	31.85	12.72	1.5	0.4	15.26	-	72.1	29.62
	Non Smoking	179	32.07	13.87	1.03	0.43	14.07	-	72.16	28.49
Raven Test (number of correct answer)	Smoking	72	31.89	13.29	1.57	0.42	15	-	58	30
	Non Smoking	179	33.33	14.3	1.07	0.43	14	-	58	31

5.2.2. Percentile Values of Response Variables

Percentile values of test results are calculated, %5, %25, %50, %75 and % 95 percentile values for each test result are shown in Table 5.7.

Table 5.7. Percentile values of test results.

Percentiles	5	25	50	75	95
Digit Forward Result (number of digits)	3.5	4	5	6	8
Digit Backward Result (number of digits)	3	3,5	4	6	7
Corsi Forward Result (length of sequences)	3	3,5	4	6	7
Corsi Backward Result (length of sequences)	3	3,5	4	5	6
Reaction Time Dominant Hand Result (millisecond)	268	291.4	308.6	373.4	506.5
Reaction Time Nondominant Hand Result (millisecond)	281	300.01	331.2	386.9	512.1
Purdue Pegboard Dominant Hand Result (number of pins)	9	11	12	15.25	17
Purdue Pegboard Nondominant Hand Result (number of pins)	8	10	11.5	14	16
Purdue Pegboard Both Hand Result (number of pins)	7.5	9.5	10.5	13	14.5
Purdue Pegboard Total (D+ND+B Hand) Result (number of pins)	25.25	30.5	35	43	47
Purdue Pegboard Assembly Result (number of pins, collars, washers)	22	26	35	40.25	44.5
Raven Test Result (number of correct answers)	16	20	30	46	56
Stroop Color - Word Test Part I (Time - Seconds)	7.65	9.75	11.48	13.13	21.11
Stroop Color - Word Test Part II (Time -Seconds)	8.04	9.45	10.46	17.17	22.78
Stroop Color - Word Test Part III (Time -Seconds)	9.33	10.38	12.15	16.78	23.45
Stroop Color - Word Test Part IV (Time -Seconds)	10.14	13.42	17.7	21.45	35.15
Stroop Color - Word Test Part V (Time -Seconds)	18.29	22.13	29.15	34.16	65.16

5.2.3. Box Plots of Response Variables

The boxplot diagrams are drawn by using Minitab. They are presented in the following. These figures show the descriptive statistics of the data and confirm the skewness.

All test responses except Raven test and Purdue Pegboard Dominant Hand test, boxplots shows that data are skewed and the majority of the data are located on one side of the graph. Skewness indicates that the data may not be normally distributed (Montgomery,2005).

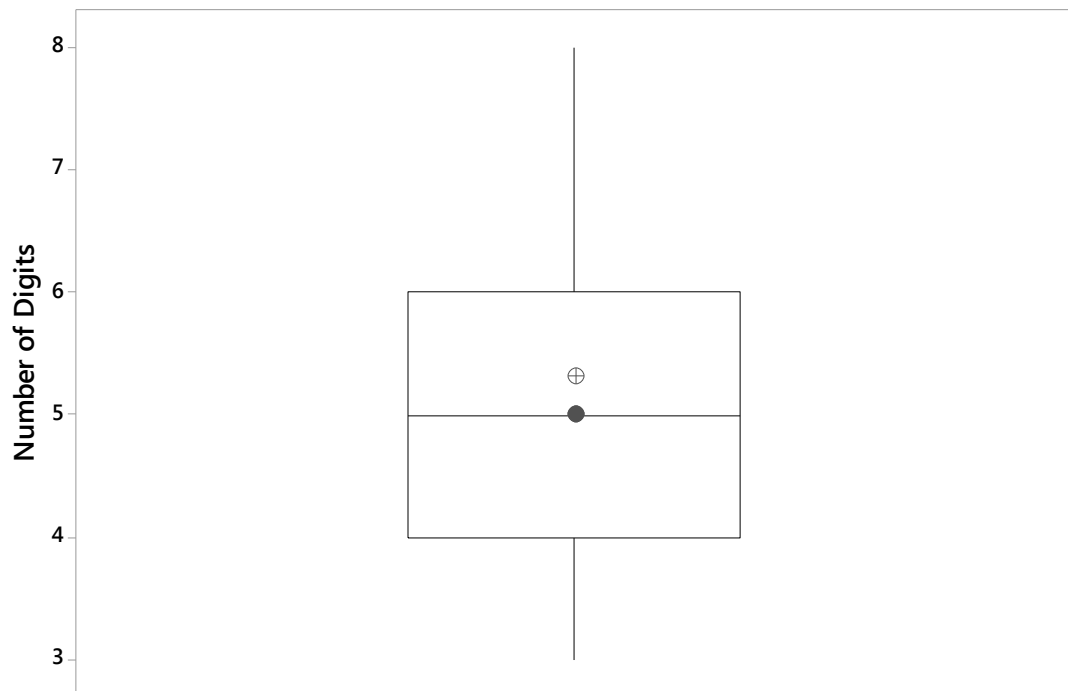


Figure 5.1. Boxplot of Digit Forward test (⊕ icon represents mean value and —●— icon represents Median value).

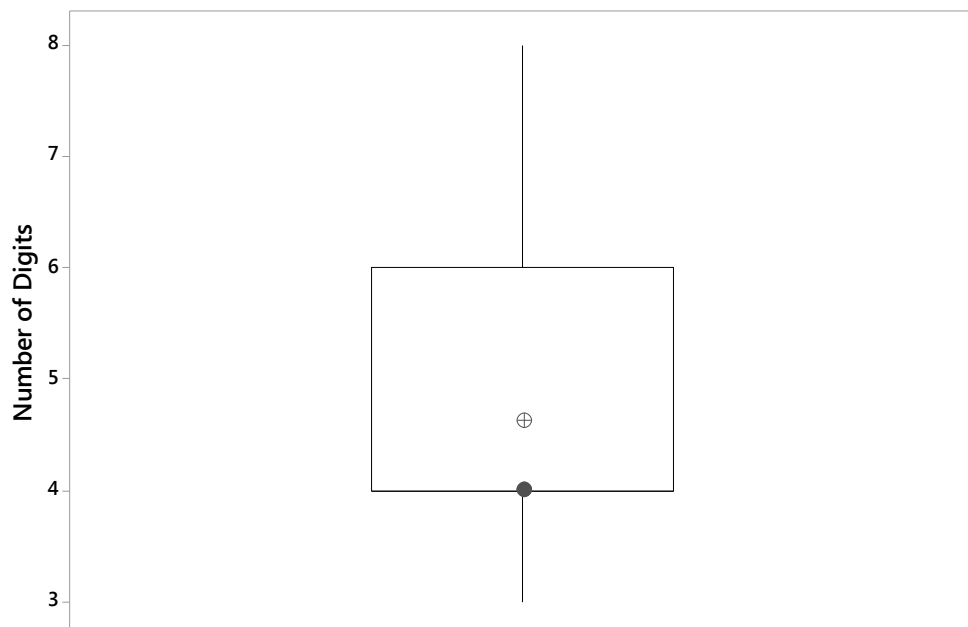


Figure 5.2. Boxplot of Digit Backward test result (⊕ icon represents mean value and —●— icon represents Median value).

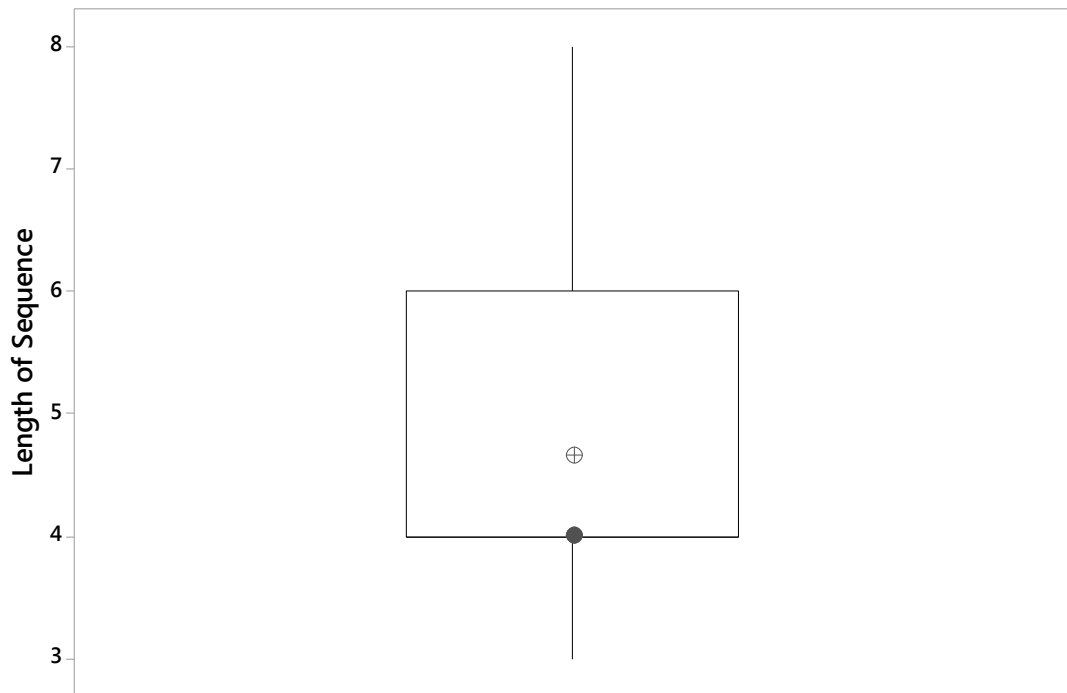


Figure 5.3. Boxplot of Corsi Forward test result (⊕ icon represents mean value and —●— icon represents Median value).

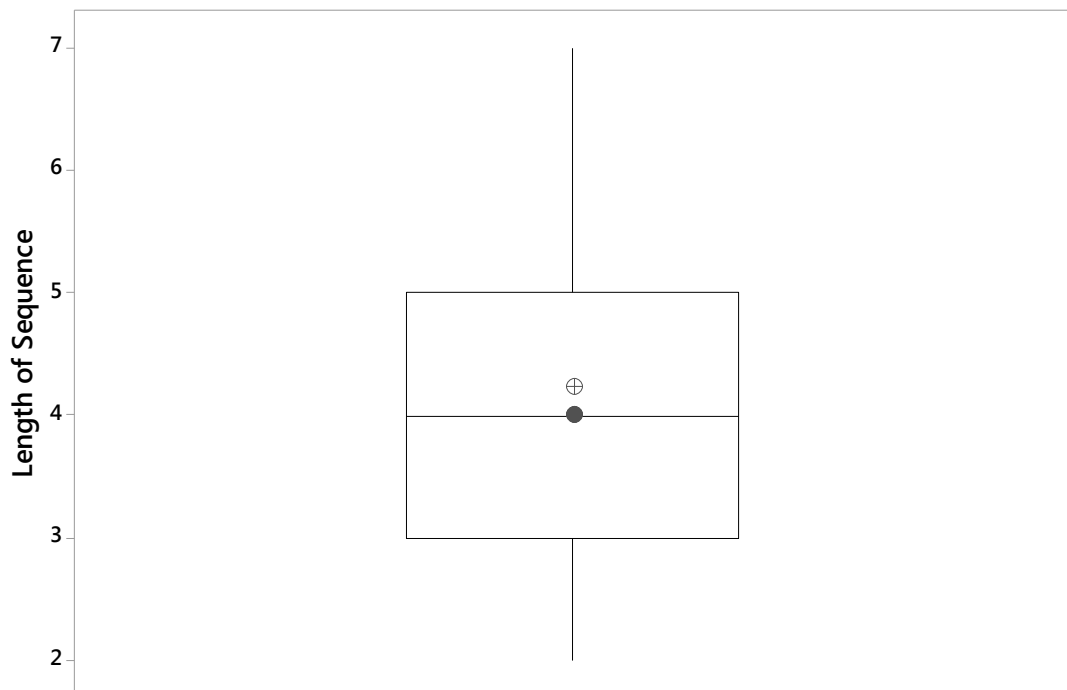


Figure 5.4. Boxplot of Corsi Backward test result (⊕ icon represents mean value and —●— icon represents Median value).

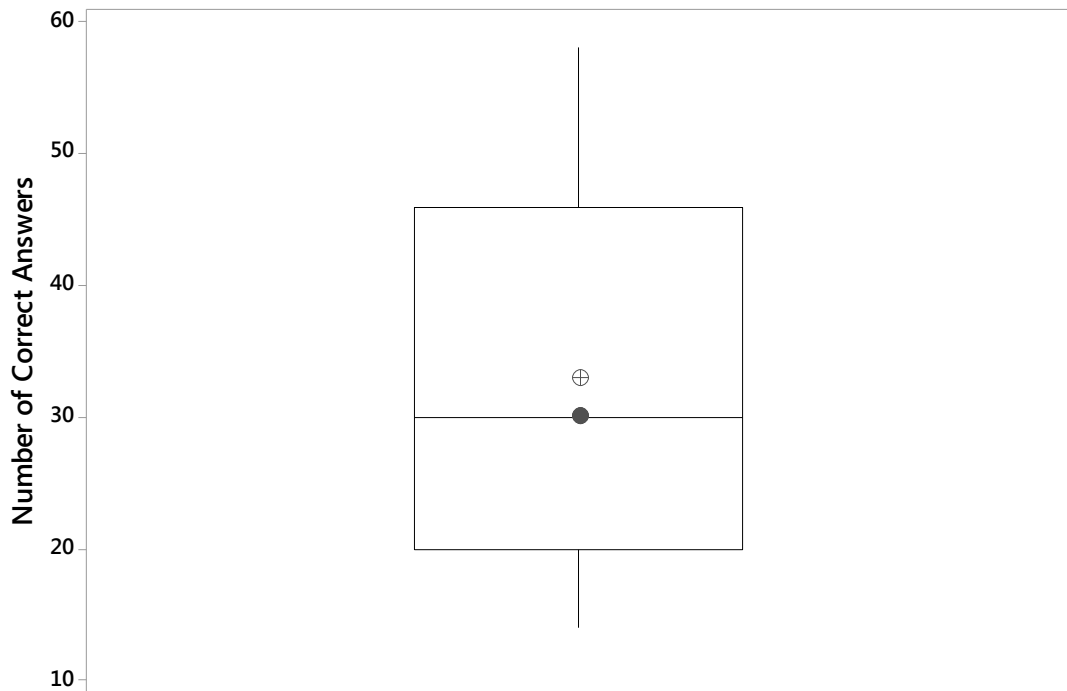


Figure 5.5. Boxplot of Raven test result (⊕ icon represents mean value and —●— icon represents Median value).

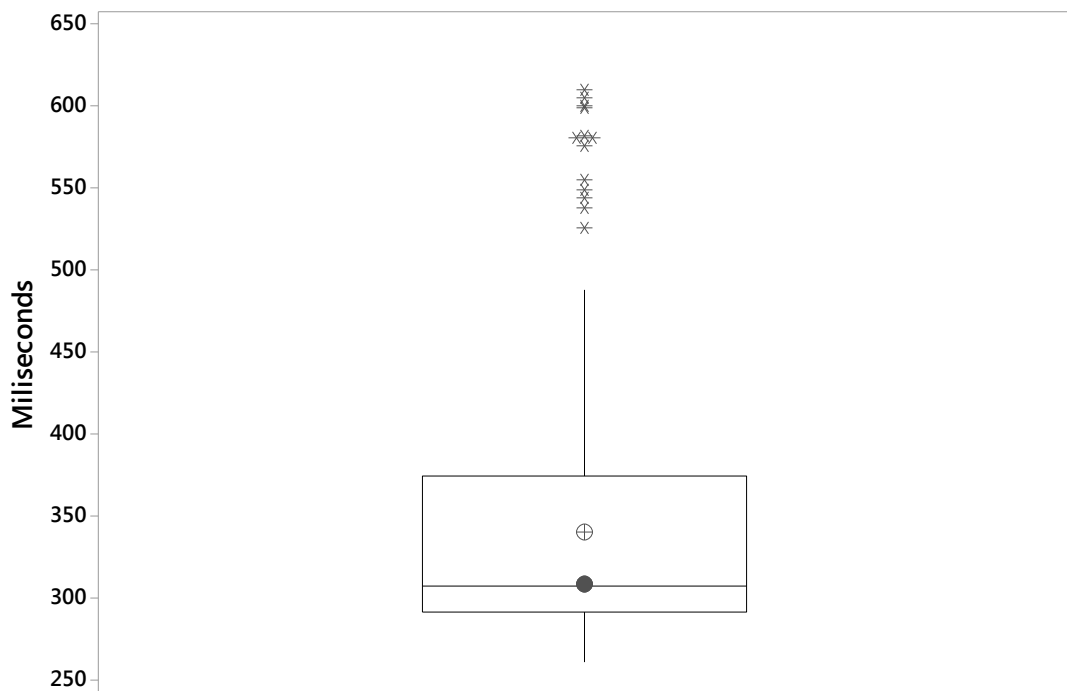


Figure 5.6. Boxplot of Reaction Time Dominant Hand test result (⊕ icon represents mean value and —●— icon represents Median value).

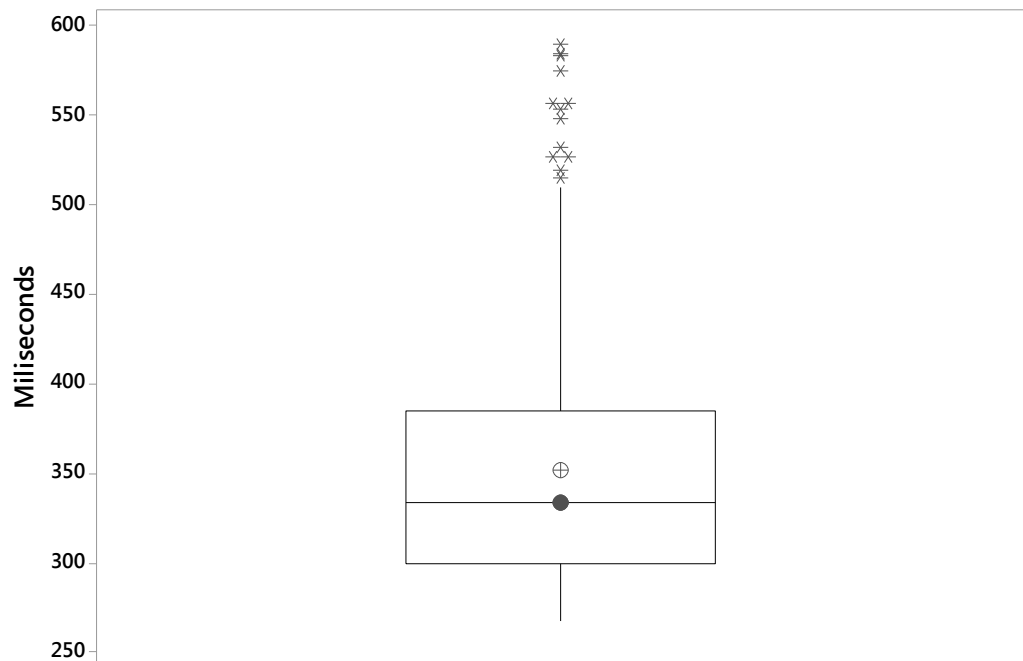


Figure 5.7. Boxplot of Reaction Time Nondominant Hand test result (⊕ icon represents mean value and —●— icon represents Median value).

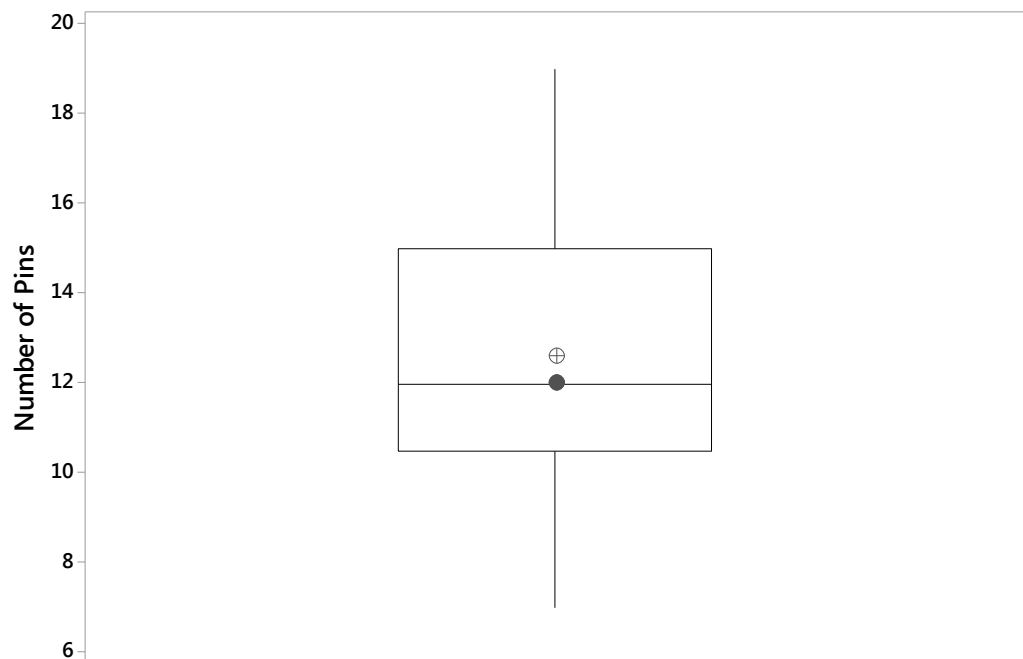


Figure 5.8. Boxplot of Purdue Pegboard Dominant Hand test result (⊕ icon represents mean value and —●— icon represents Median value).

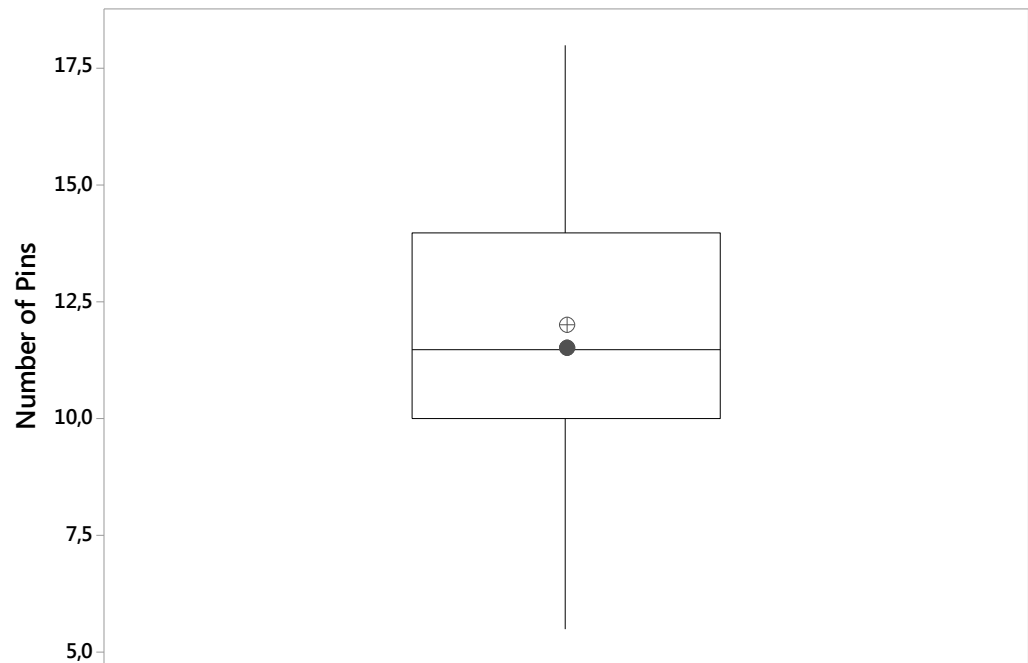


Figure 5.9. Boxplot of Purdue Pegboard Nondominant Hand test result (⊕ icon represents mean value and —●— icon represents Median value).

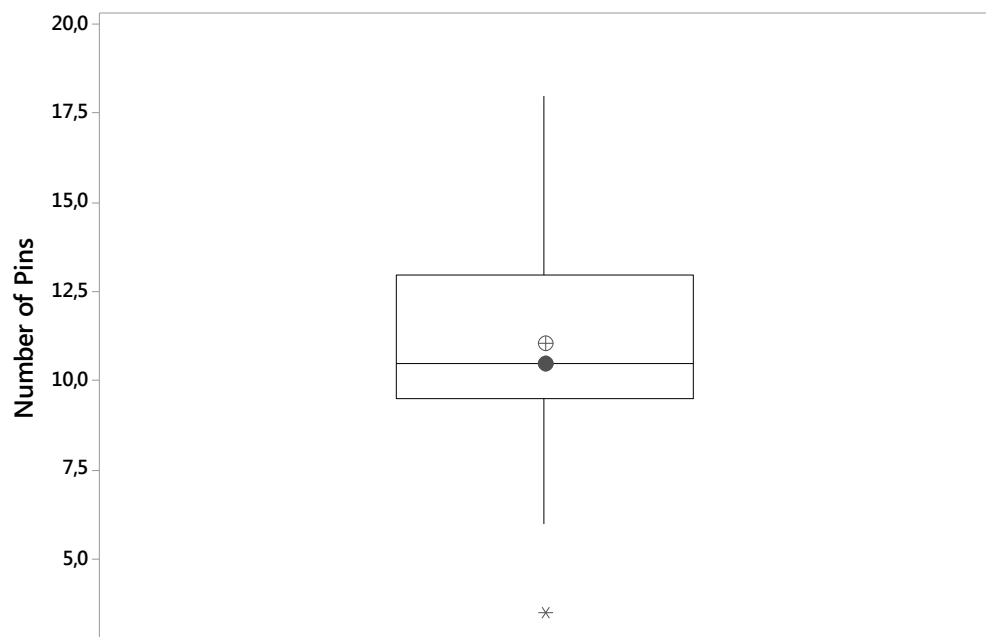


Figure 5.10. Boxplot of Purdue Pegboard Both Hand test result (⊕ icon represents mean value and —●— icon represents Median value).

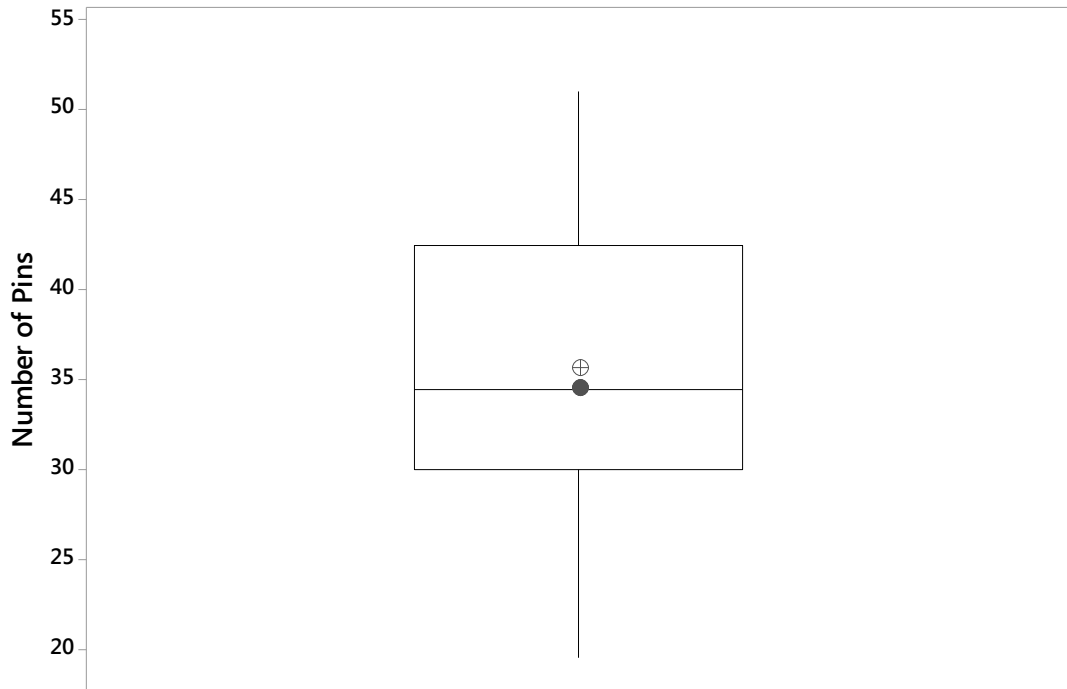


Figure 5.11. Boxplot of Purdue Pegboard Total test result (⊕ icon represents mean value and —●— icon represents Median value).

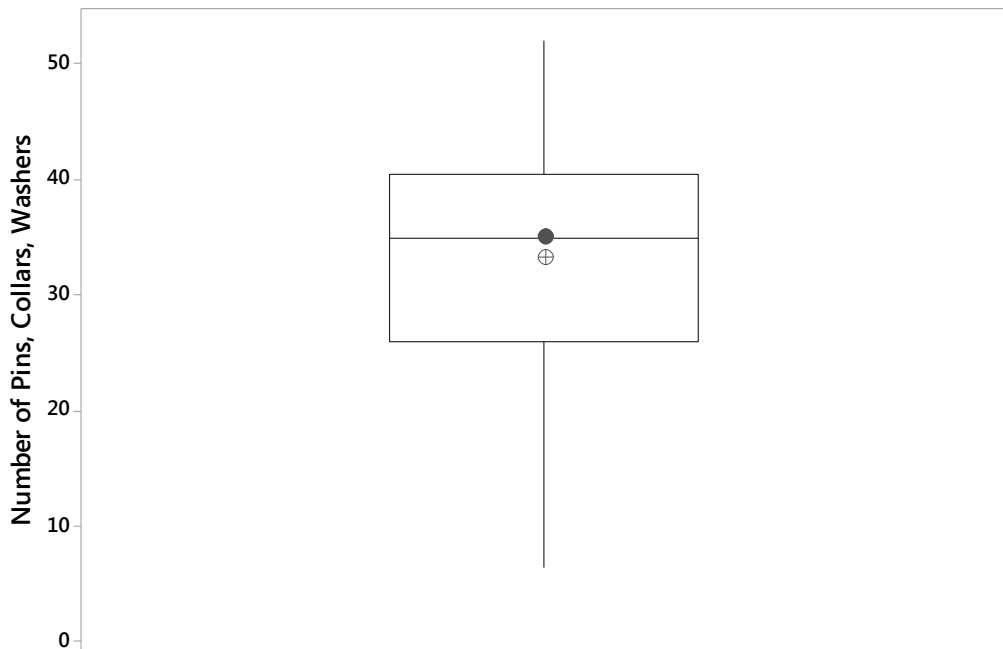


Figure 5.12. Boxplot of Purdue Pegboard Assembly test result (⊕ icon represents mean value and —●— icon represents Median value).

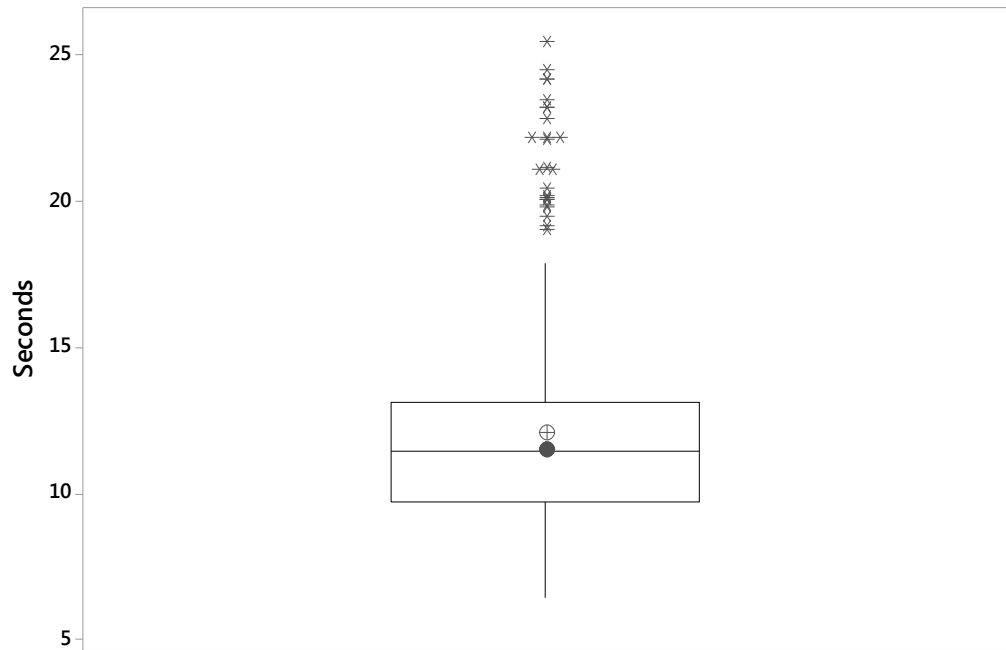


Figure 5.13. Boxplot of Stroop Color Word Test Part I result (⊕ icon represents mean value and —●— icon represents Median value).

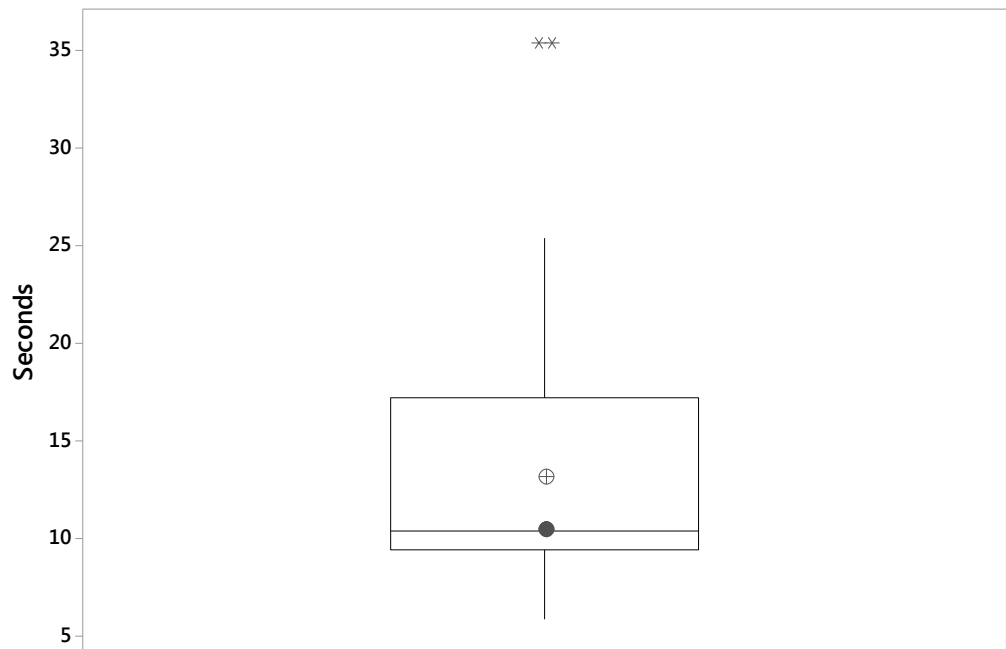


Figure 5.14. Boxplot of Stroop Color Word Test Part II result (⊕ icon represents mean value and —●— icon represents Median value).

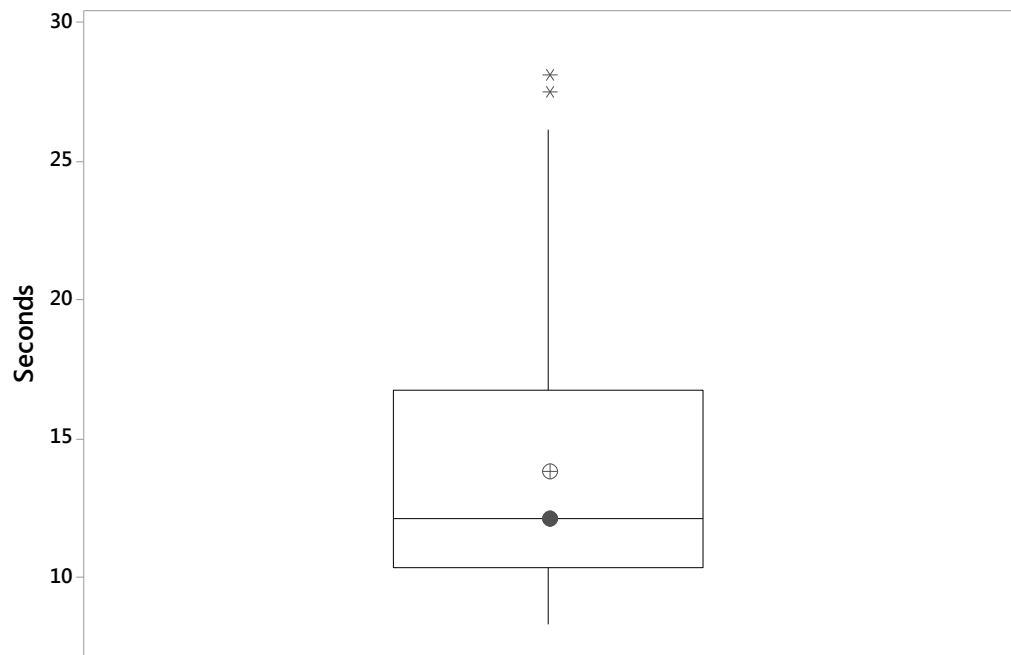


Figure 5.15. Boxplot of Stroop Color Word Test Part III result (⊕ icon represents mean value and —●— icon represents Median value).

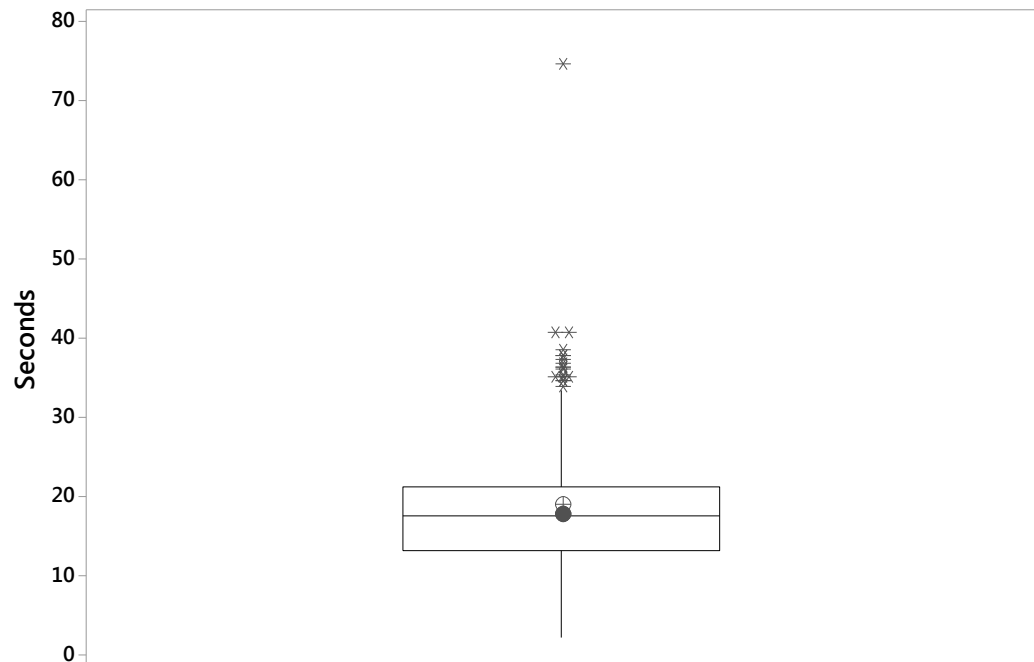


Figure 5.16. Boxplot of Stroop Color Word Test Part IV result (⊕ icon represents mean value and —●— icon represents Median value).

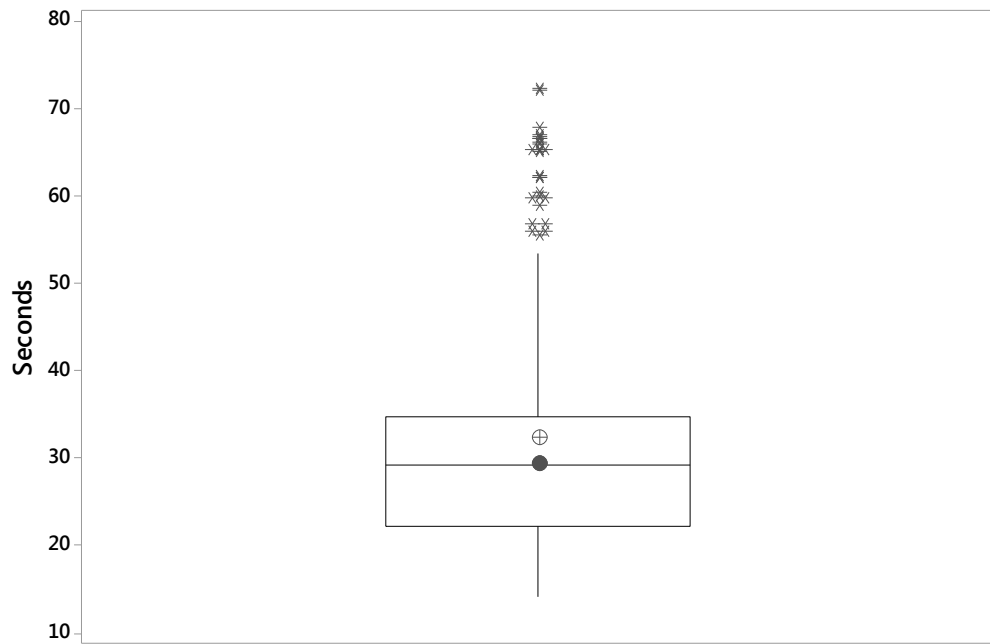


Figure 5.17. Boxplot of Stroop Color Word Test Part V result (⊕ icon represents mean value and —●— icon represents Median value).

Boxplot diagrams of independent variable groups are drawn at below.

For Age Factor;

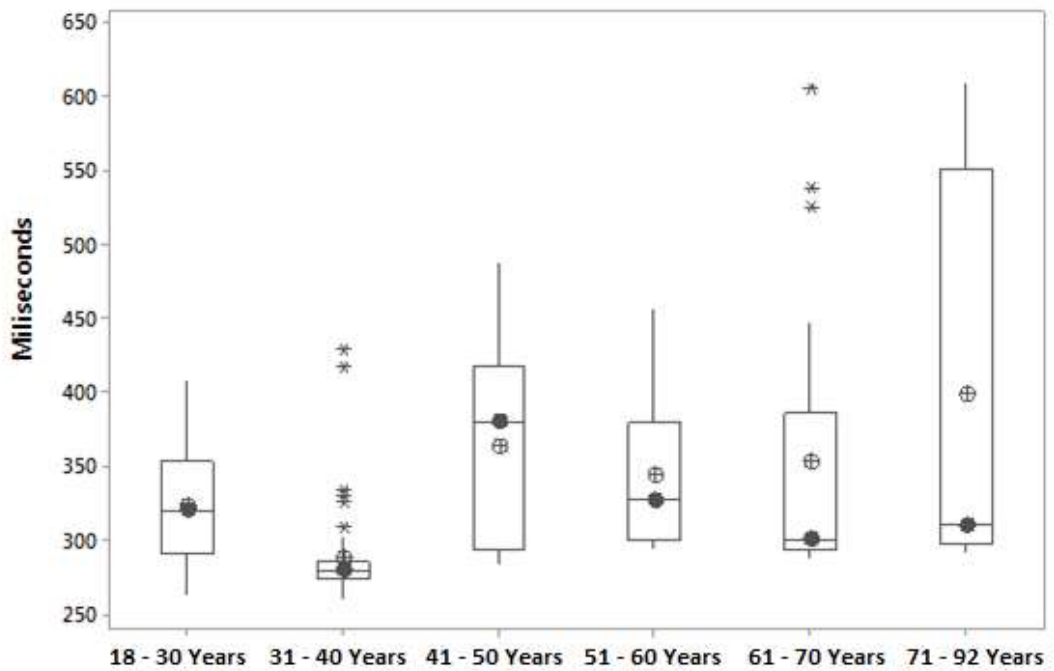


Figure 5.18. Box plot of Reaction Time Test (Dominant Hand).

For Reaction Time test (dominant hand), mean values first decrease than start to increase for age groups.

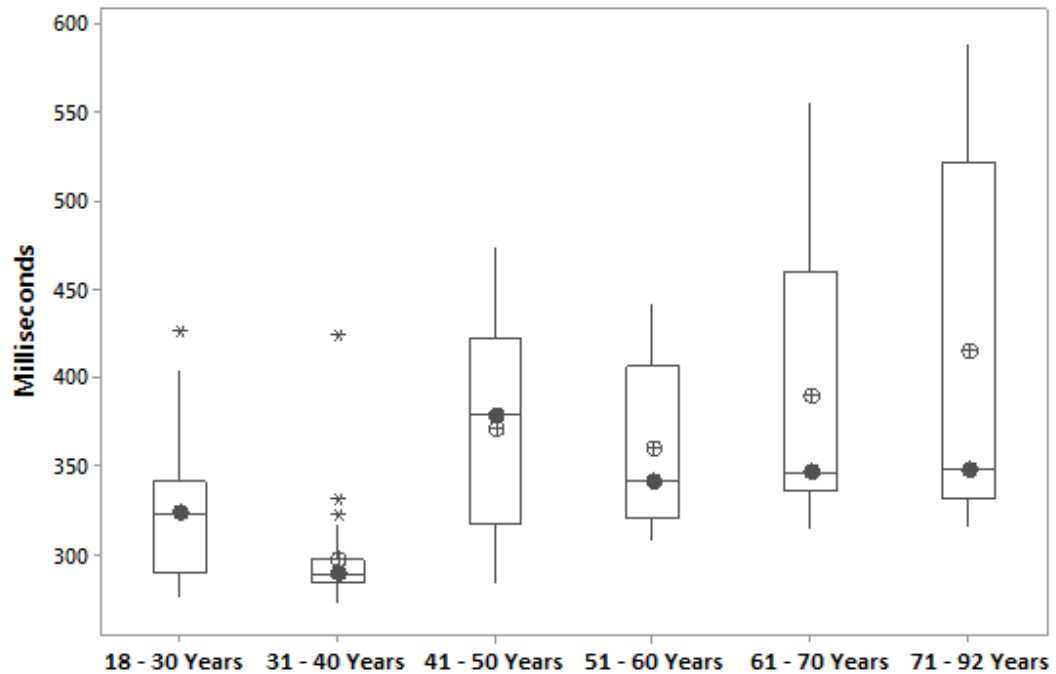


Figure 5.19. Box plot of Reaction Time Test (Nondominant Hand).

For Reaction Time test (nondominant hand), mean values first decrease than start to increase for age groups. It has similar path to reaction time test (nondominant hand).

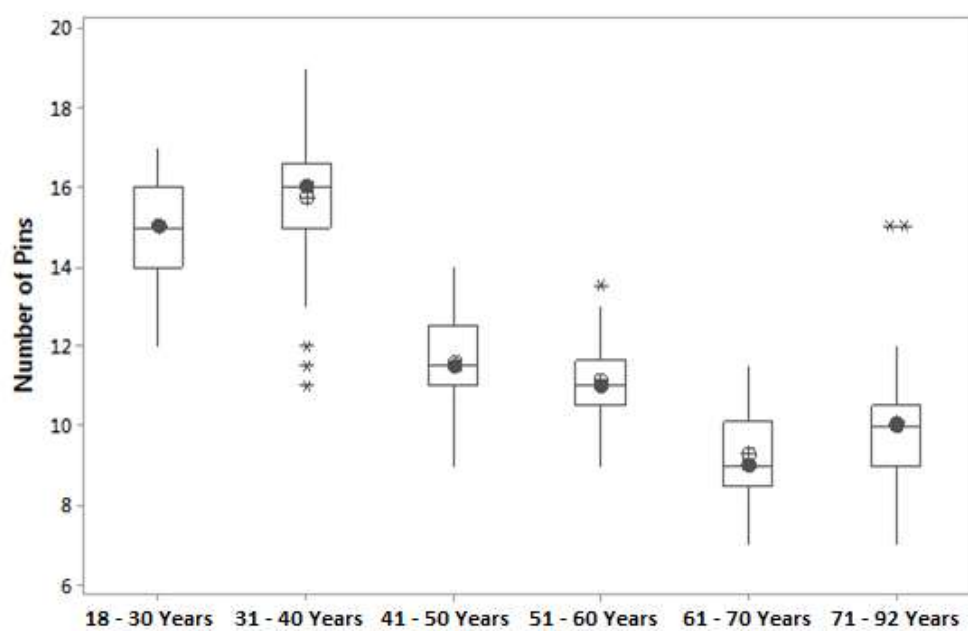


Figure 5.20. Box plot Purdue Pegboard Test (Dominant Hand).

For Purdue Pegboard test (dominant hand), mean values first increase for between age groups (18-30 years and 31-40 years) than start to decrease.

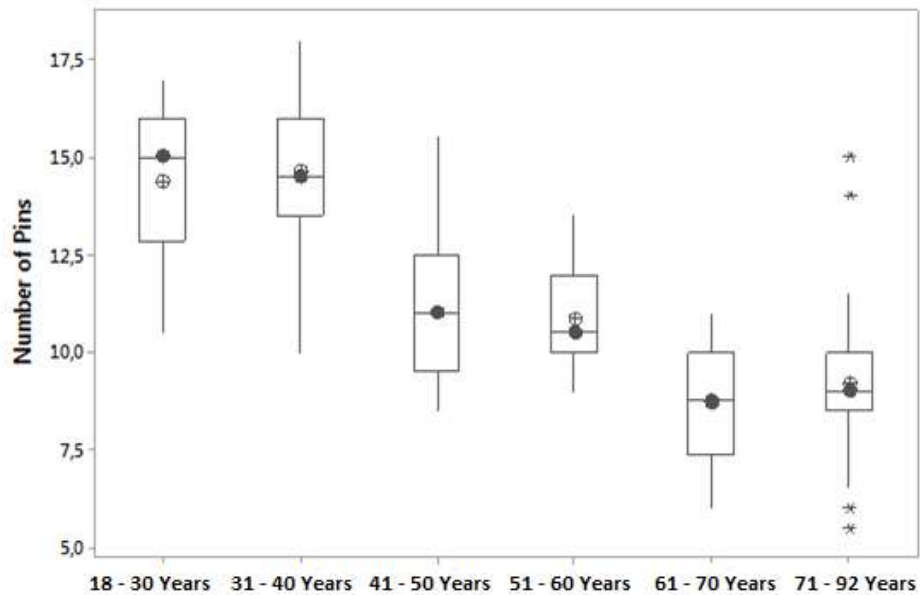


Figure 5.21. Box plot Purdue Pegboard Test (Nondominant Hand).

For Purdue Pegboard test (nondominant hand), mean values first increase for between age groups (18-30 years and 31-40 years) than start to decrease similar to Purdue Pegboard test (dominant hand).

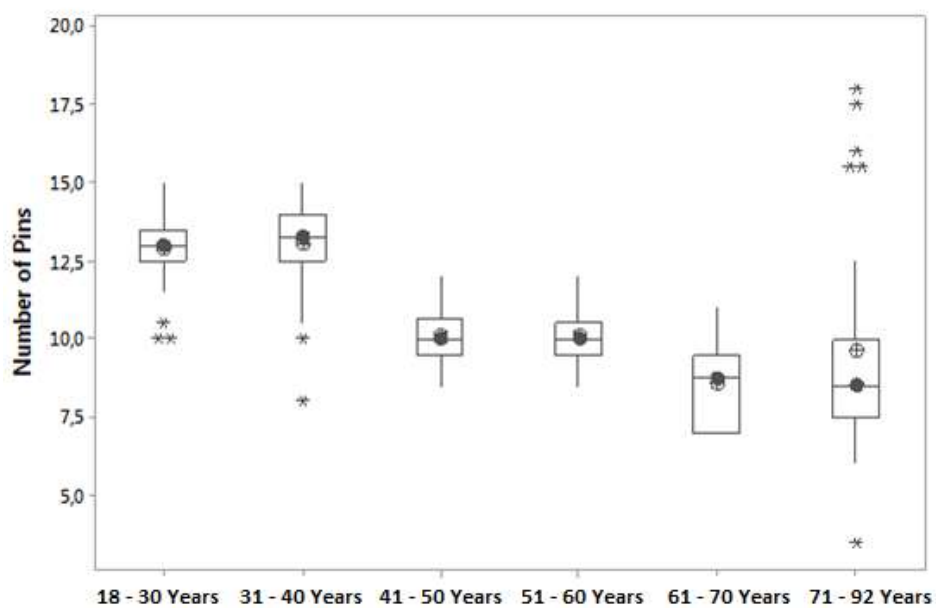


Figure 5.22. Box plot Purdue Pegboard Test (Both Hand).

For Purdue Pegboard test (both hand), mean values first increase for between age groups (18-30 years and 31-40 years) than start to decrease until age of 71. After that mean value mean value increases again.

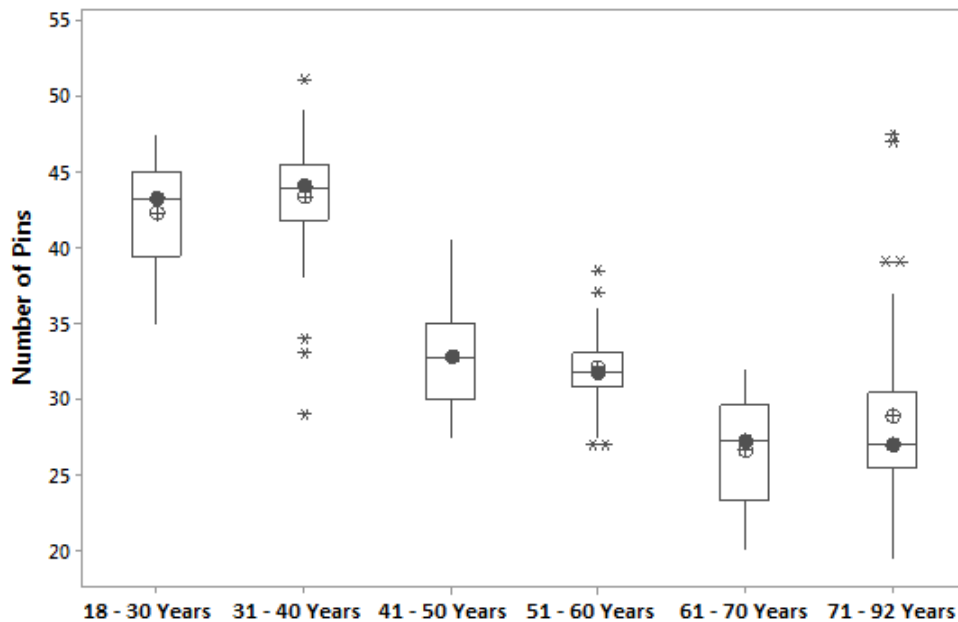


Figure 5.23. Box plot Purdue Pegboard Test (Total).

For Purdue Pegboard test (Total), mean values first increase for between age groups (18-30 years and 31-40 years) than start to decrease until age of 71. After that mean value mean value increases again.

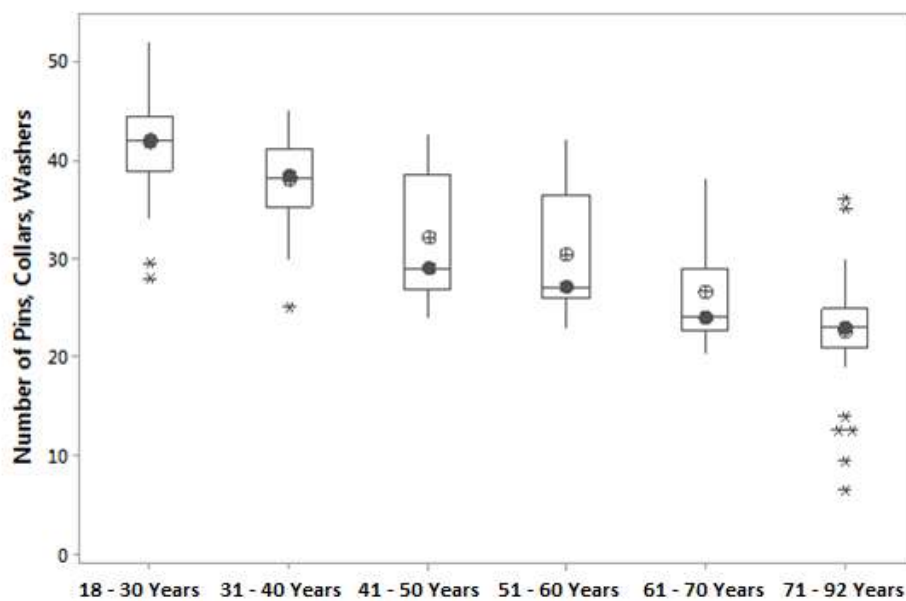


Figure 5.24. Box plot Purdue Pegboard Test (Assembly).

For Purdue Pegboard test (Assembly), mean values decreases with age.

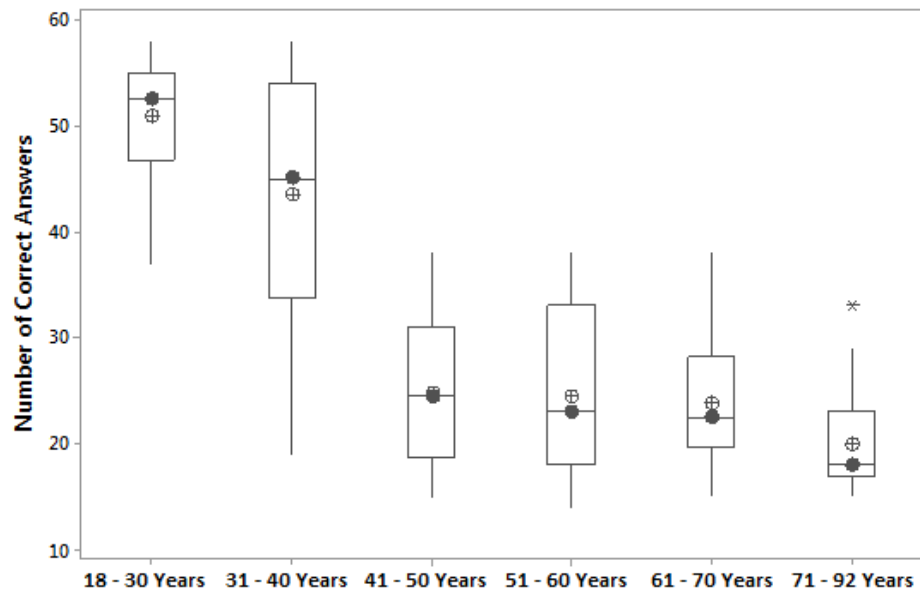


Figure 5.25. Box plot Raven Test.

For Raven test, mean values decreases with age.

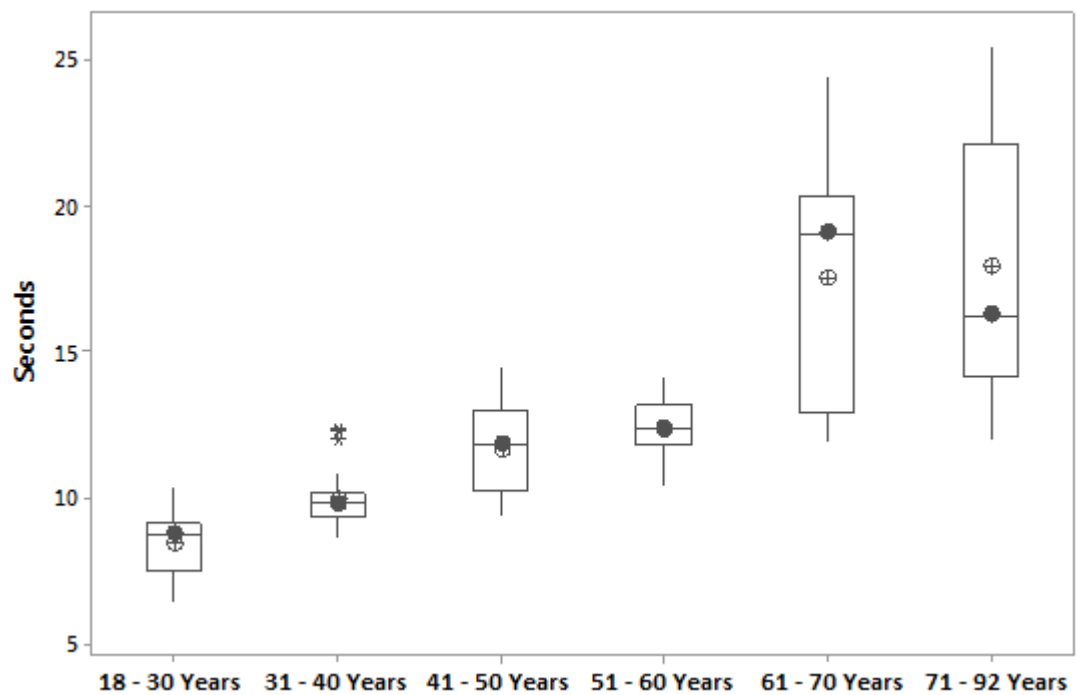


Figure 5.26. Box plot (SCWT Part I).

For Stroop Color Word Test Part I, mean values increases gradually with age.

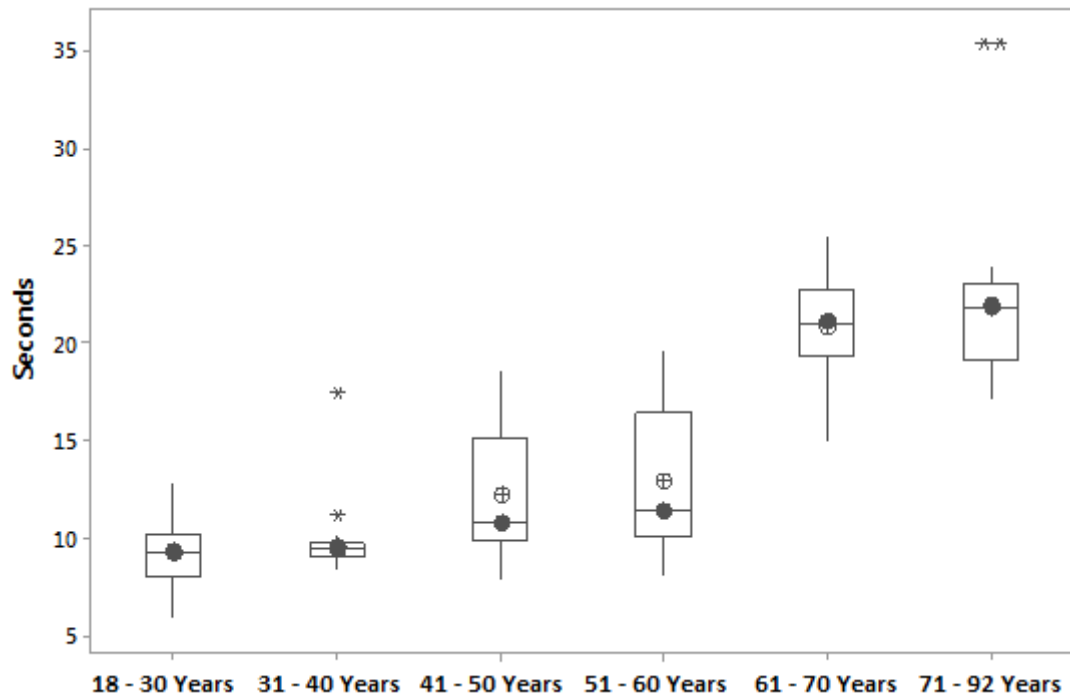


Figure 5.27. Box plot (SCWT Part II).

For Stroop Color Word Test Part II, mean values increases gradually with age.

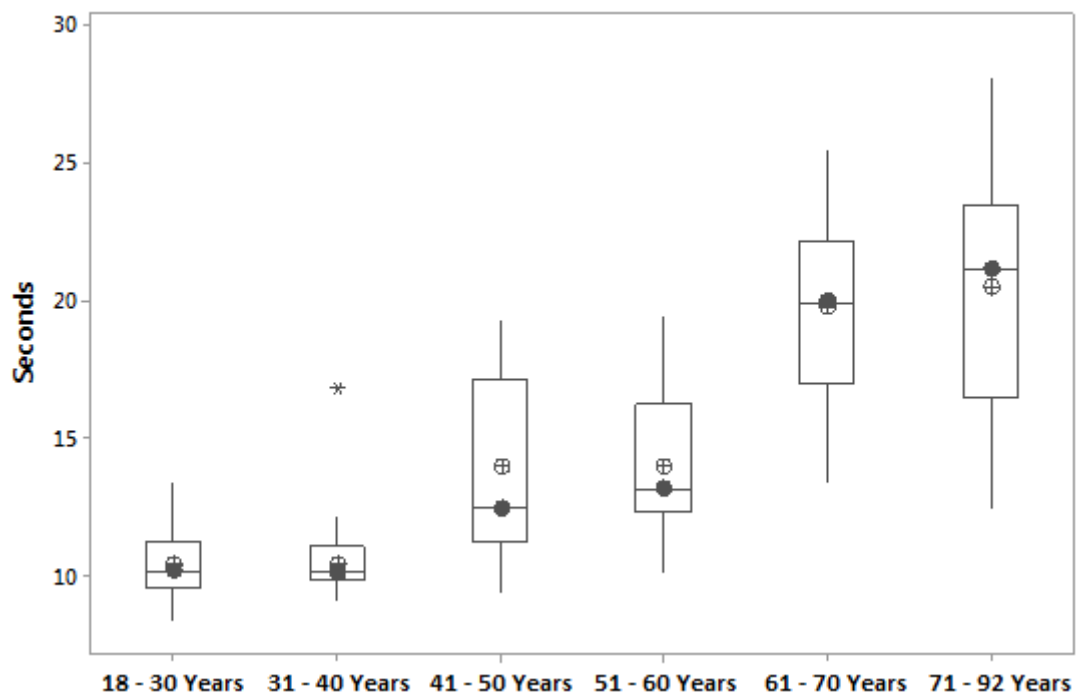


Figure 5.28. Box plot (SCWT Part III).

For Stroop Color Word Test Part III, mean values increases gradually with age.

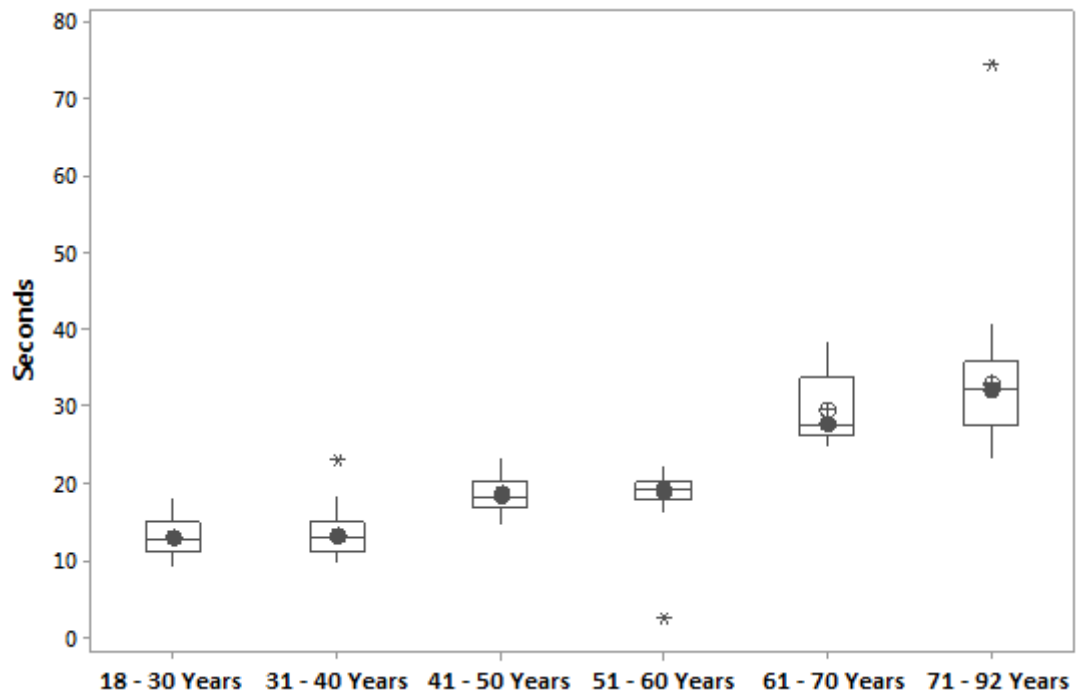


Figure 5.29. Box plot (SCWT Part IV).

For Stroop Color Word Test Part IV, mean values increases gradually with age.

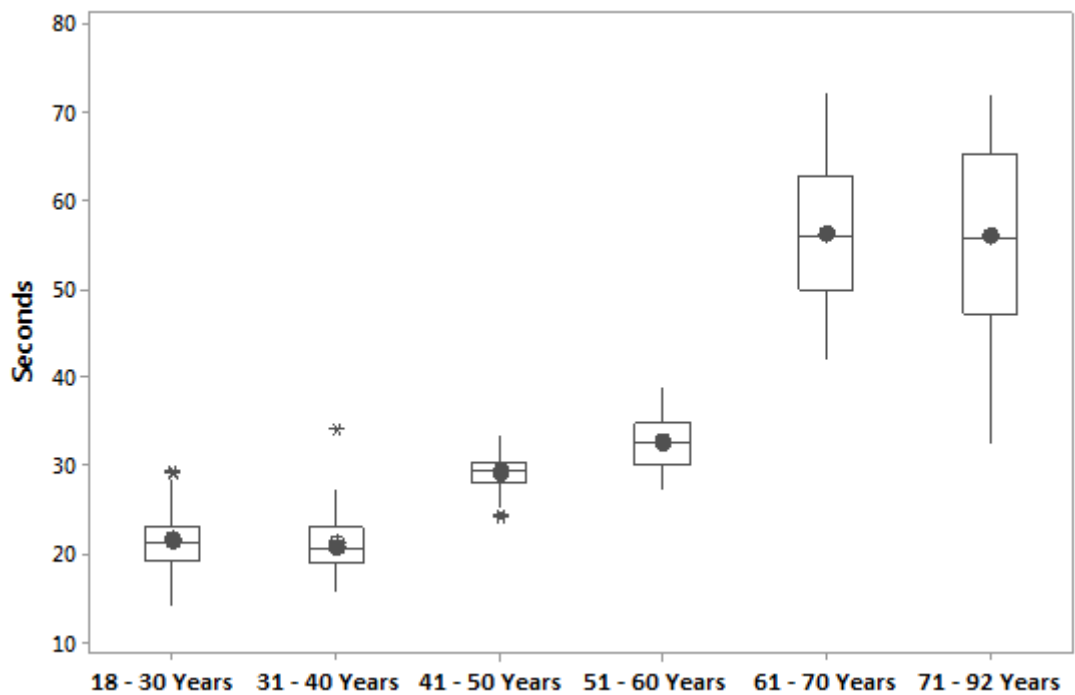


Figure 5.30. Box plot (SCWT Part V).

For Stroop Color Word Test Part V, mean values increases gradually with age.

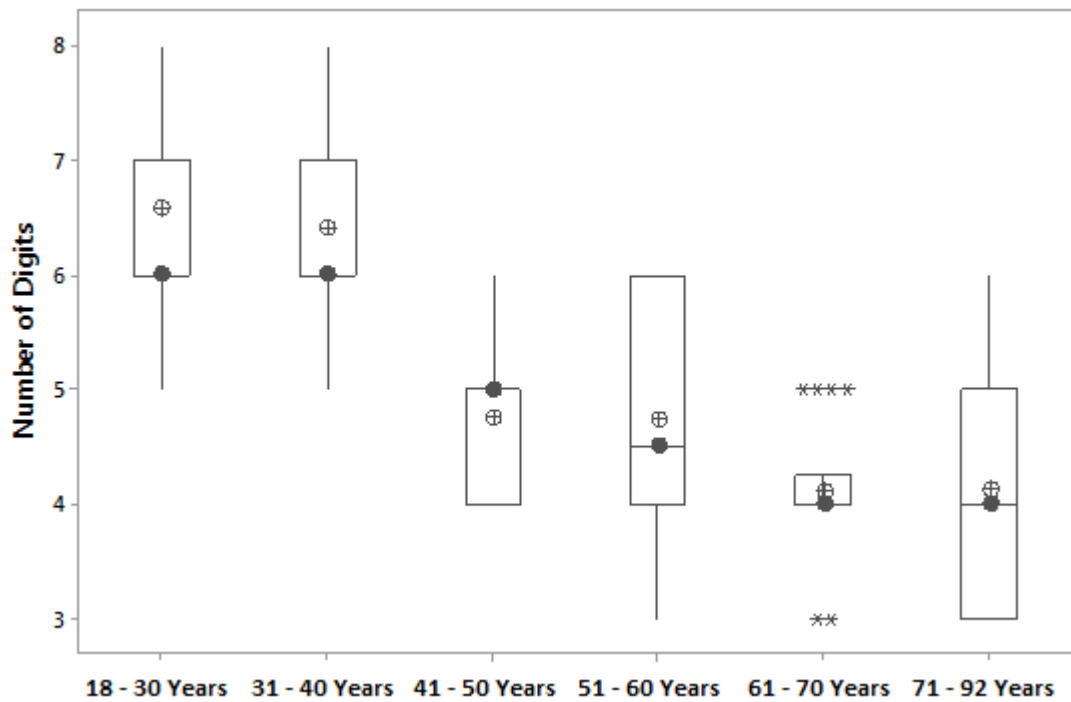


Figure 5.31. Box plot Digit Span Forward Test.

For Digit Span forward test, mean values decreases gradually with age.

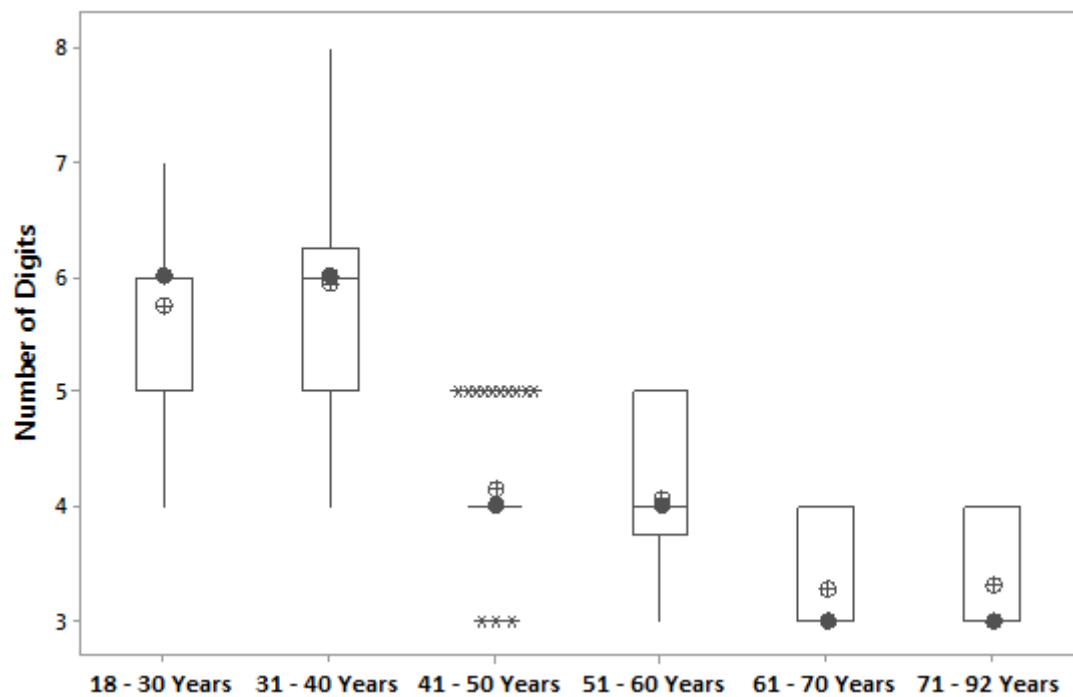


Figure 5.32. Box plot Digit Span Backward Test.

For Digit Span backward test, mean values decreases gradually with age.

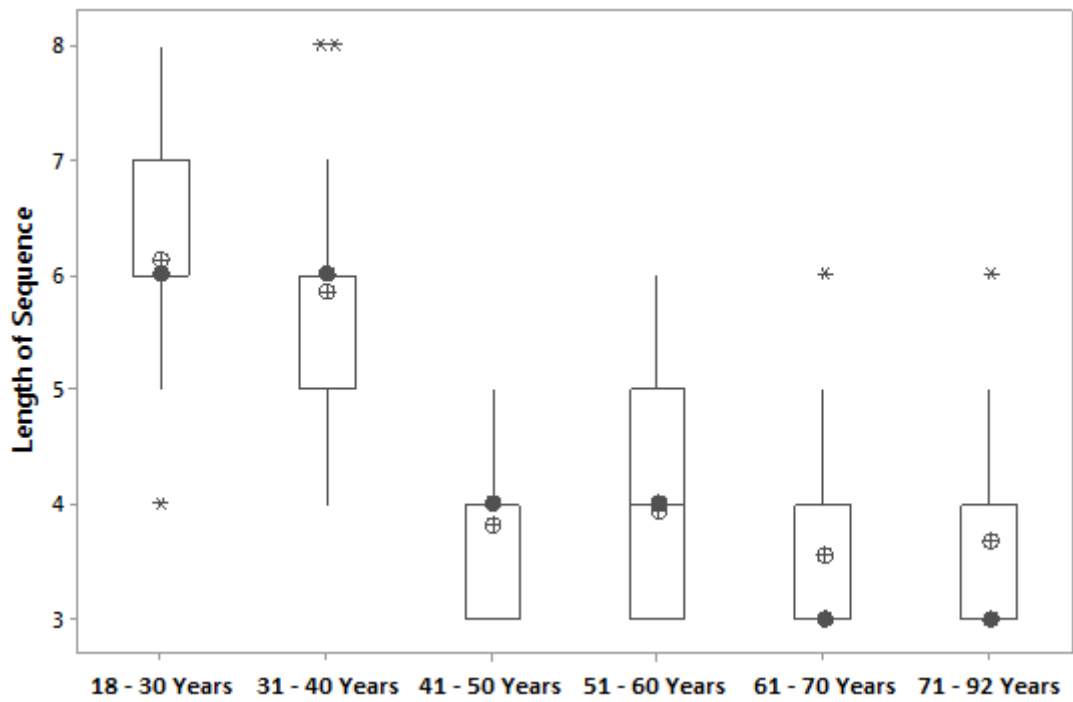


Figure 5.33. Box plot Corsi Span Forward Test.

For Corsi Span forward test, mean values decreases gradually with age.

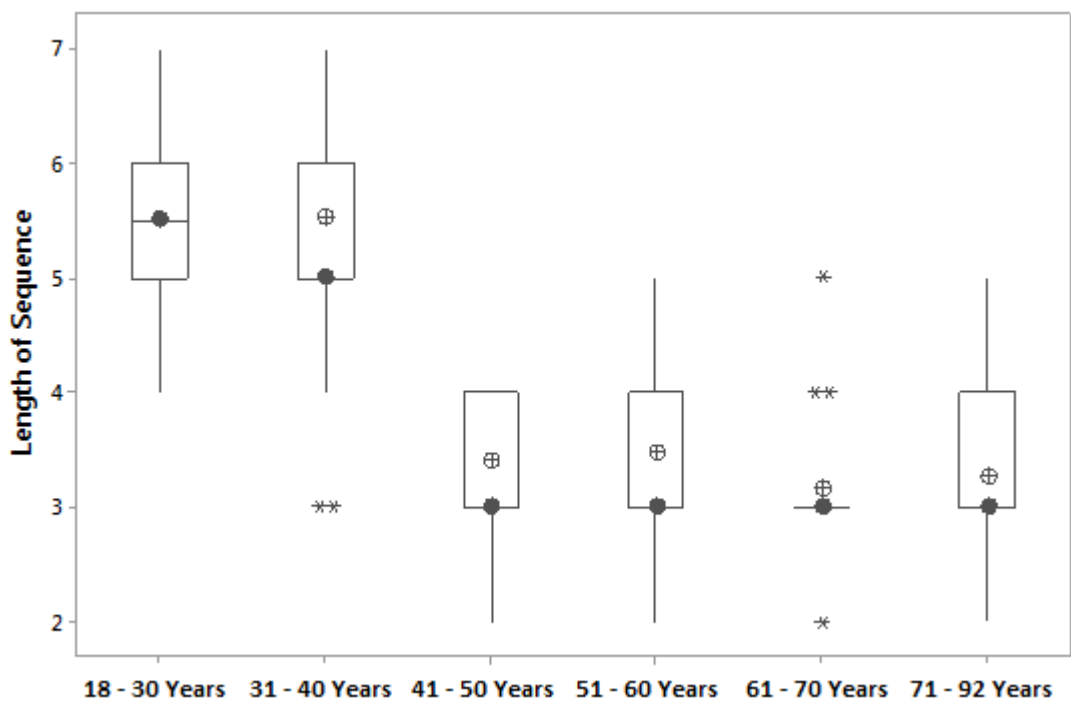


Figure 5.34. Box plot Corsi Span Backward Test.

For Corsi Span backward test, mean values decreases gradually with age.

For Education factor;

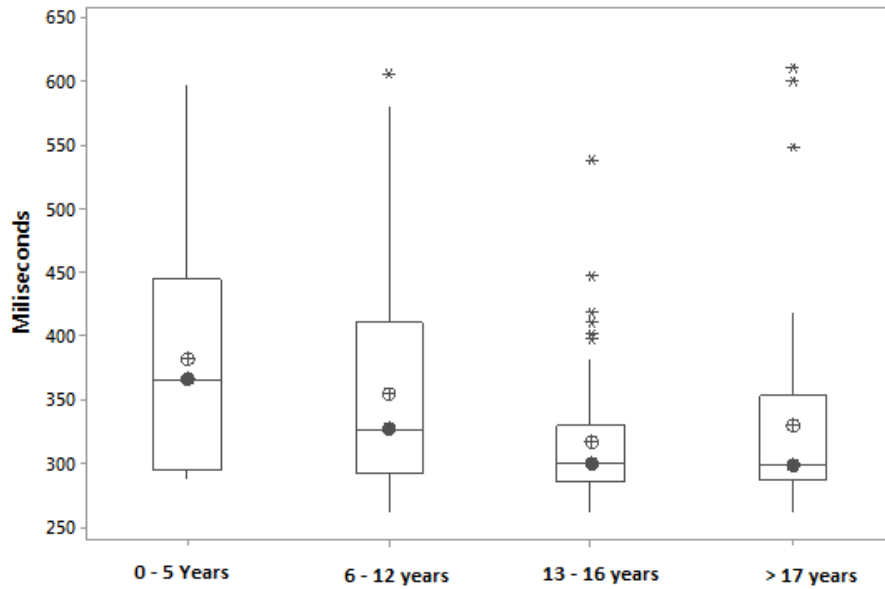


Figure 5.35 Box plot Reaction Time Test (Dominant Hand).

For Reaction Time test (dominant hand), mean values decreases gradually with education level.

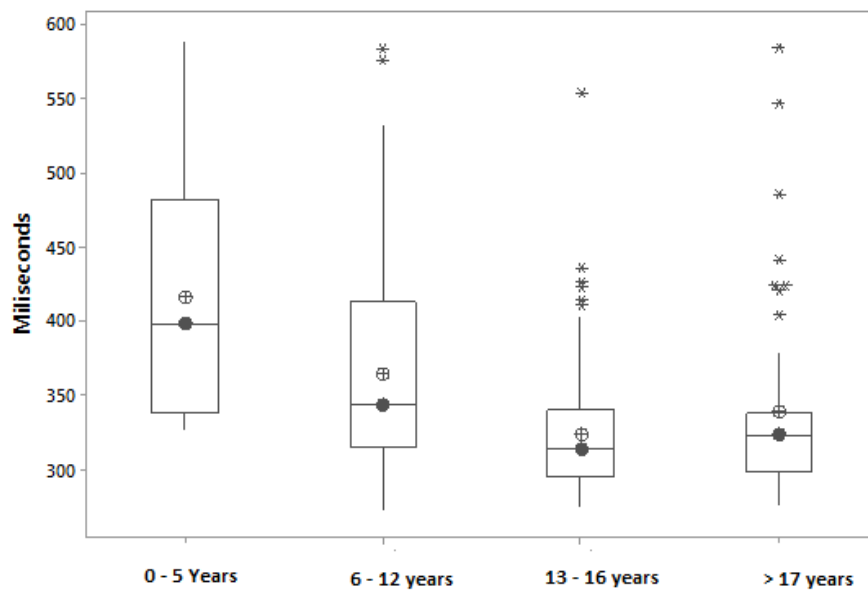


Figure 5.36. Box plot Reaction Time Test (Nondominant Hand).

For Reaction Time test (nondominant hand), mean values decreases gradually with education level.

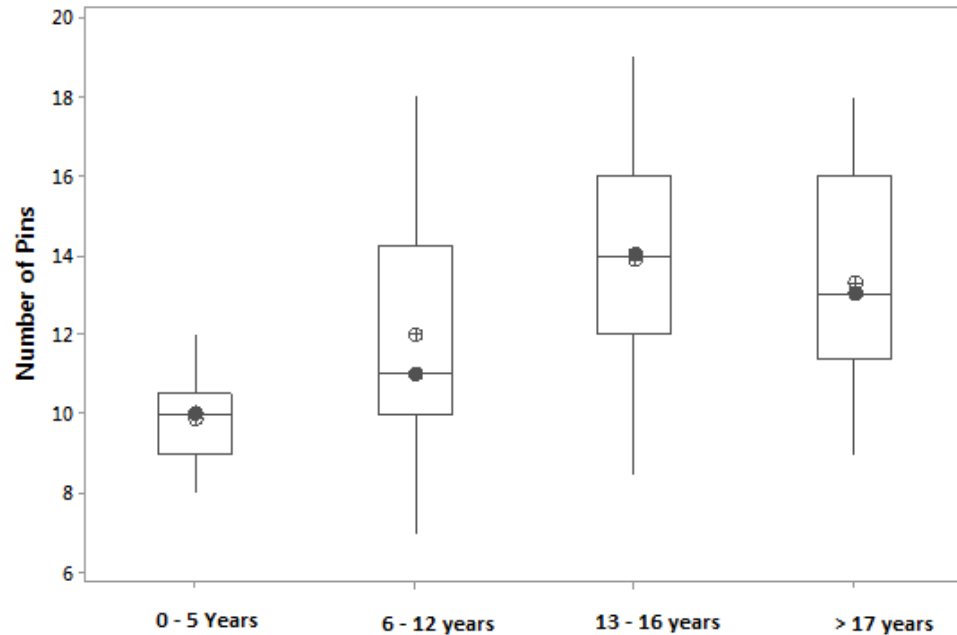


Figure 5.37. Box plot Purdue Pegboard Test (Dominant Hand).

For Purdue Pegboard test (dominant hand), mean values increases with education level until 12-16 years after that it decreases.

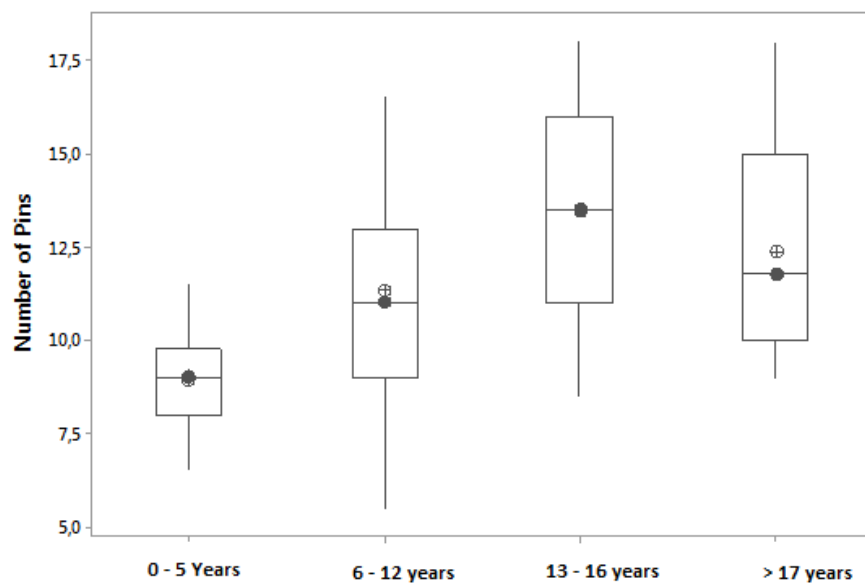


Figure 5.38. Box plot Purdue Pegboard Test (Nondominant Hand).

For Purdue Pegboard test (nondominant hand), mean values increases with education level until 12-16 years after that it decreases.

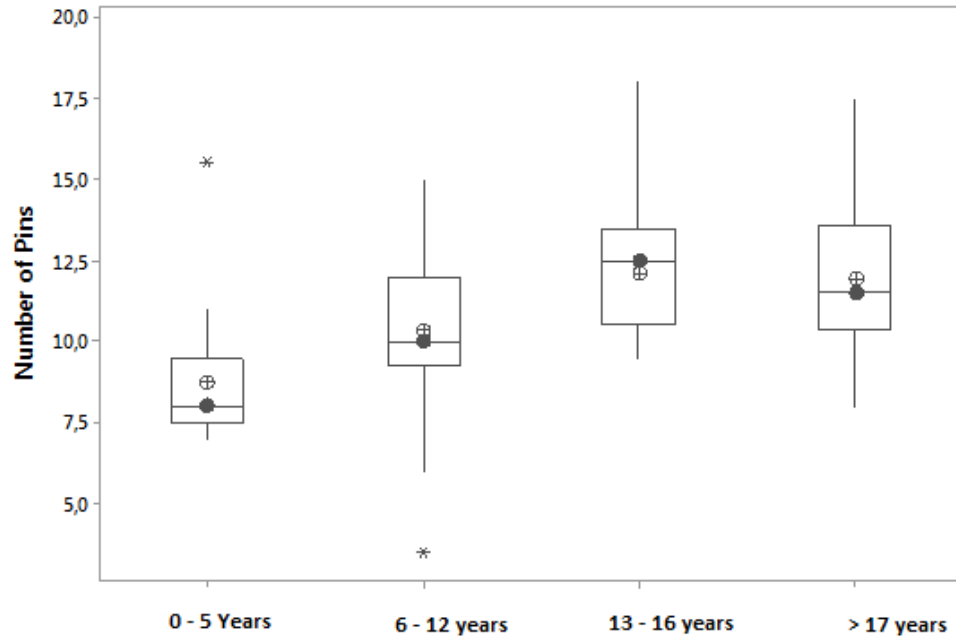


Figure 5.39. Box plot Purdue Pegboard Test (Both Hand).

For Purdue Pegboard test (both hand), mean values increases with education level until 12-16 years after that it decreases.

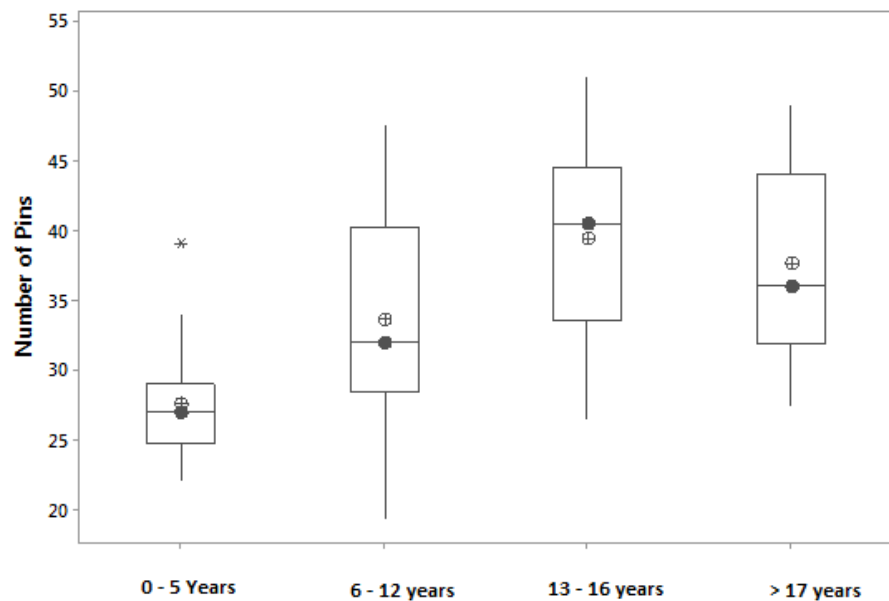


Figure 5.40. Box plot Purdue Pegboard Test (Total).

For Purdue Pegboard test (total), mean values increases with education level until 12-16 years after that it decreases.

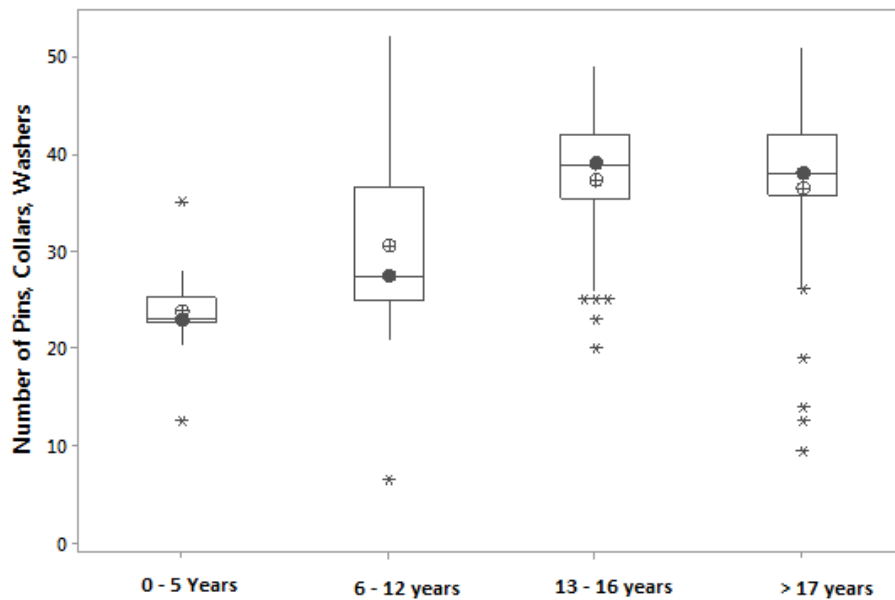


Figure 5.41. Box plot Purdue Pegboard Test (Assembly).

For Purdue Pegboard test (assembly), mean values increases with education level until 12-16 years after that it decreases.

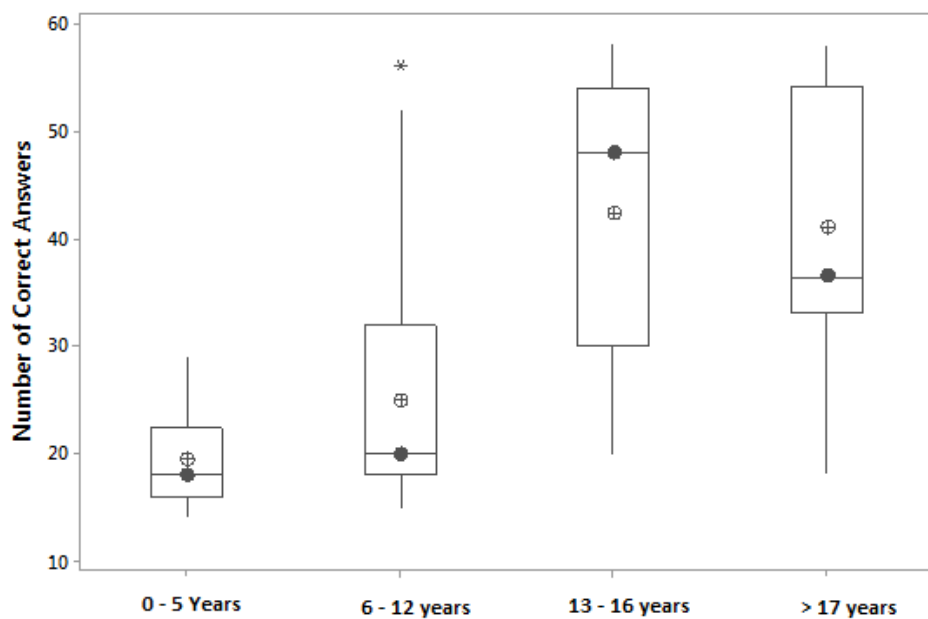


Figure 5.42. Box plot Purdue Raven Test.

For Raven test, mean values increases with education level until 12-16 years after that it decreases.

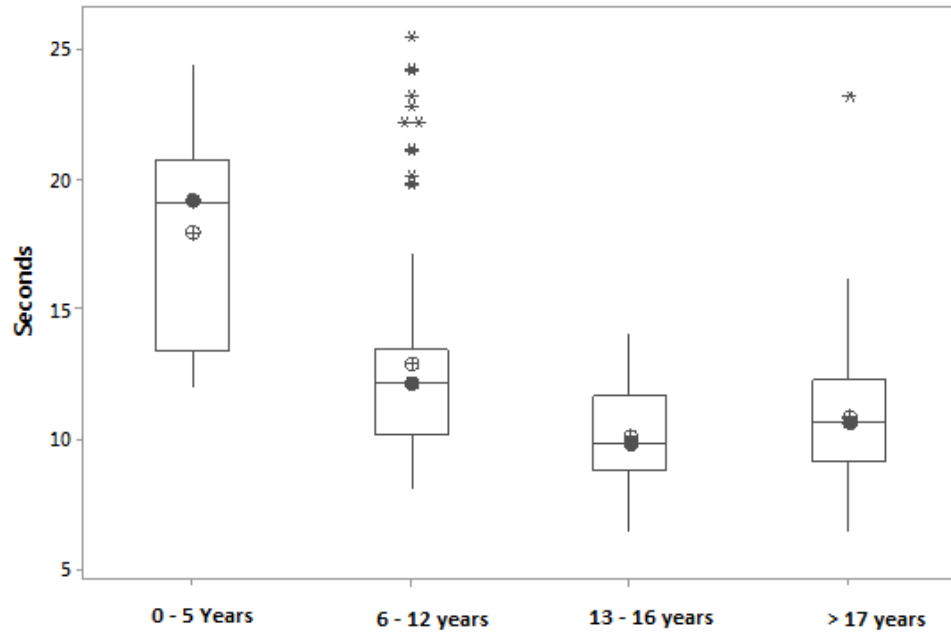


Figure 5.43. Box plot SCWT (Part I) Test.

For Stroop Color Word test part I, mean values decreases gradually with education level.

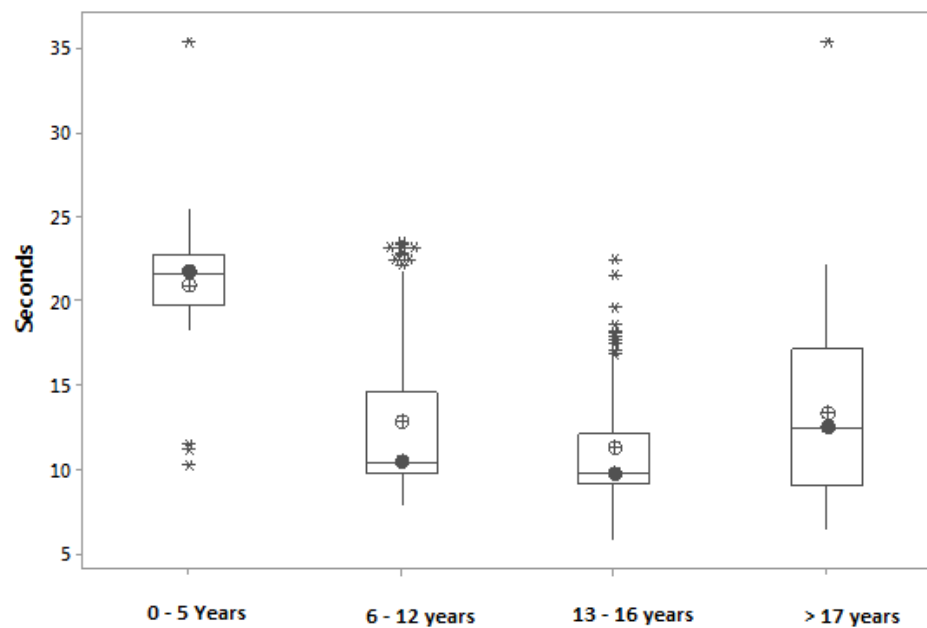


Figure 5.44. Box plot SCWT (Part II) Test.

For Stroop Color Word test part II, mean values decreases gradually with education level until 12-16 years after that it increases.

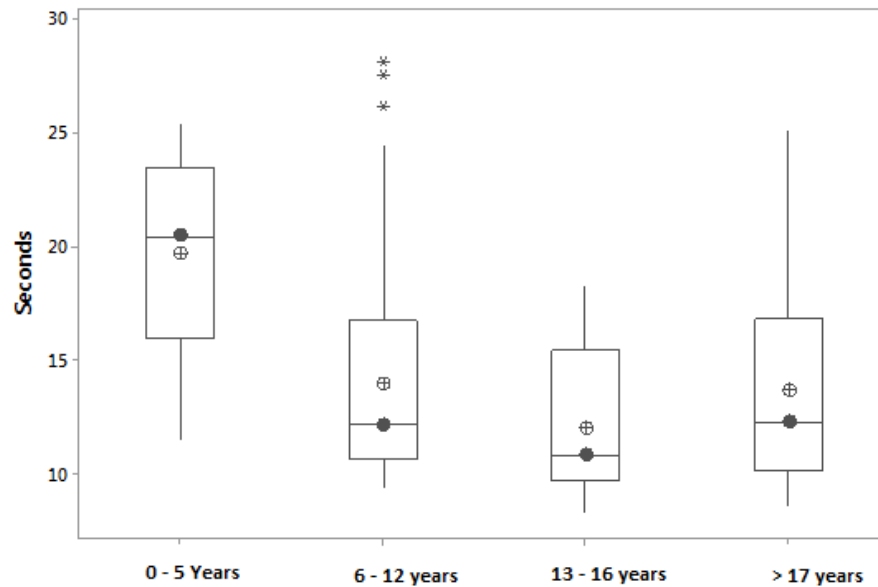


Figure 5.45. Box plot SCWT (Part III) Test.

For Stroop Color Word test part III, mean values decreases gradually with education level until 12-16 years after that it increases.

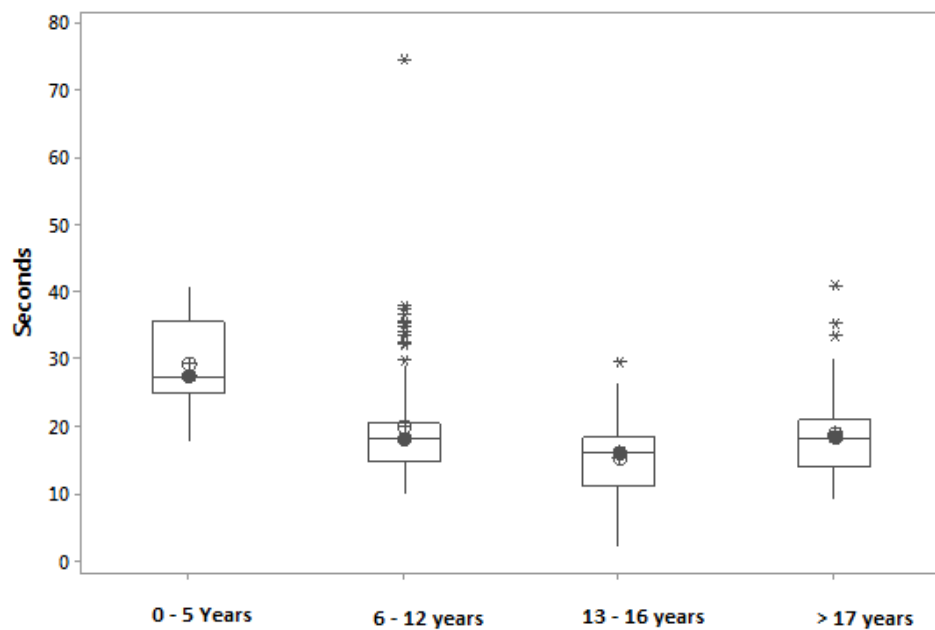


Figure 5.46. Box plot SCWT (Part IV) Test.

For Stroop Color Word test part IV, mean values decreases gradually with education level until 12-16 years after that it increases.

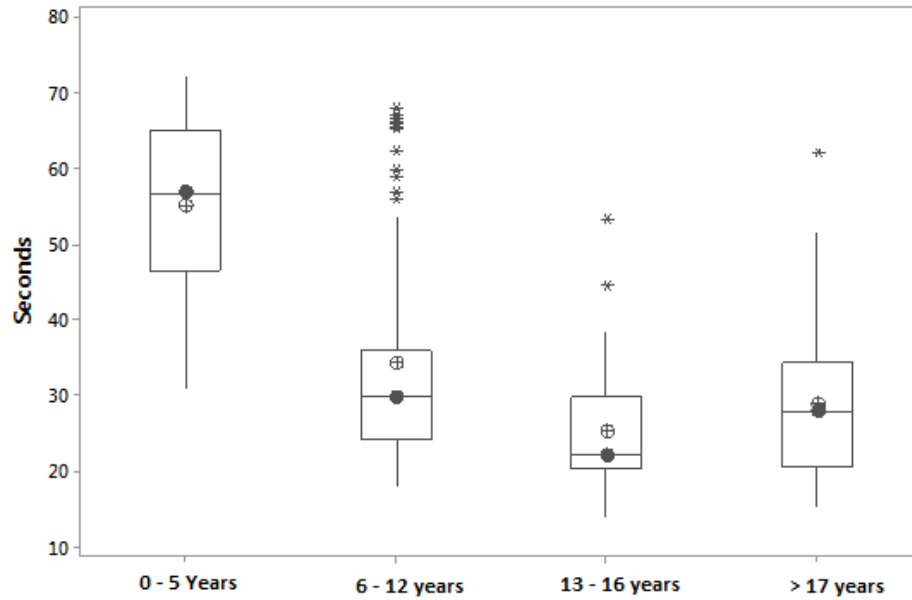


Figure 5.47. Box plot SCWT (Part V) Test.

For Stroop Color Word test part V, mean values decreases gradually with education level until 12-16 years after that it increases.

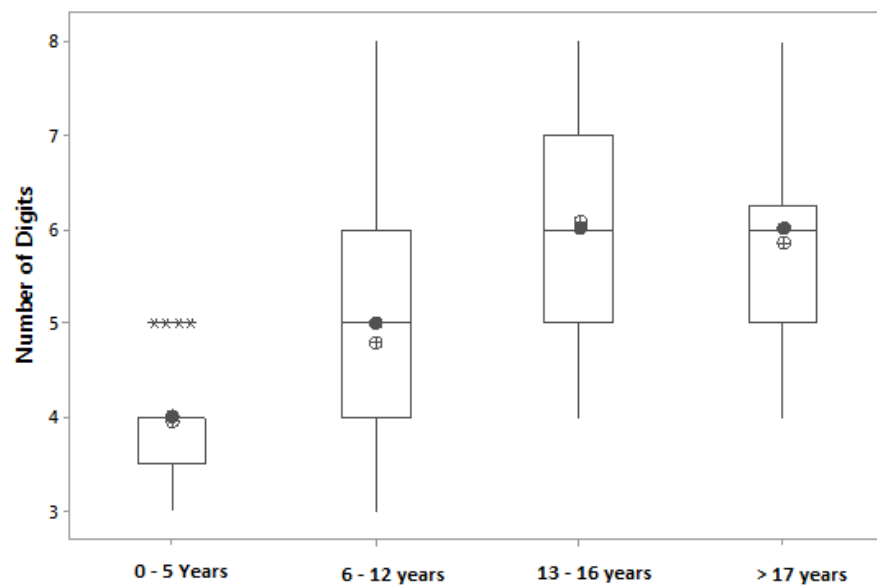


Figure 5.48. Box plot Digit Span Forward Test.

For Digit Span forward test, mean values increases gradually with education level until 12-16 years after that it decreases.

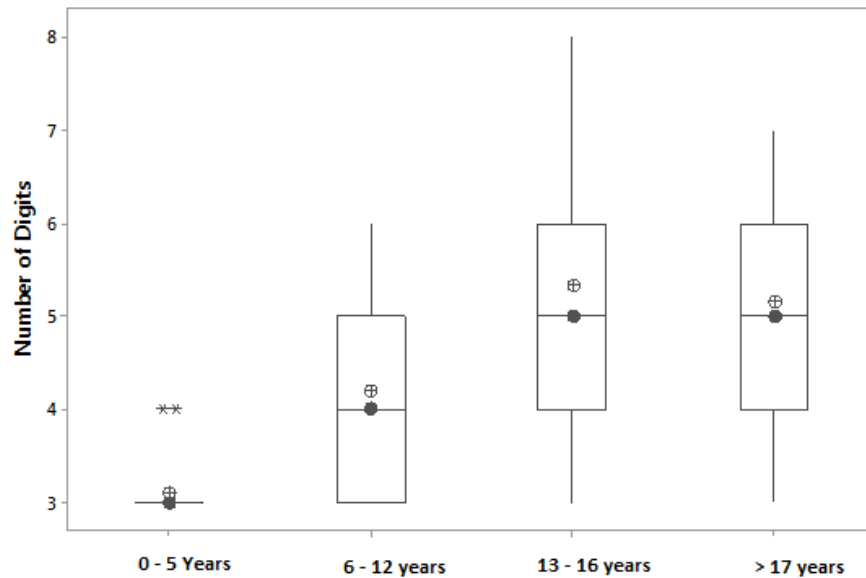


Figure 5.49. Box plot Digit Span Backward Test.

For Digit Span backward test, mean values increases gradually with education level until 12-16 years after that it decreases.

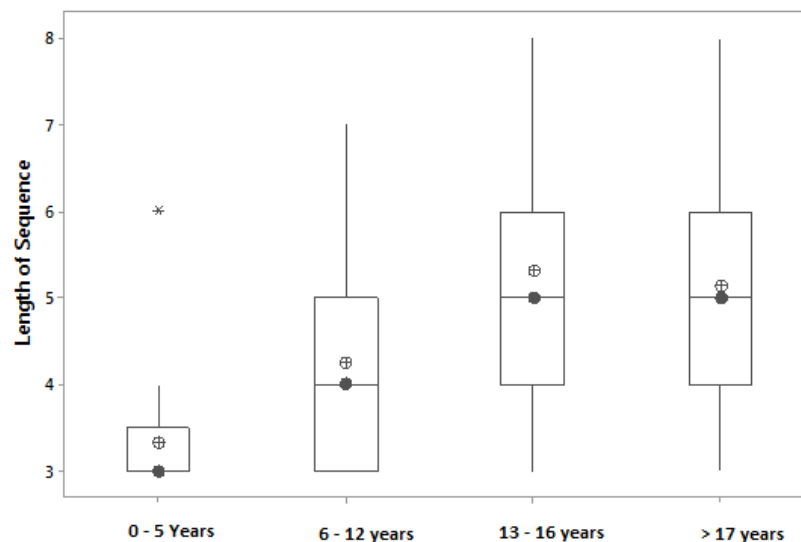


Figure 5.50. Box plot Corsi Span Forward Test.

For Corsi Span forward test, mean values increases gradually with education level until 12-16 years after that it decreases.

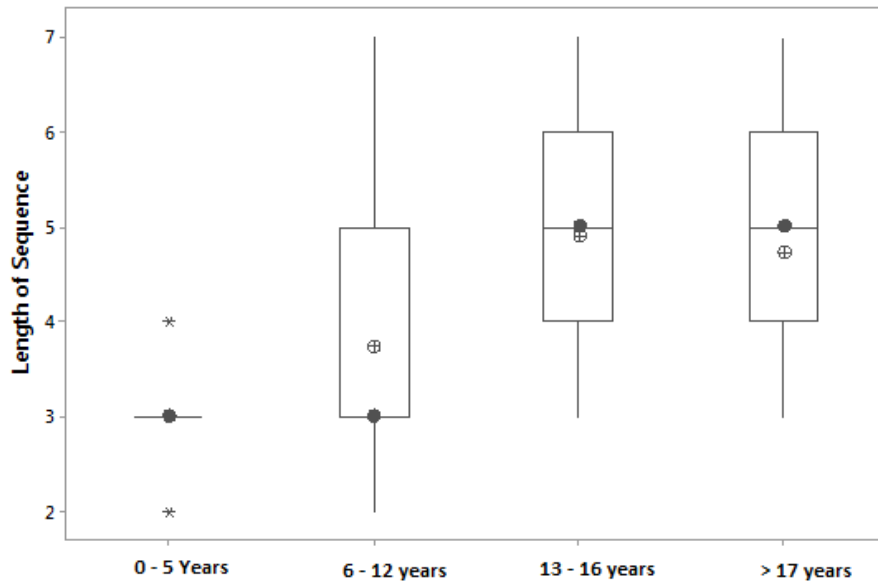


Figure 5.51. Box plot Corsi Span Backward Test.

For Corsi Span backward test, mean values increases gradually with education level until 12-16 years after that it decreases.

For Marital Status;

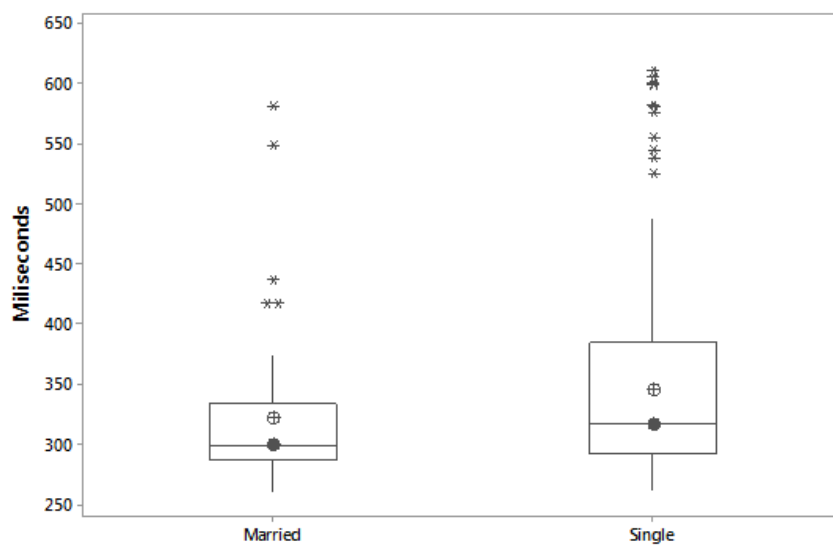


Figure 5.52. Box plot Reaction Time Test (Dominant Hand).

Single subjects have higher mean value for Reaction Time test (dominant hand).

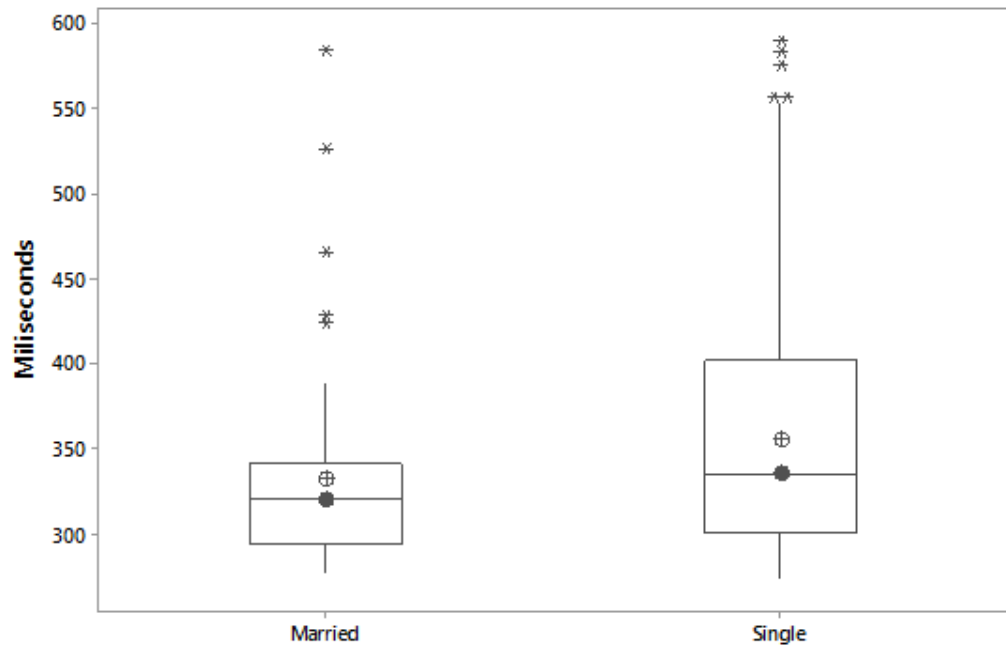


Figure 5.53. Box plot Reaction Time Test (Nondominant Hand).

Single subjects have higher mean value for Reaction Time test (nondominant hand).

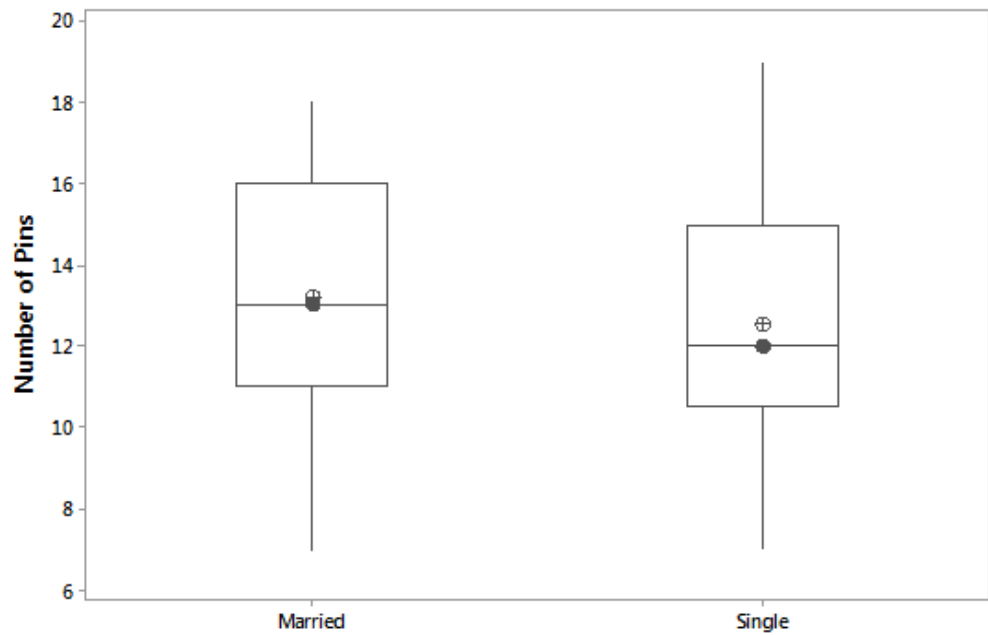


Figure 5.54. Box plot Purdue Pegboard Test (Dominant Hand).

Single subjects have lower mean value for Purdue Pegboard test (dominant hand).

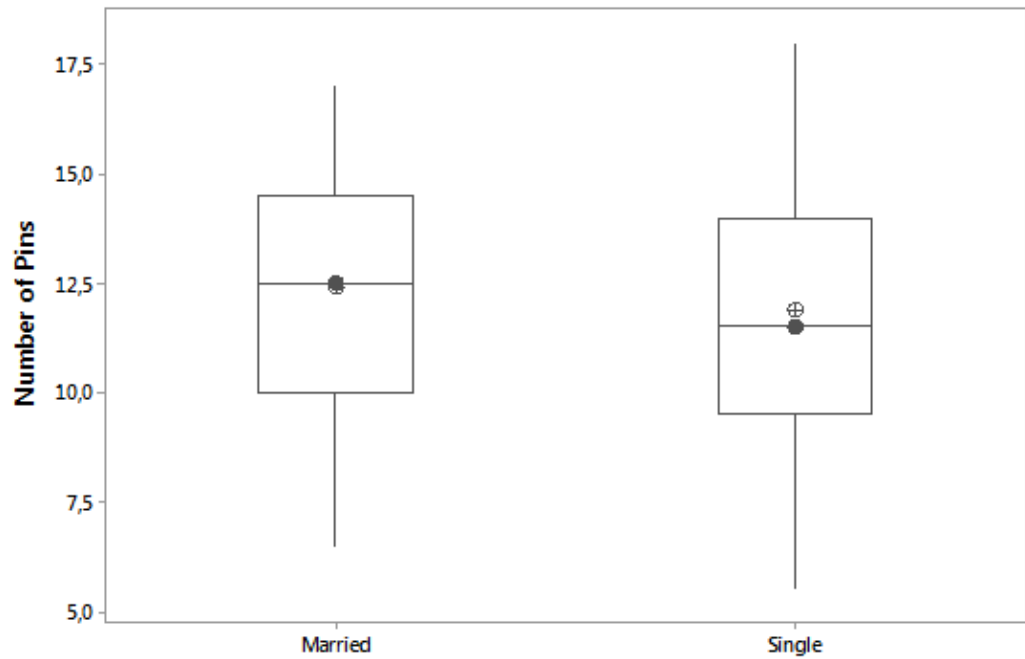


Figure 5.55. Box plot Purdue Pegboard Test (Nondominant Hand).

Single subjects have lower mean value for Purdue Pegboard test (nondominant hand).

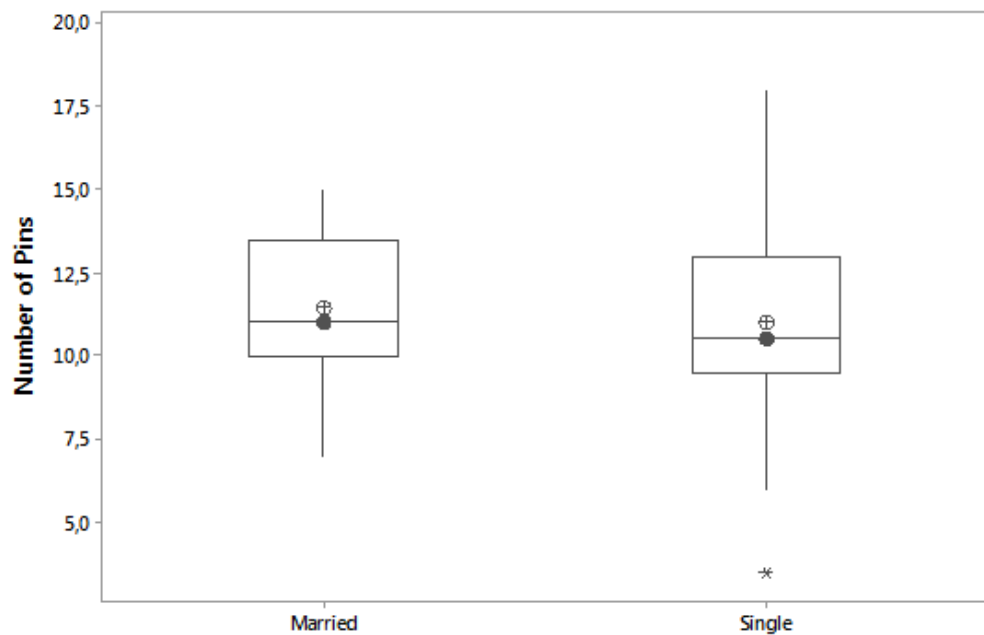


Figure 5.56. Box plot Purdue Pegboard Test (Both Hand).

Single subjects have lower mean value for Purdue Pegboard test (both hand)

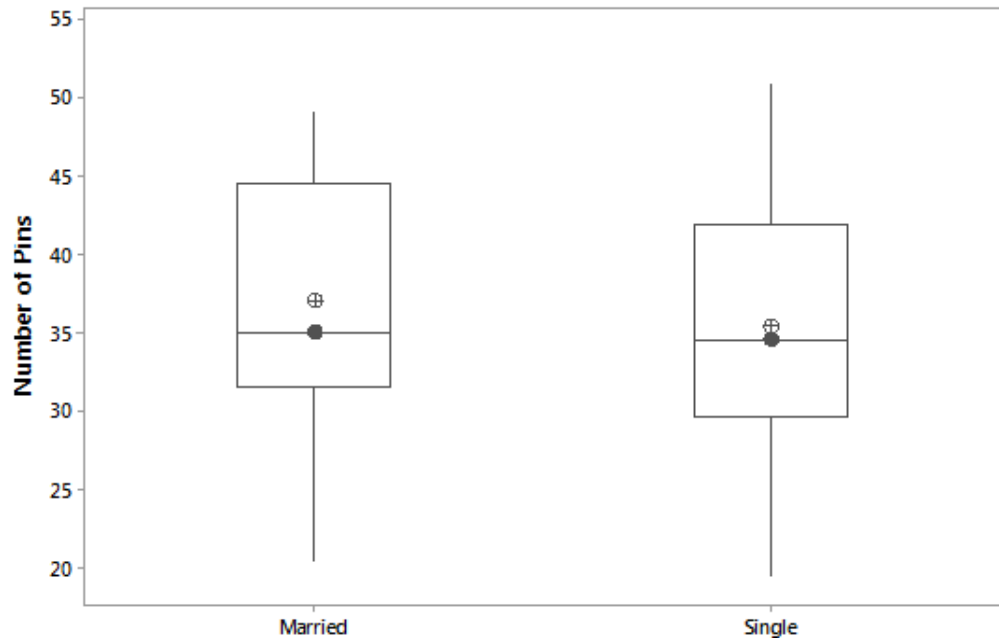


Figure 5.57. Box plot Purdue Pegboard Test (Total).

Single subjects have lower mean value for Purdue Pegboard test (total).

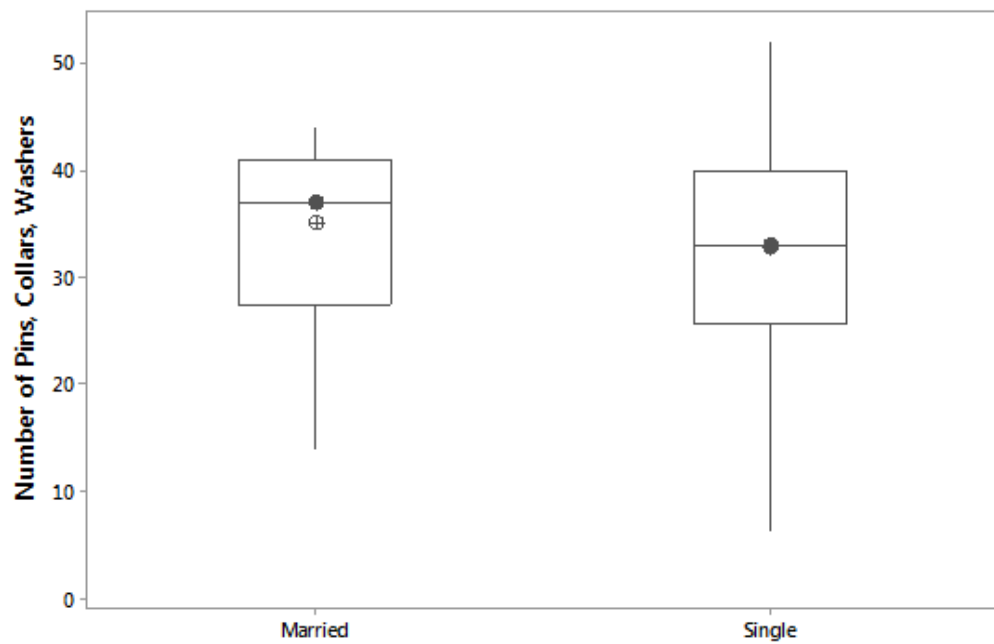


Figure 5.58. Box plot Purdue Pegboard Test (Assembly).

Single subjects have lower mean value for Purdue Pegboard test (Assembly).

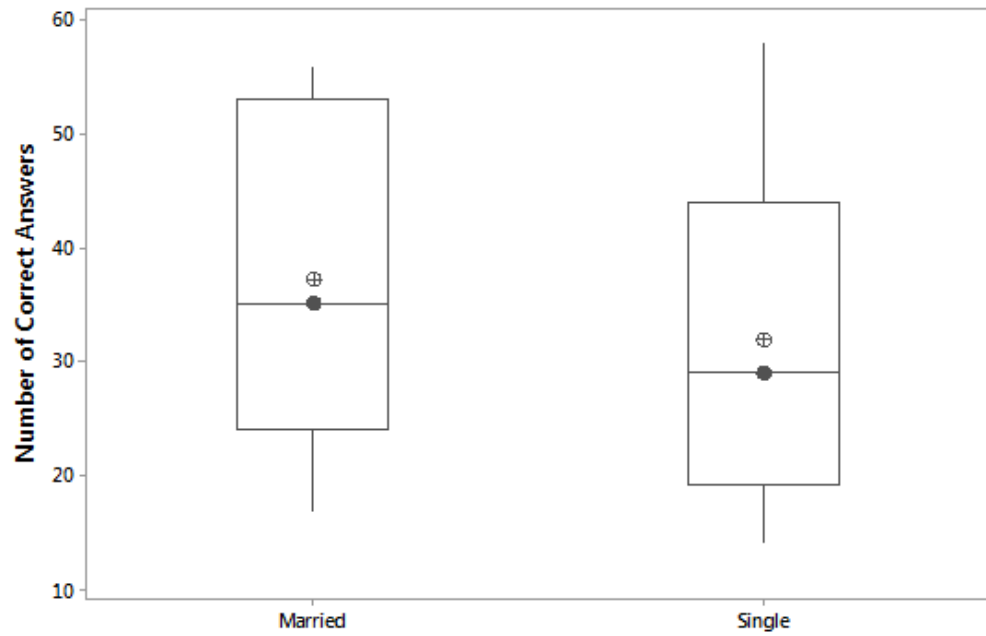


Figure 5.59. Box plot Raven Test.

Single subjects have lower mean value for Raven test.

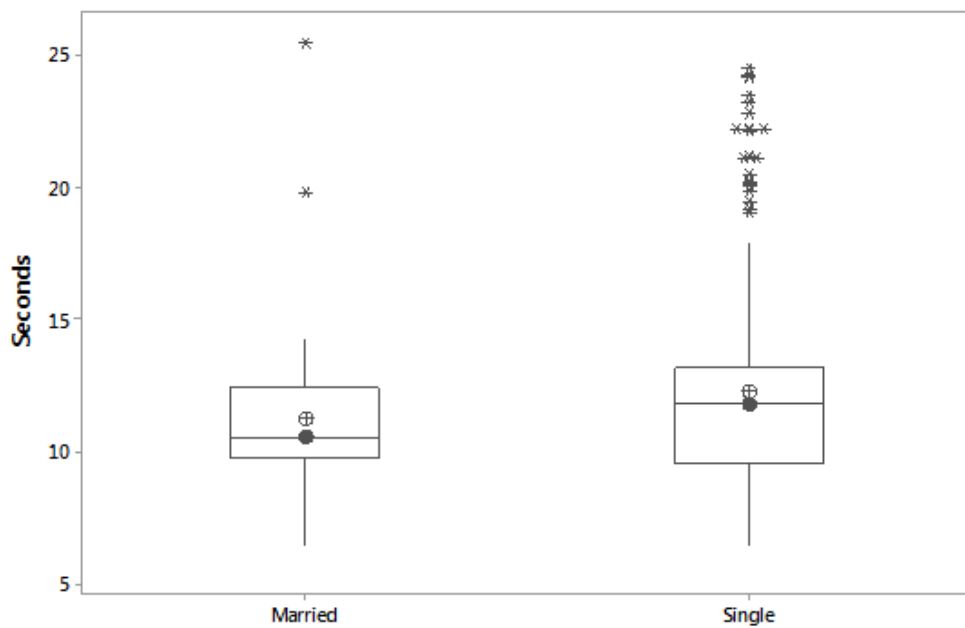


Figure 5.60. Box plot SCWT (Part I) Test.

Single subjects have higher mean value for Stroop Color Word Test Part I.

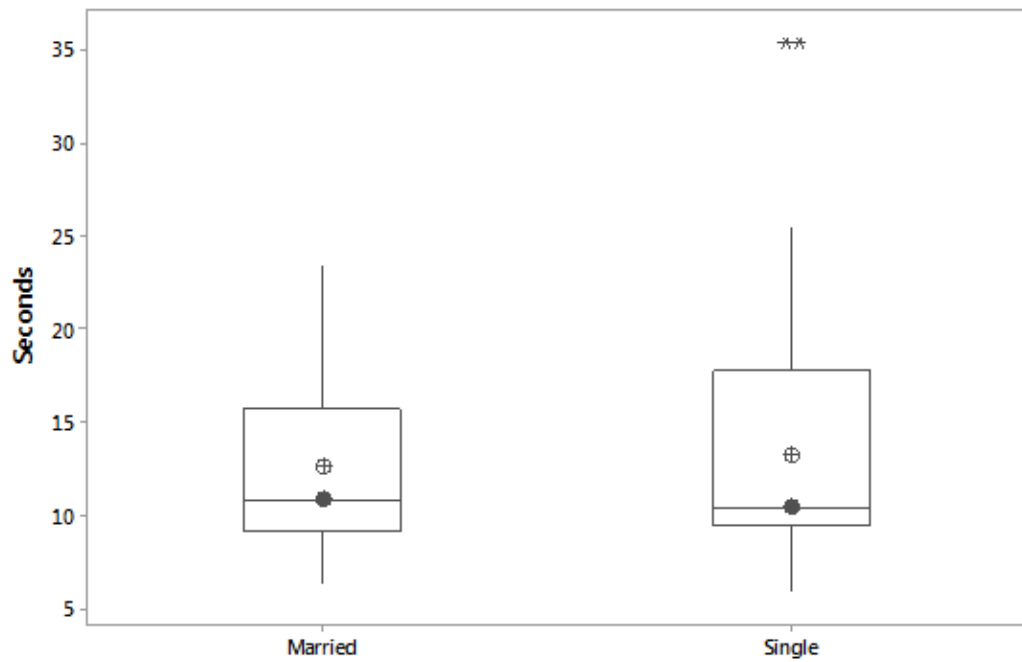


Figure 5.61. Box plot SCWT (Part II) Test.

Single subjects have higher mean value for Stroop Color Word Test Part II.

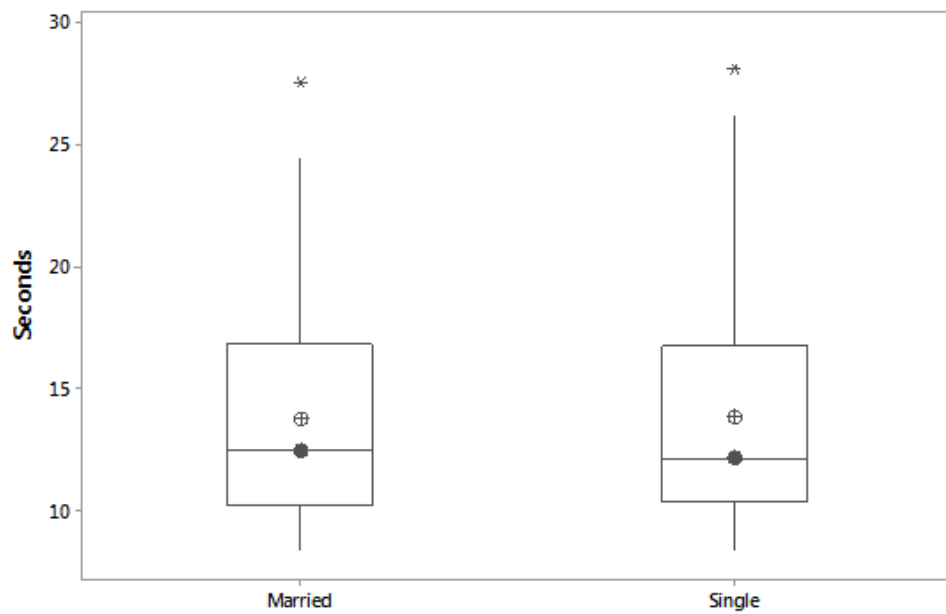


Figure 5.62. Box plot SCWT (Part III) Test.

Single and Married subjects have similar mean values for Stroop Color Word Test Part III.

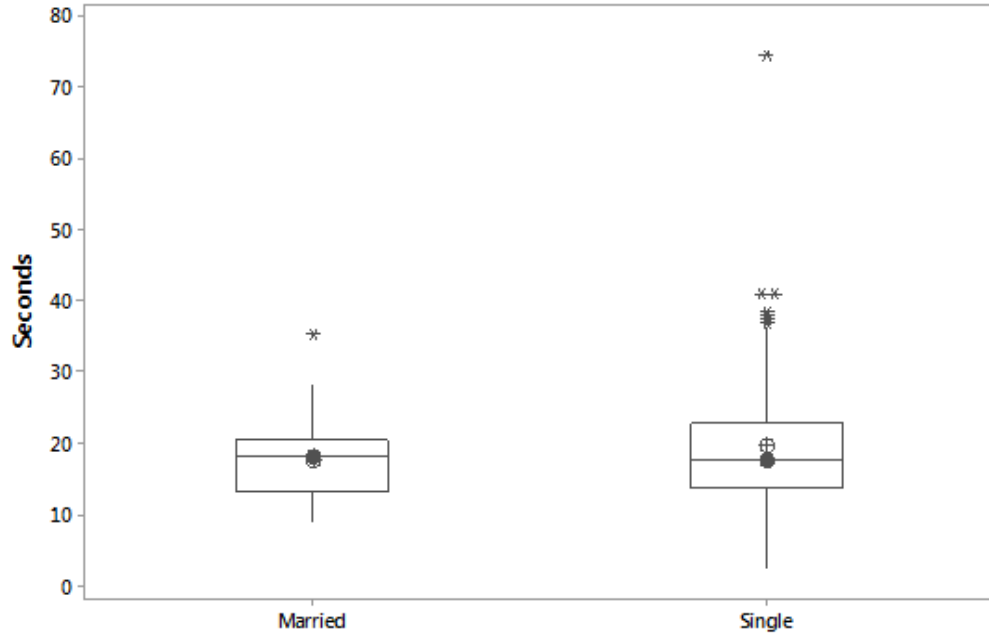


Figure 5.63. Box plot SCWT (Part IV) Test.

Single and Married subjects have similar mean values for Stroop Color Word Test Part IV.

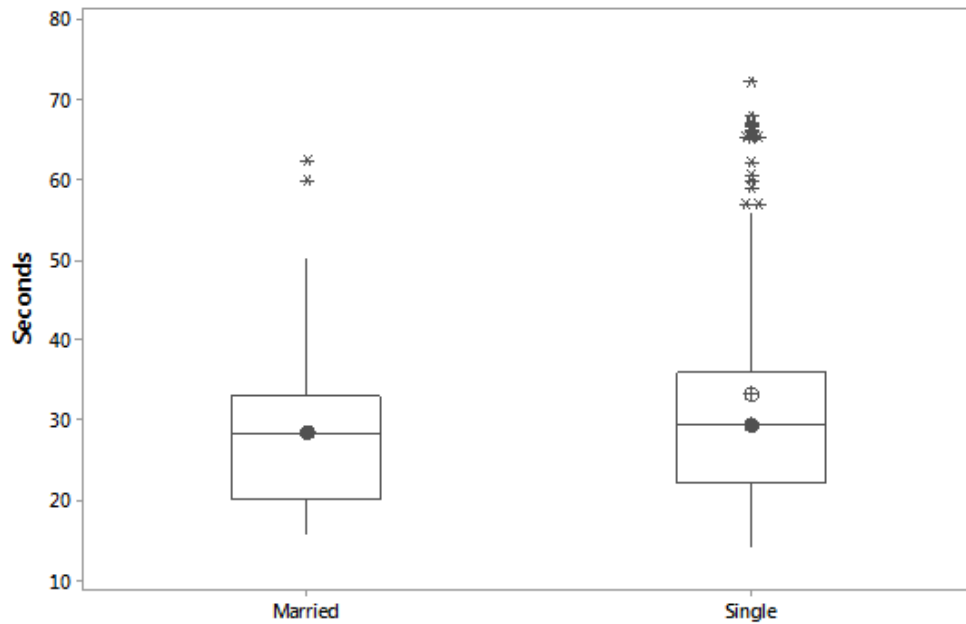


Figure 5.64. Box plot SCWT (Part V) Test.

Single subjects have higher mean value for Stroop Color Word Test Part V.

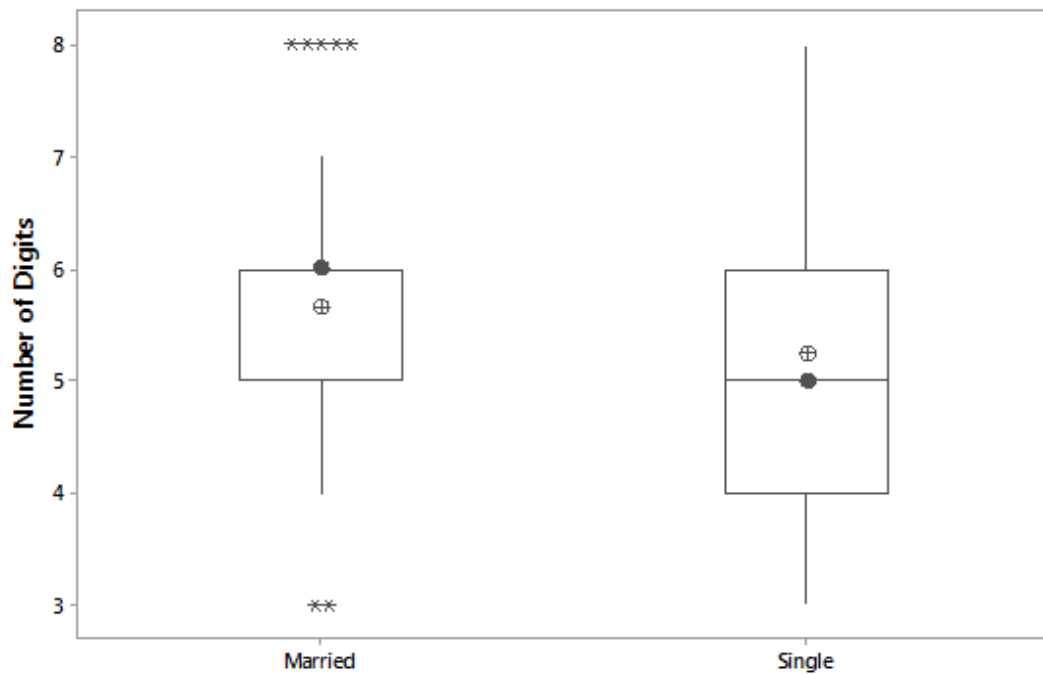


Figure 5.65. Box plot Digit Span Forward Test.

Single subjects have lower mean value for Digit Span Forward test.

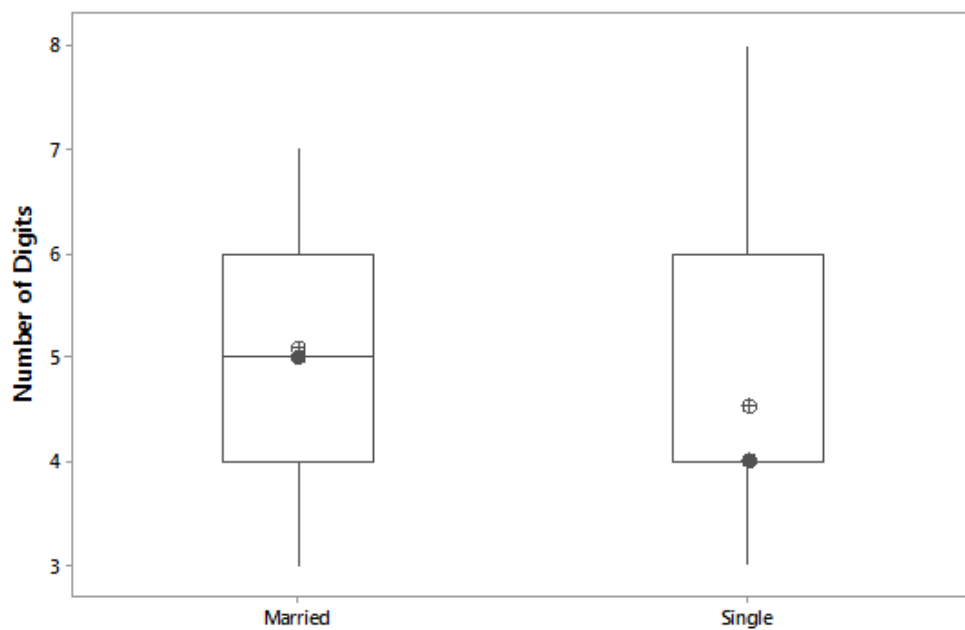


Figure 5.66. Box plot Digit Span Backward Test.

Single subjects have lower mean value for Digit Span Backward test.

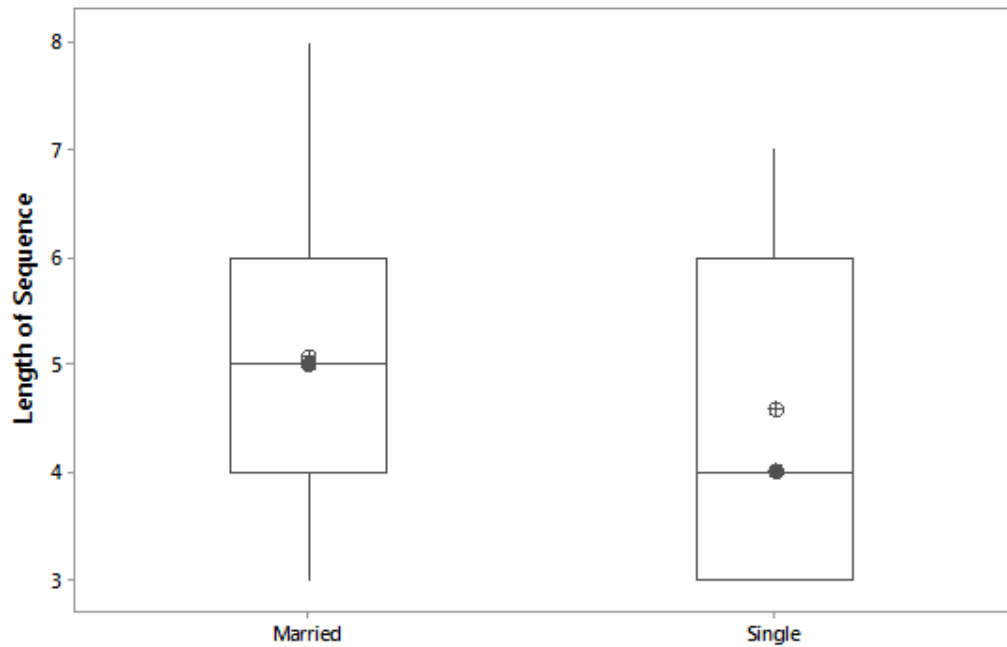


Figure 5.67. Box plot Corsi Span Forward Test.

Single subjects have lower mean value for Corsi Span Forward test.

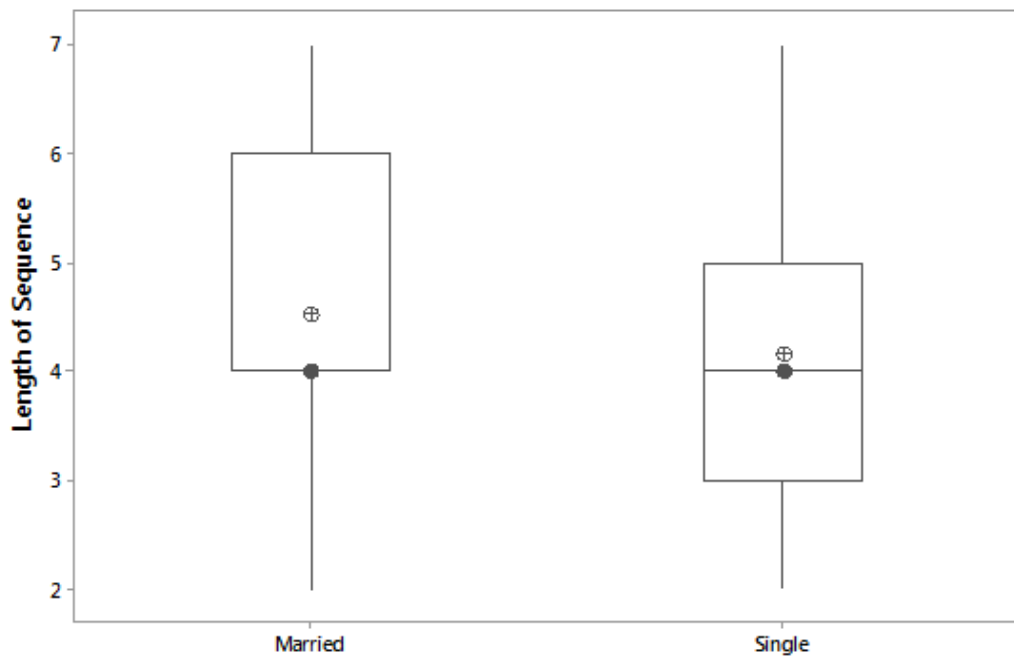


Figure 5.68. Box plot Corsi Span Backward Test.

For Income Factor;

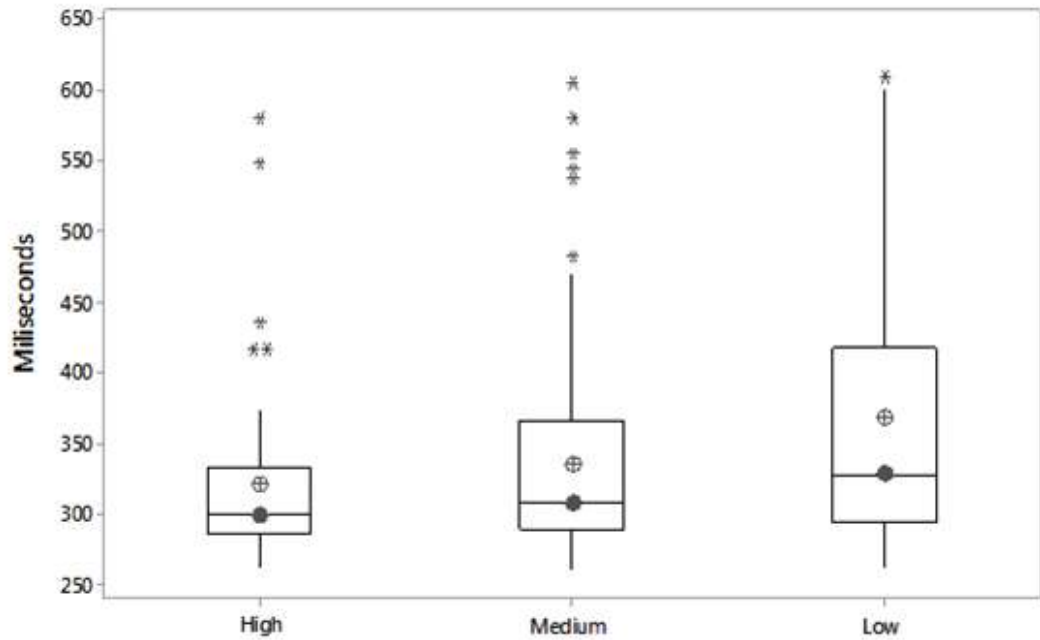


Figure 5.69. Box plot Reaction Time Test (Dominant Hand).

Reaction Time test (dominant hand) response value increases through high income level group to low income level group.

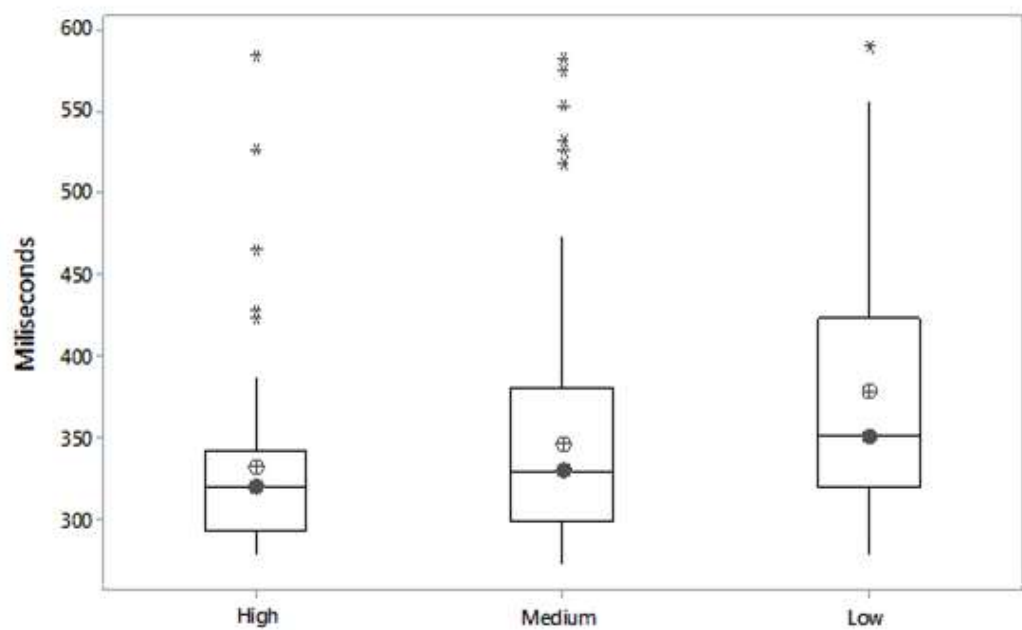


Figure 5.70. Box plot Reaction Time Test (Nondominant Hand).

Reaction Time test (nondominant hand) response value increases through high income level group to low income level group.

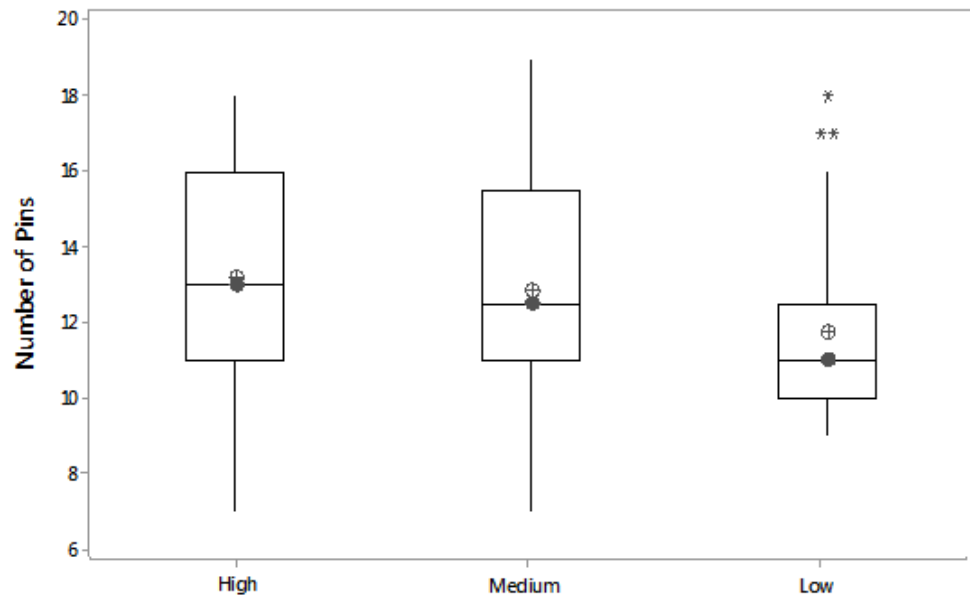


Figure 5.71. Box plot Purdue Pegboard Test (Dominant Hand).

Purdue Pegboard test (dominant hand) response value decreases through high income level group to low income level group.

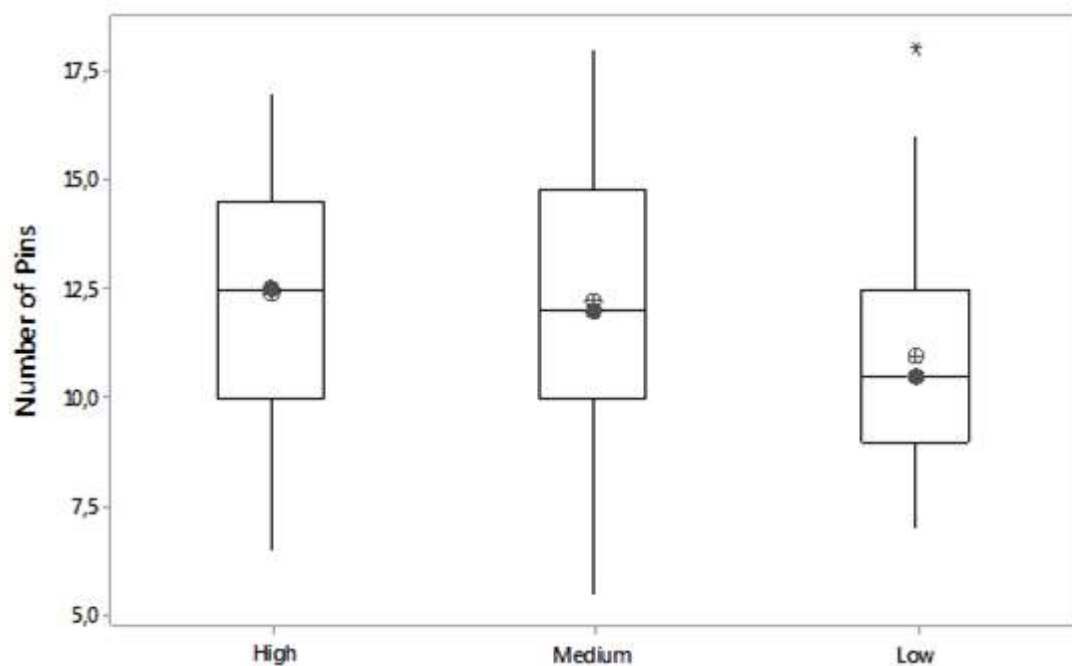


Figure 5.72. Box plot Purdue Pegboard Test (Nondominant Hand).

Purdue Pegboard test (nondominant hand) response value decreases through high income level group to low income level group.

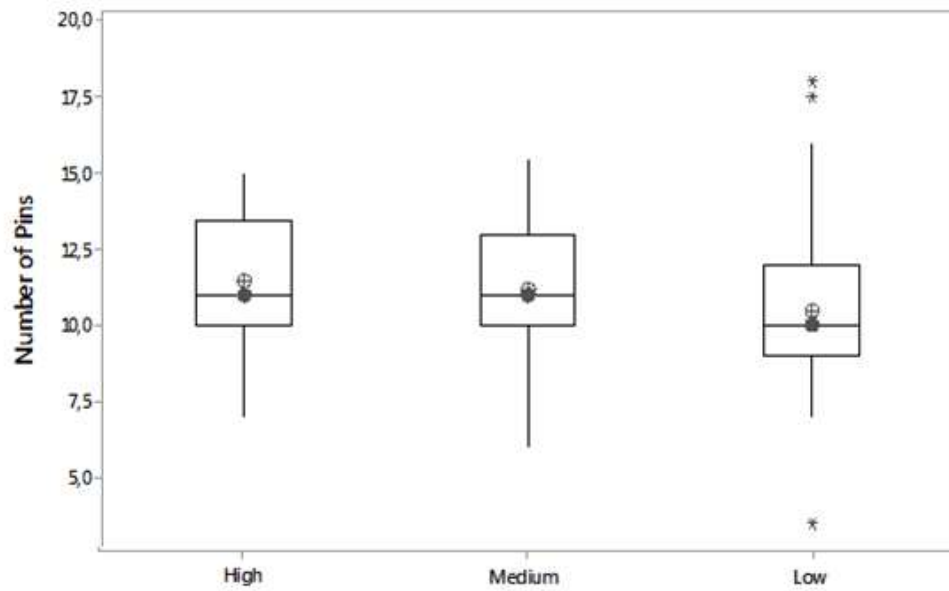


Figure 5.73. Box plot Purdue Pegboard Test (Both Hand).

Purdue Pegboard test (both hand) response value slightly decreases through high income level group to low income level group.

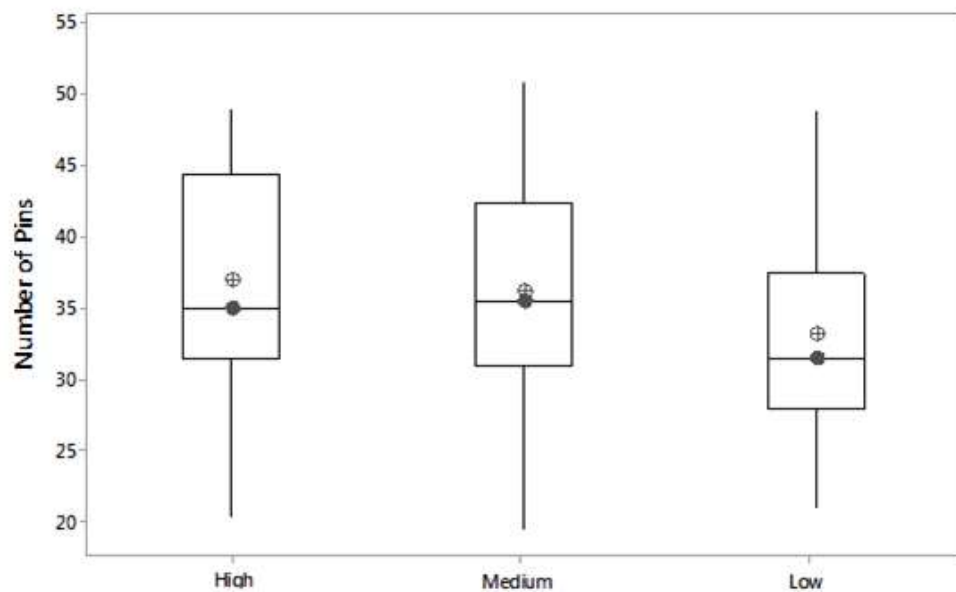


Figure 5.74. Box plot Purdue Pegboard Test (Total).

Purdue Pegboard test (total) response value slightly decreases through high income level group to low income level group.

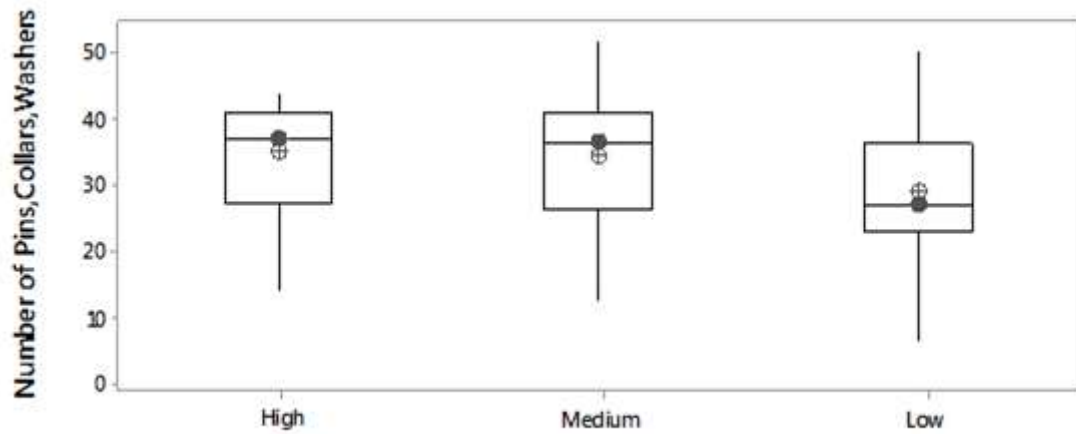


Figure 5.75. Box plot Purdue Pegboard Test (Assembly).

Purdue Pegboard test (assembly) response value slightly decreases through high income level group to low income level group.

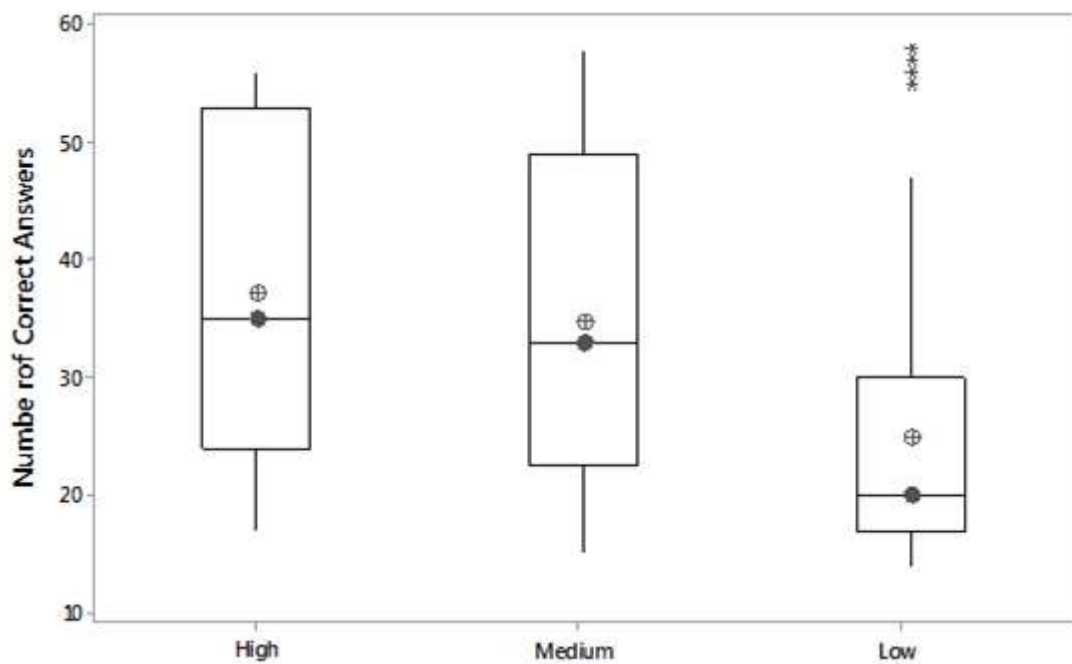


Figure 5.76. Box plot Raven Test.

Raven test response value decreases through high income level group to low income level group.

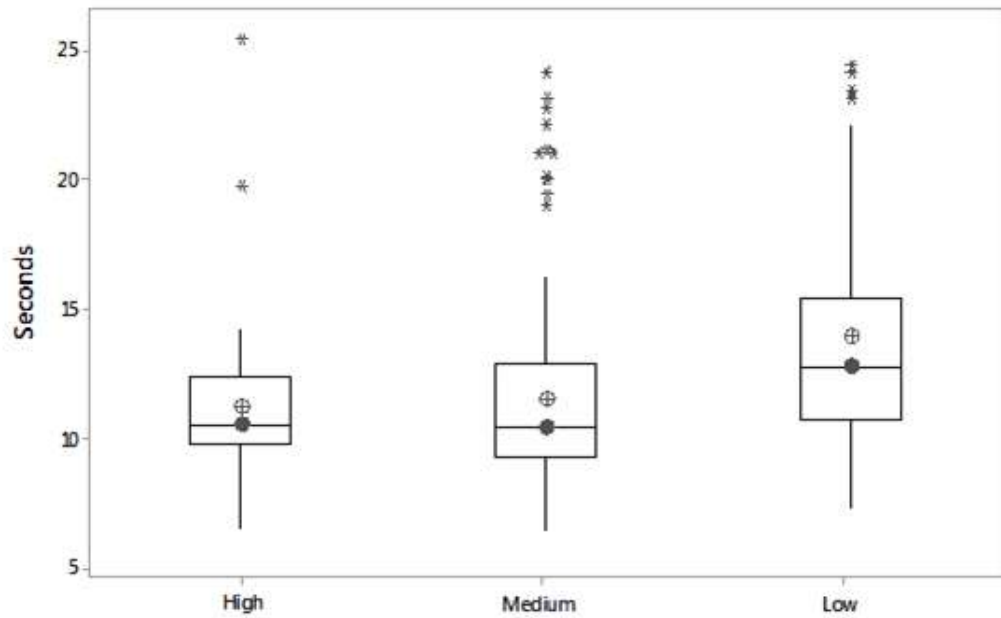


Figure 5.77. Box plot SCWT (Part I) Test.

Stroop Color Word test part I response value slightly increases through high income level group to low income level group.

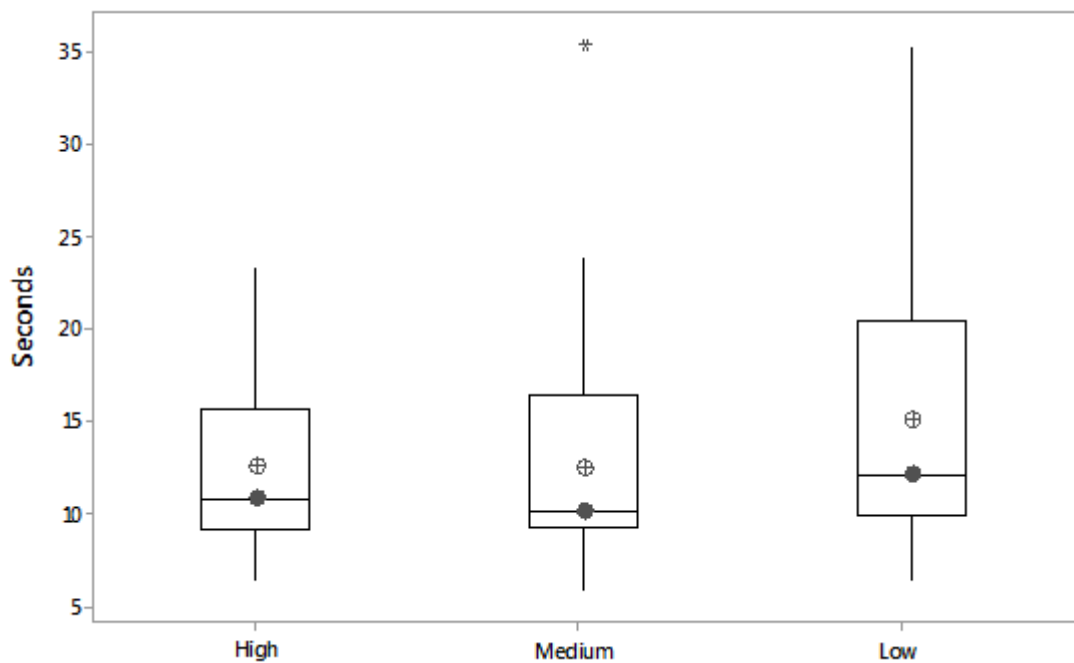


Figure 5.78. Box plot SCWT (Part II) Test.

Stroop Color Word test part II response value slightly increases through high income level group to low income level group.

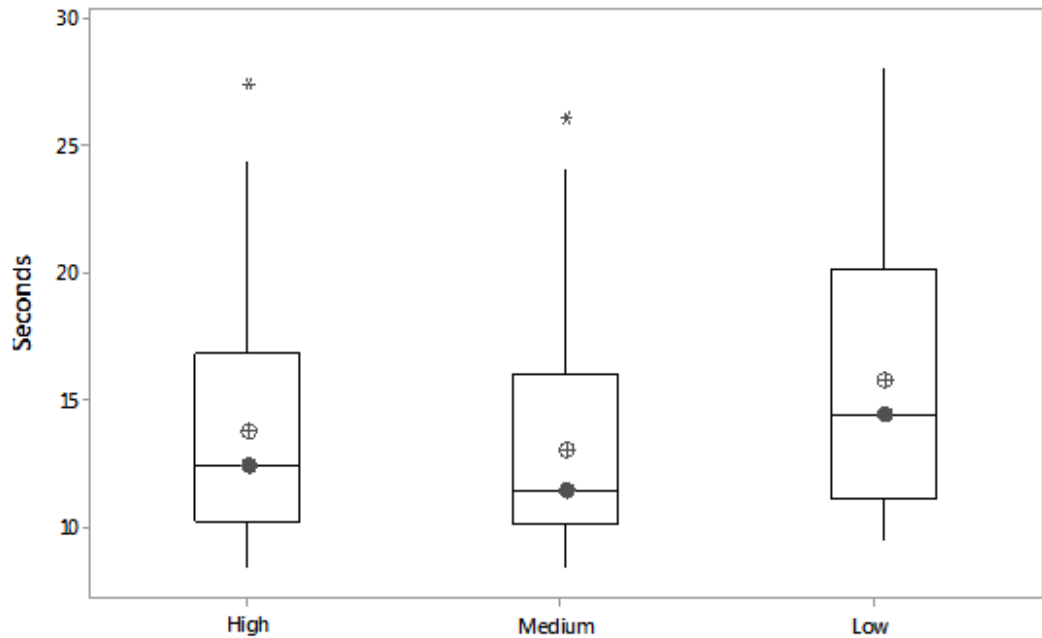


Figure 5.79. Box plot SCWT (Part III) Test.

Stroop Color Word test part III response value slightly increases through high income level group to low income level group.

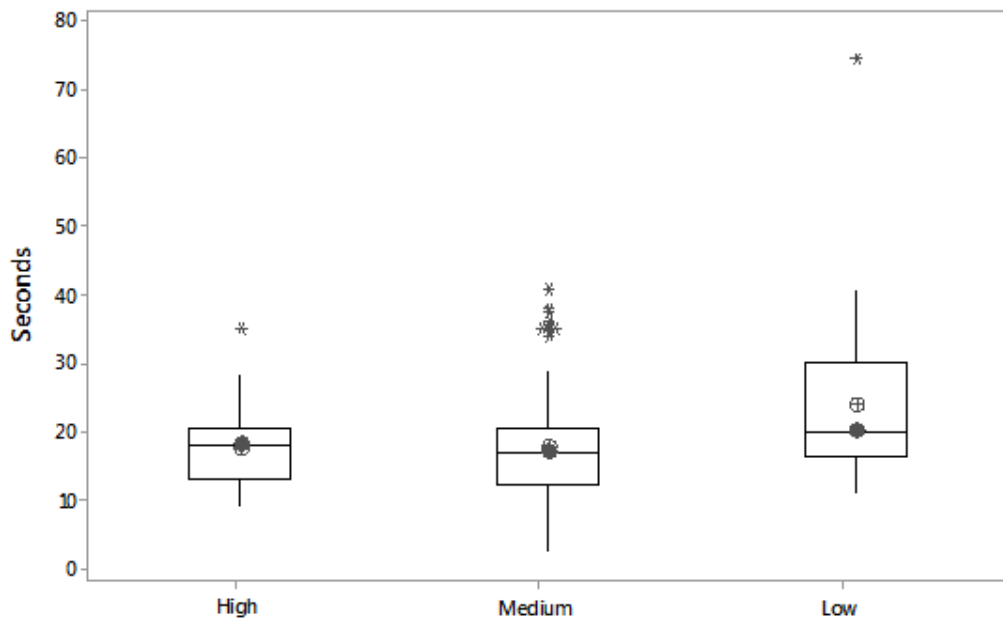


Figure 5.80. Box plot SCWT (Part IV) Test.

Stroop Color Word test part IV response value slightly increases through high income level group to low income level group.

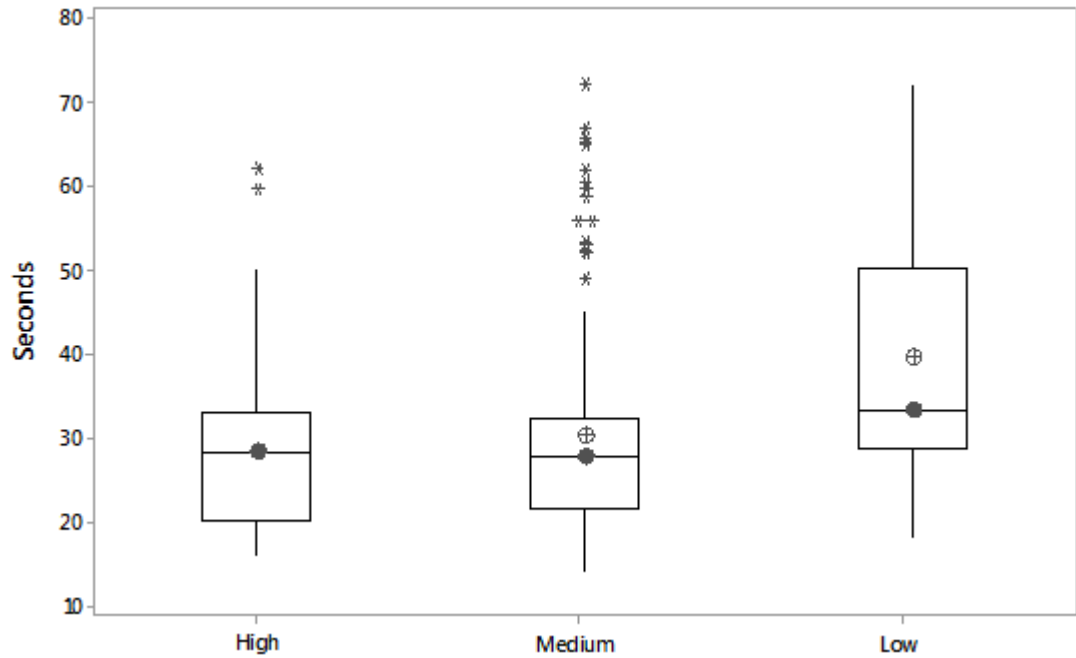


Figure 5.81. Box plot SCWT (Part V) Test.

Stroop Color Word test part V response value slightly increases through high income level group to low income level group.

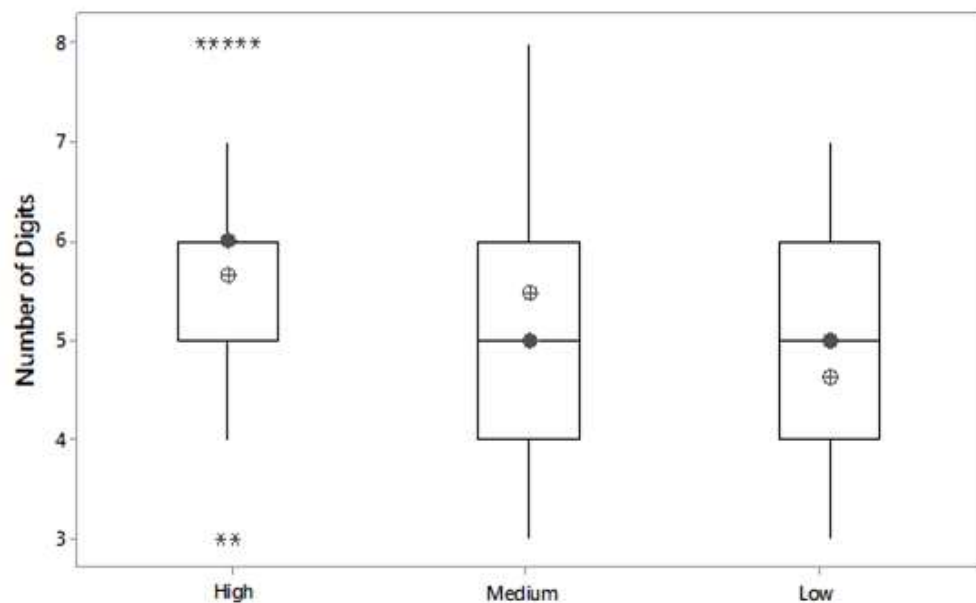


Figure 5.82. Box plot Digit Span Forward Test.

Digit Span Forward test response value decreases through high income level group to low income level group.

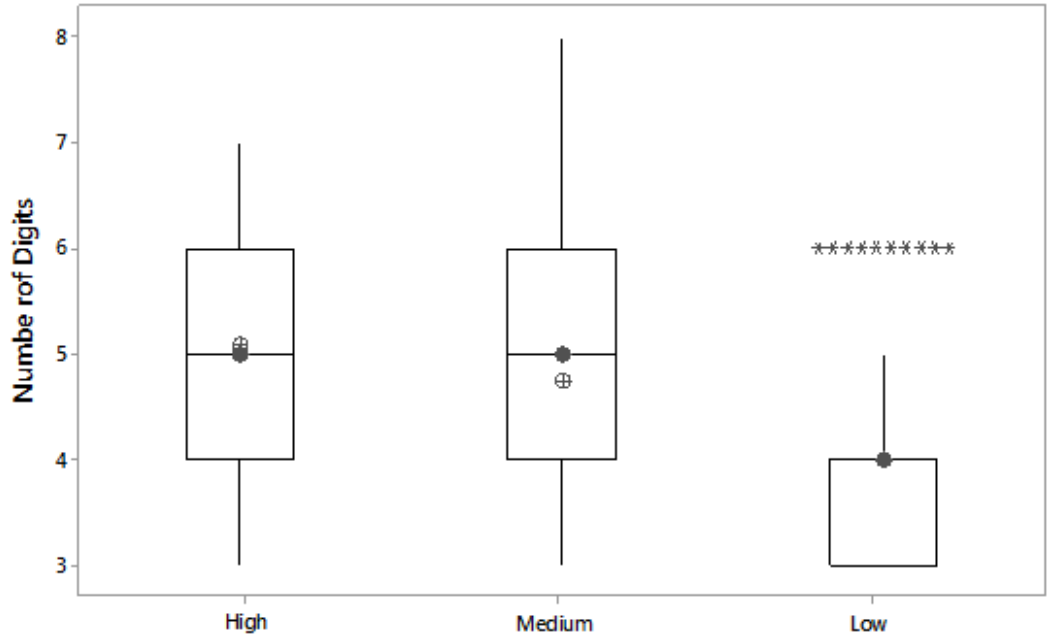


Figure 5.83. Box plot Digit Span Backward Test.

Digit Span Backward test response value decreases through high income level group to low income level group.

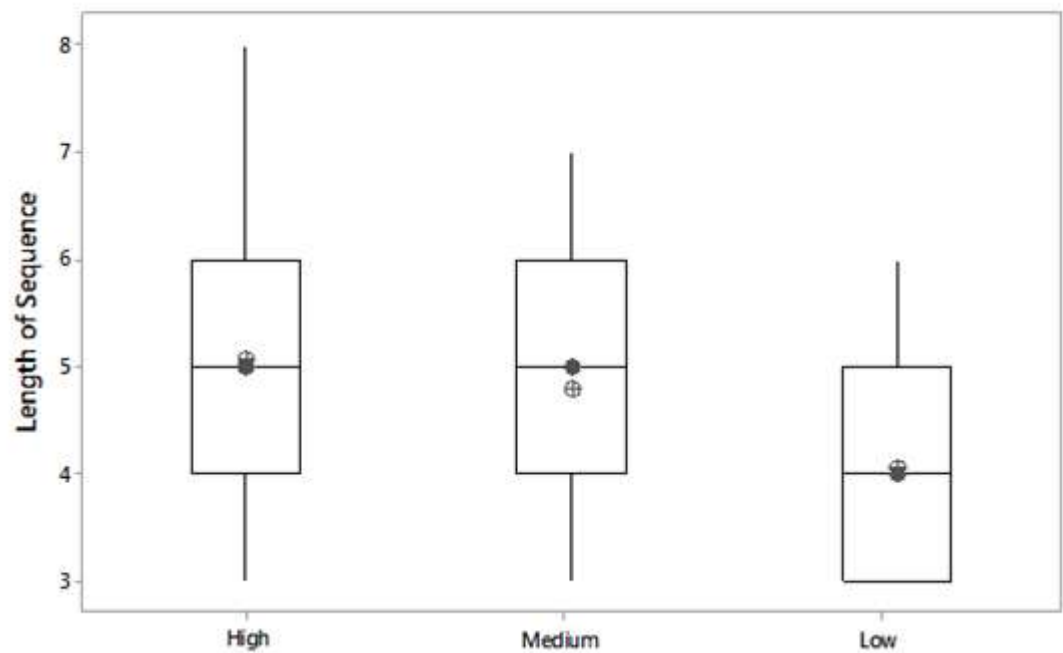


Figure 5.84. Box plot Corsi Span Forward Test

Corsi Span Forward test response value decreases through high income level group to low income level group.

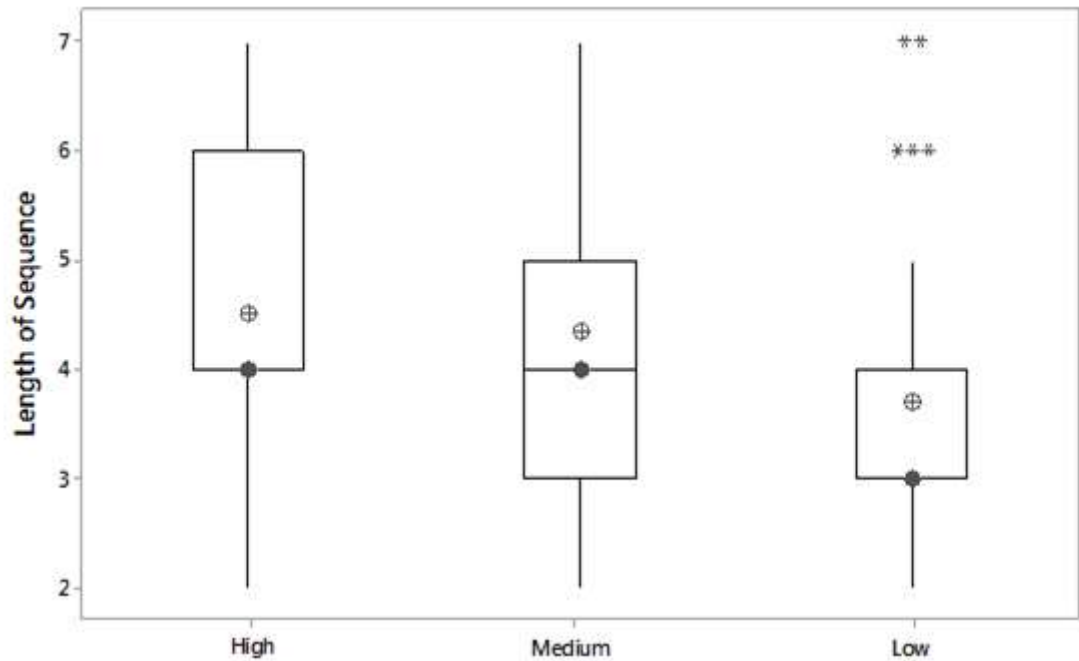


Figure 5.85. Box plot Corsi Span Backward Test.

Corsi Span Backward test response value decreases through high income level group to low income level group.

For Smoking Habit;

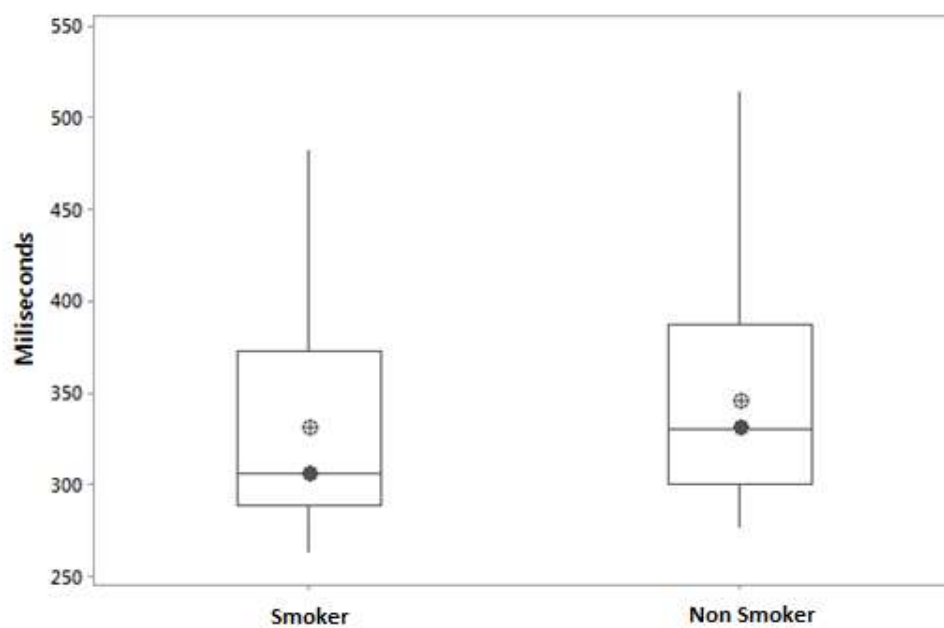


Figure 5.86. Box plot of Reaction Time Test (Dominant Hand).

For Reaction Time test (dominant hand) response value, smoker and nonsmoker groups have similar means.

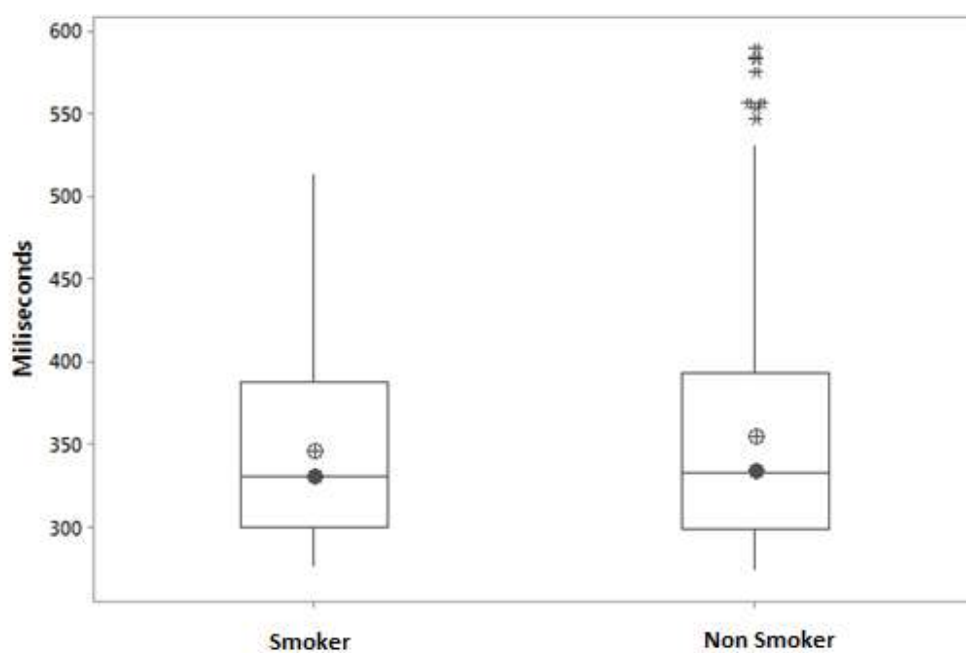


Figure 5.87. Box plot of Reaction Time Test (Nondominant Hand).

For Reaction Time test (nondominant hand) response value, smoker and nonsmoker groups have similar means.

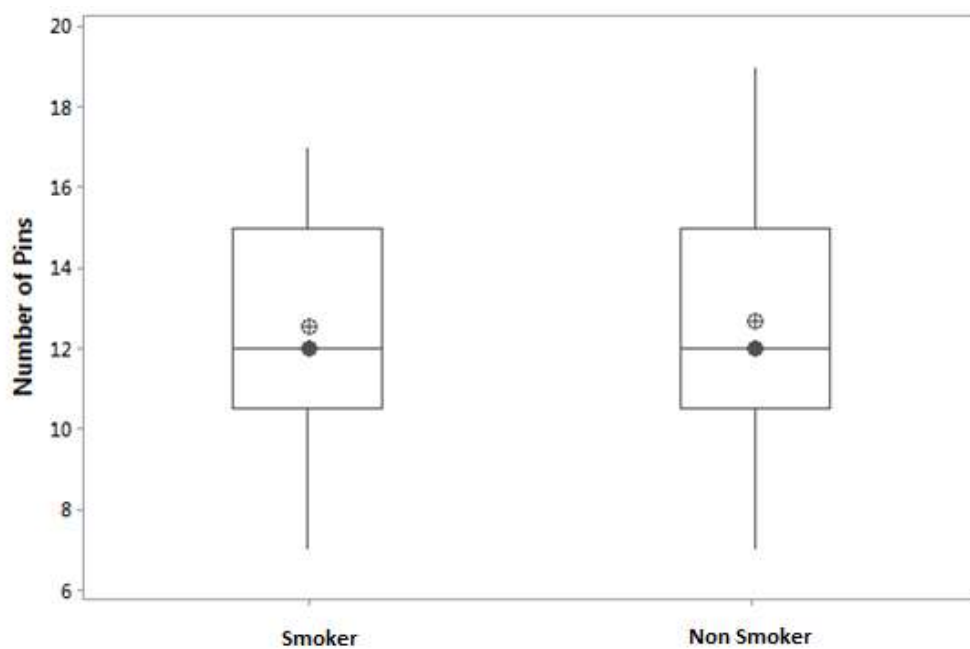


Figure 5.88. Box plot of Purdue Pegboard Test (Dominant Hand).

For Purdue Pegboard test (dominant hand) response value, smoker and nonsmoker groups have similar means.

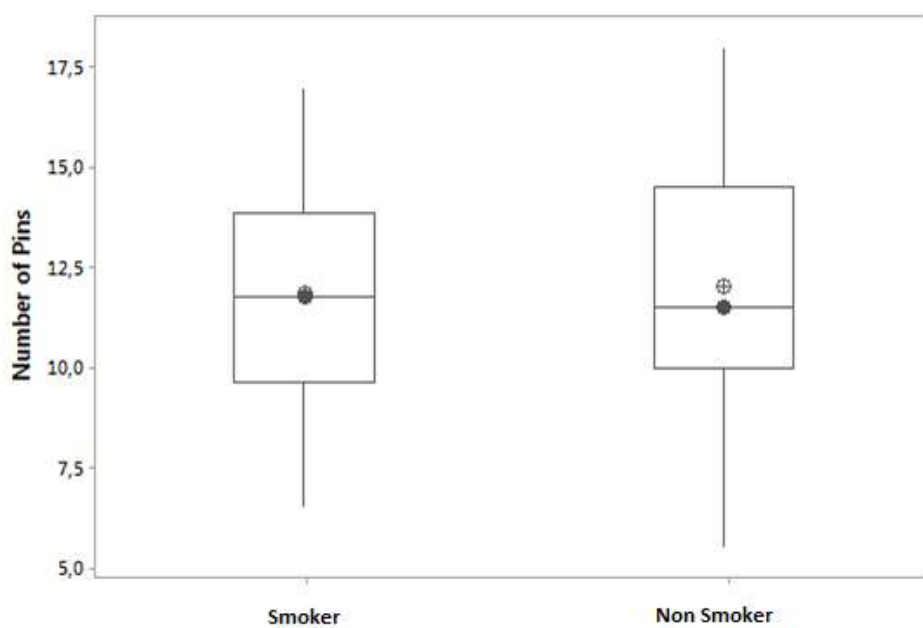


Figure 5.89. Box plot of Purdue Pegboard Test (Both Hand).

For Purdue Pegboard test (both hand) response value, smoker and nonsmoker groups have similar means.

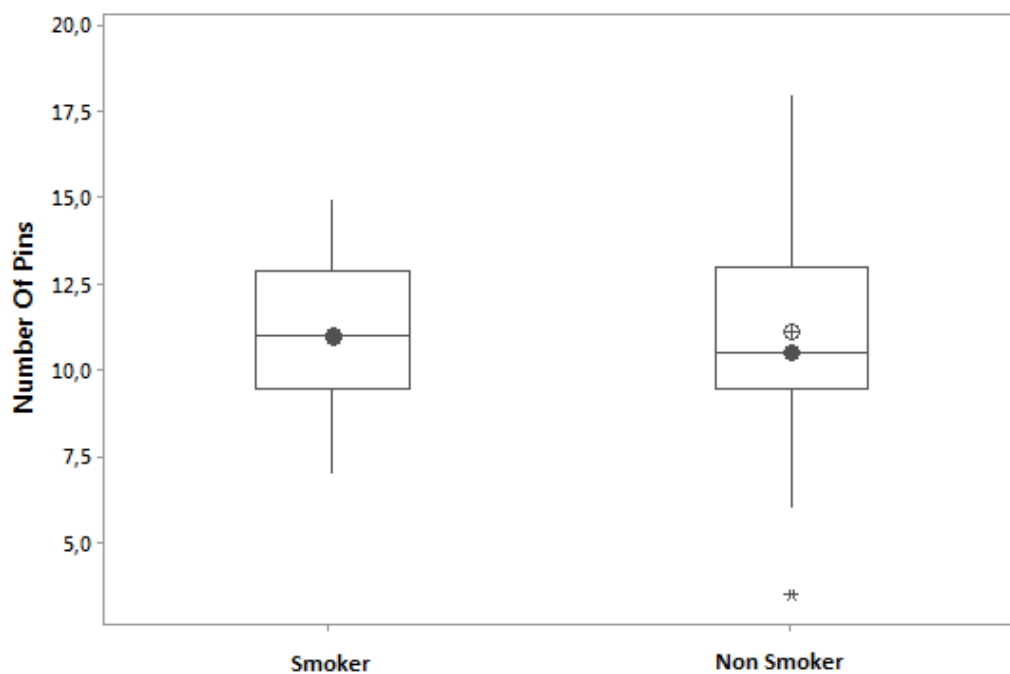


Figure 5.90. Box plot of Purdue Pegboard Test (Total).

For Purdue Pegboard test (total) response value, smoker and nonsmoker groups have similar means.

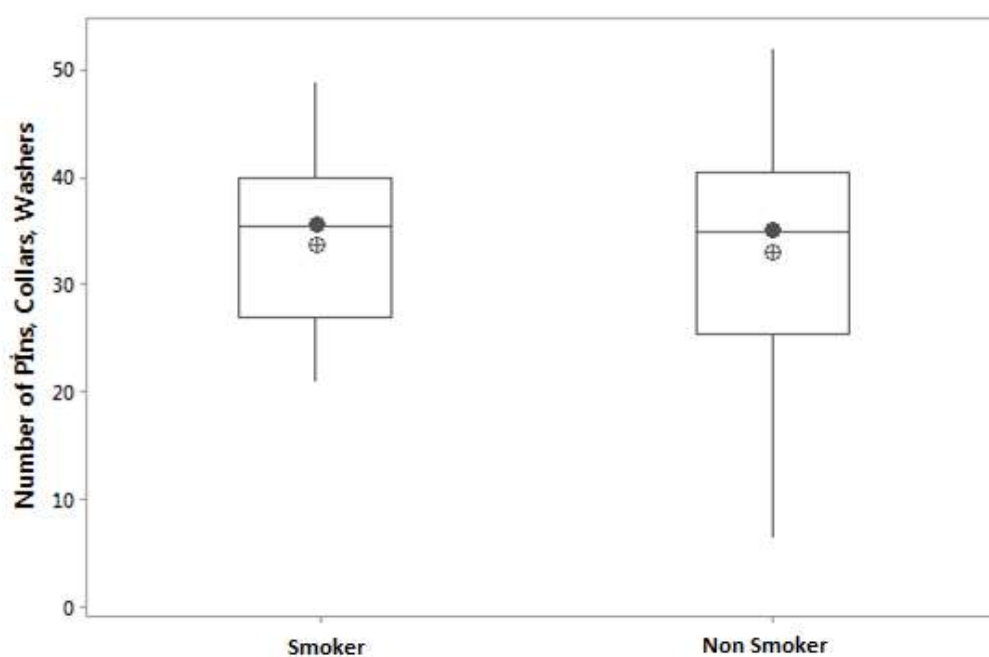


Figure 5.91. Box plot of Purdue Pegboard Assembly Test.

For Purdue Pegboard test (assembly) response value, smoker and nonsmoker groups have similar means.

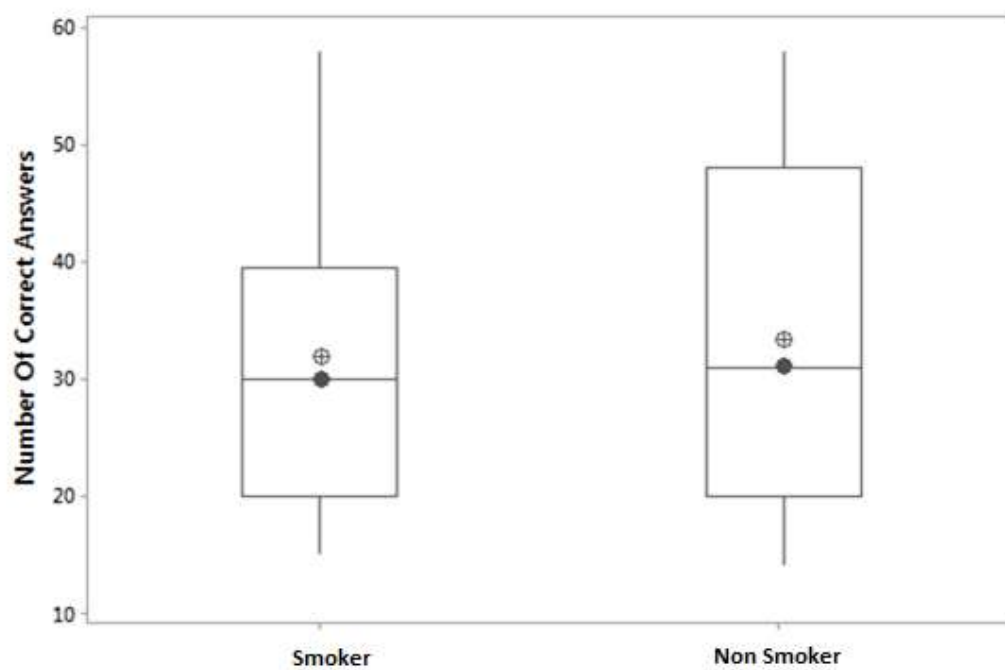


Figure 5.92. Box plot of Raven Test.

For Raven test response value, smoker and nonsmoker groups have similar means.

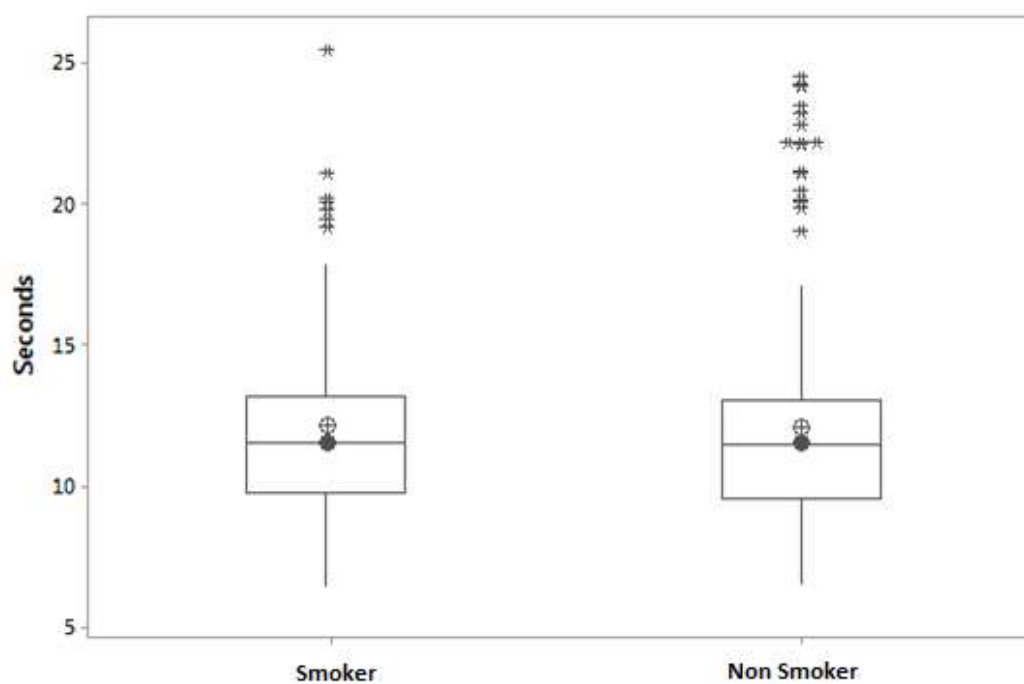


Figure 5.93. Box plot of SCWT (Part I) Test.

For Stroop Color Word test part I response value, smoker and nonsmoker groups have similar means.

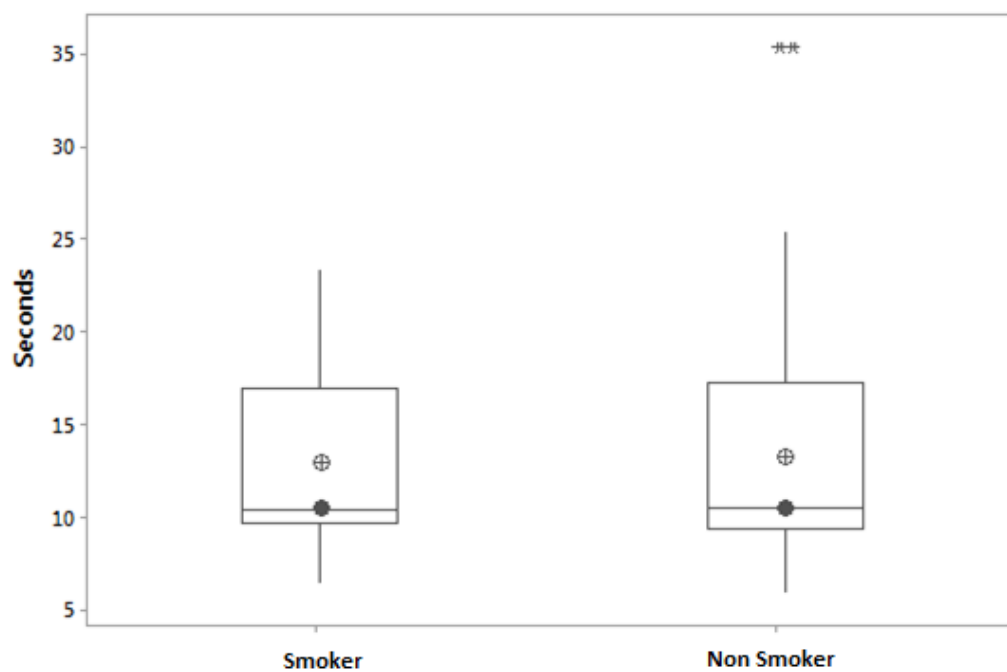


Figure 5.94. Box plot of SCWT (Part II) Test.

For Stroop Color Word test part II response value, smoker and nonsmoker groups have similar means.

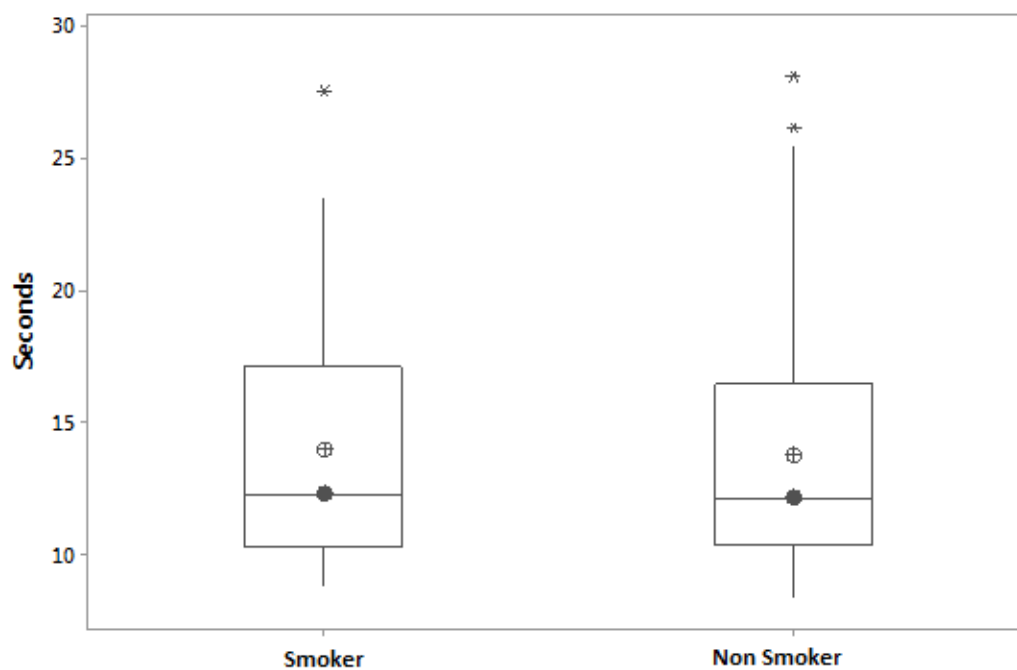


Figure 5.95. Box plot of SCWT (Part III) Test.

For Stroop Color Word test part III response value, smoker and nonsmoker groups have similar means.

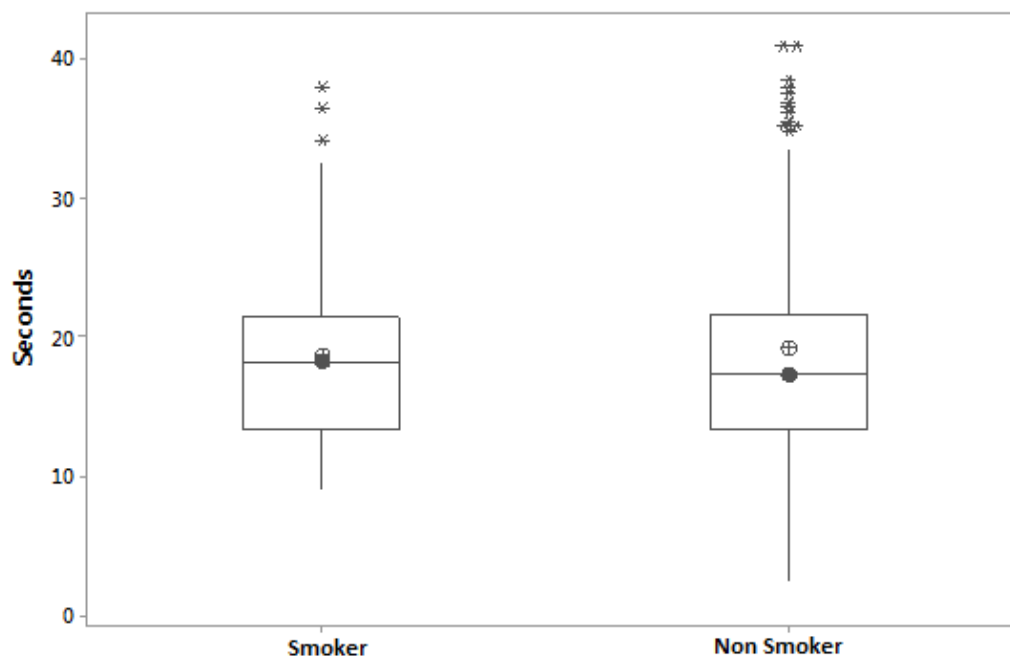


Figure 5.96. Box plot of SCWT (Part IV) Test.

For Stroop Color Word test part IV response value, smoker and nonsmoker groups have similar means.

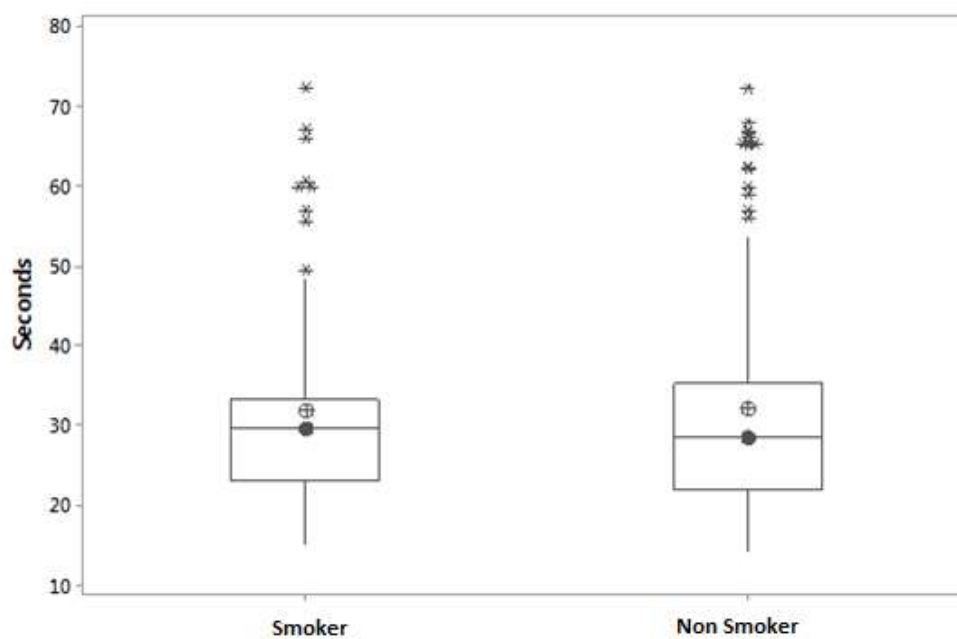


Figure 5.97. Box plot of SCWT (Part V) Test.

For Stroop Color Word test part V response value, smoker and nonsmoker groups have similar means.

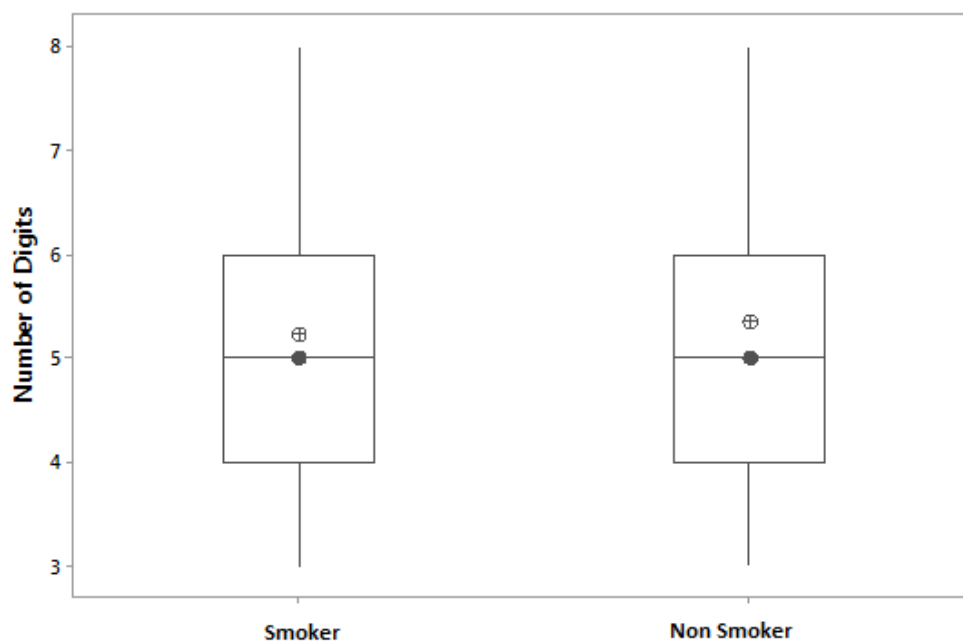


Figure 5.98. Box plot of Digit Span Forward Test.

For Digit Span Forward test response value, smoker and nonsmoker groups have similar means.

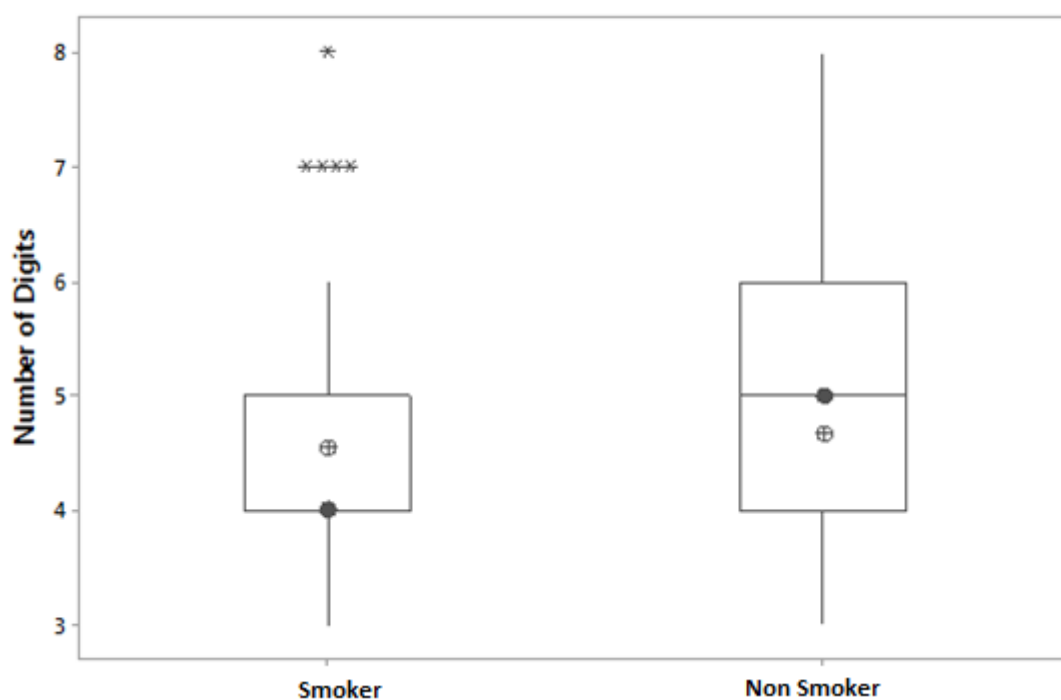


Figure 5.99. Box plot of Digit Span Backward Test.

For Digit Span Backward test response value, smoker and nonsmoker groups have similar means.

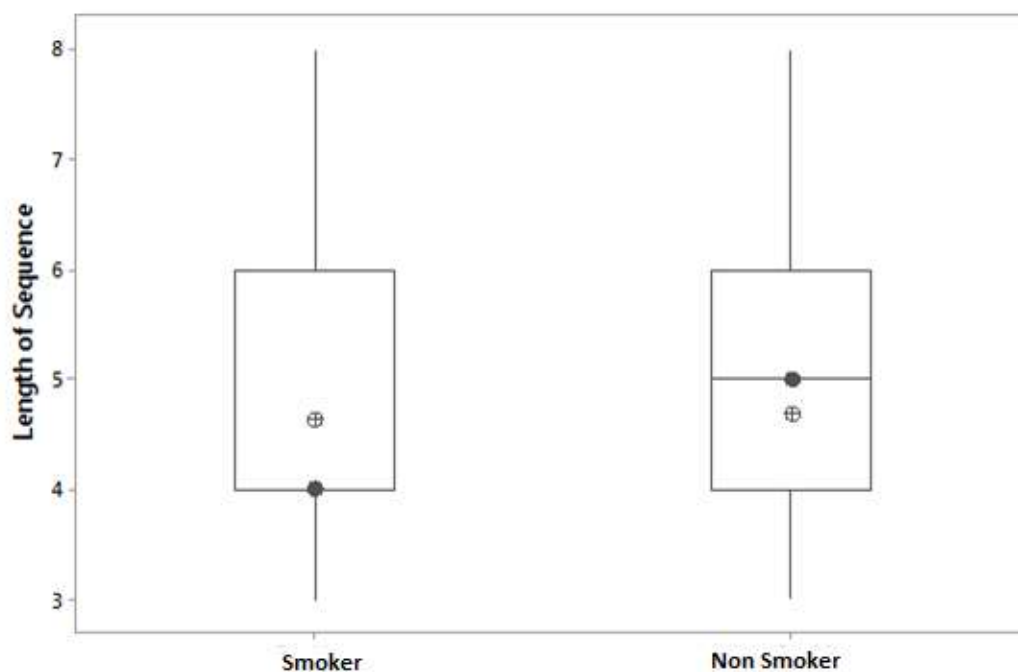


Figure 5.100. Box plot of Corsi Span Forward Test.

For Corsi Span Forward test response value, smoker and nonsmoker groups have similar means.

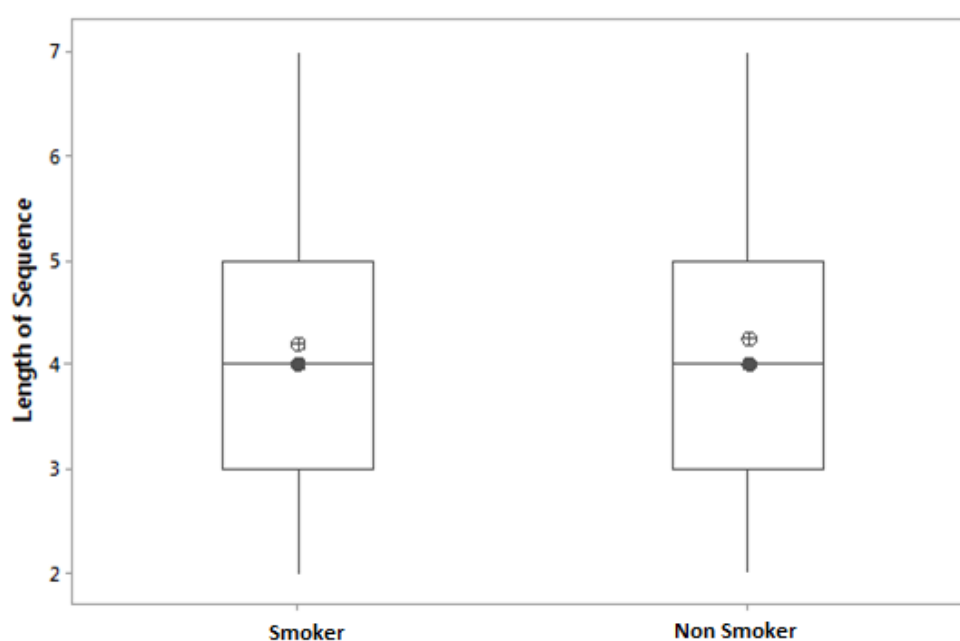


Figure 5.101. Box plot of Corsi Span Backward Test.

For Corsi Span Backward test response value, smoker and nonsmoker groups have similar means.

5.2.4. Independent Variable Groups

Demographic variables were divided two groups as continuous and categorical variables (Table 5.8).

Table 5.8. Independent Variables Details

Variables	Continuous	Categorical	Group	Range	Sample Size
Age (years)	X		1	18-30	50
			2	31-40	50
			3	41-50	50
			4	51-60	50
			5	61-70	18
			6	71- 92	32
Education (years)	X		1	0-5	45
			2	6-12	130
			3	13-16	58
			4	17+	18
Income		X	1	Low	59
			2	Medium	145
			3	High	47
Marital Status		X	1	Married	204
			2	Single	47
Smoking Habit		X	1	Smoking	72
			2	Non smoking	179

5.3. Inferential Statistics

5.3.1. Correlation Analysis

To apply Pearson correlation linearity and normality assumptions should be satisfied (Dugbartey and Tornes, 2000). According to scatter plots, there is linear relationship between all variables. In this study Pearson Correlation Coefficient is used for continuous variables. Table 5.9 shows the results of Pearson correlation for continuous variables of this study.

Spearman's correlation coefficient could be used for ordinal, interval or ratio variables (Hauke and Kossowski, 2011). Since income level is an ordinal variable, for this factor Spearman's correlation coefficient is calculated. Table 5.10 shows the results of Spearman correlation for ordinal variable of this study.

The Pearson's Product Moment Correlation Coefficient calculates the correlation between two interval or ratio variables (Yount, 2006). But in this study there are two independent variables that are dichotomous. They are marital status (Single/Married) and smoking habit (Yes/No). Since The Phi Coefficient (r_ϕ) 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 Biserial correlation calculation for these three variables (Yount, 2006).

It is obvious that independent variables are dichotomous and result variables are interval, so Table 5.11 shows the results of Point Biserial Correlation of these variables. Since the Point Biserial Correlation is the special case of Pearson Product moment correlation, we use the same mathematical concept; we do need to fulfill the same assumptions again.

Table 5.9. Pearson correlation matrix.

Pearson rho		Age	Education
P Value			
Digit Span	Forward	-0.68	0.55
		<0.001	<0.001
	Backward	-0.76	0.55
		<0.001	<0.001
Corsi Span	Forward	-0.68	0.48
		<0.001	<0.001
	Backward	-0.68	0.49
		<0.001	<0.001
Reaction Time Test	Dominant Hand	0.39	-0.25
		<0.001	<0.001
	Nondominant Hand	0.5	-0.37
		<0.001	<0.001
Purdue Pegboard Test	Dominant Hand	-0.75	0.42
		<0.001	<0.001
	Nondominant Hand	-0.73	0.43
		<0.001	<0.001
	Both Hand	-0.59	0.49
		<0.001	<0.001
	Total	-0.74	0.47
		<0.001	<0.001
Raven Test		-0.76	0.61
		<0.001	<0.001
Stroop Color And Word Test	Part I	0.79	-0.54
		<0.001	<0.001
	Part II	0.80	-0.32
		<0.001	<0.001
	Part III	0.76	-0.35
		<0.001	<0.001
	Part IV	0.82	-0.38
		<0.001	<0.001
Part V		0.85	-0.52
		<0.001	<0.001

Table 5.10. Spearman correlation matrix.

Spearman rho		Income Level
P Value		
Digit Span	Forward	0.27
		<0.001
	Backward	0.3
		<0.001
Corsi Span	Forward	0.25
		<0.001
	Backward	0.21
		<0.001
Reaction Time Test	Dominant Hand	-0.19
		<0.001
	Nondominant Hand	-0.23
		<0.001
Purdue Pegboard Test	Dominant Hand	0.16
		<0.001
	Nondominant Hand	0.20
		<0.001
	Both Hand	0.15
		0.01
	Total	0.18
		<0.001
Raven Test		0.30
		<0.001
Stroop Color And Word Test	Part I	-0.24
		<0.001
	Part II	-0.16
		0.04
	Part III	-0.17
		0.02
	Part IV	-0.28
		<0.001
Part V	-0.27	
	<0.001	

To calculate the r_{pbi} for each item the following formula is used (Brown, 2001):

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

Where:

r_{pbi} = point-biserial correlation coefficient

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

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

St = standard deviation for the entire test

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 5.11. Point Biserial correlation matrix.

Responses		Marital Status	Smoking Habit
Digit Span	Forward (number of digits)	-0.386	-0.046
	Backward (number of digits)	-0.27	-0.045
Corsi Span	Forward (length of sequence)	-0.401	-0.014
	Backward (length of sequence)	-0.309	-0.021
Reaction Time Test	Dominant Hand (completion time)	-0.093	-0.081
	Nondominant Hand (completion time)	0.021	-0.059
Purdue Pegboard Test	Dominant Hand	-0.31	-0.04
	Nondominant Hand	-0.32	-0.03
	Both Hand	-0.331	-0.04
	Total	-0.365	-0.047
	Assembly	-0.223	0.033
Raven Test	(number of correct answers)	-0.421	-0.046
Stroop Color And Word Test	Part I (completion time)	0.293	0.007
	Part II (completion time)	0.134	-0.025
	Part III (completion time)	0.209	0.026
	Part IV (completion time)	0.118	-0.032
	Part V (completion time)	0.186	-0.019

The results of correlation analysis between independent variables (age, education and income level) and response variables shows that; age is negatively correlated with all test results except Stroop Color and Word test and Reaction Time test. Education factor has positive correlations with some response variables.

Education and Digit Span Test results, Education and Corsi Span Test results, Education and Purdue Pegboard Test results, Education and Raven test results pairs are positively, and Education and Reaction time test results, Education and Stroop Color Word Test results pairs are negatively correlated. Income level and Digit Span Test results, Income level and Corsi Span Test results, Income level and Purdue Pegboard Test results, Income level and Raven test results pairs are positively, and Income level and Reaction time test results, Income level and Stroop Color Word Test results pairs are negatively correlated.

The results of correlation analysis for between independent variables and result variables for Marital Status, Hand Preference and Smoking Habit show that; marital status has significant negative correlation between Raven, Digit span and Corsi span test response variables. Smoking habit is not strongly correlated with test results.

The correlations among response variables are calculated by using Pearson correlation formula and results are shown in Table 5.12.

Table 5.12. Pearson correlation matrix of response variables.

Test / Pearson rho and P-Value	Reaction Time DH	Reaction Time NDH	Purdue Peg. DH	Purdue Peg. NDH	Purdue Peg. BH	Purdue Peg. Total	Purdue Peg. Assembly	Raven Test	SCWT Part 1	SCWT Part 2	SCWT Part 3	SCWT Part 4	SCWT Part 5	Digit Span F.	Digit Span B.	Corsi Span F.
Reaction Time NDH	0.87 <0.001															
Purdue Peg. DH	-0.52 <0.001	-0.61 <0.001														
Purdue Peg. NDH	-0.43 <0.001	-0.57 <0.001	0.90 <0.001													
Purdue Peg. BH	-0.41 <0.001	-0.54 <0.001	0.83 <0.001	0.83 <0.001												
Purdue Peg. Total	-0.46 <0.001	-0.59 <0.001	0.96 <0.001	0.96 <0.001	0.92 <0.001											
Purdue Peg. Assembly	-0.48 <0.001	-0.60 <0.001	0.69 <0.001	0.68 <0.001	0.69 <0.001	0.71 <0.001										
Raven Test	-0.50 <0.001	-0.61 <0.001	0.75 <0.001	0.72 <0.001	0.75 <0.001	0.77 <0.001	0.79 <0.001									
SCWT Part 1	0.38 <0.001	0.54 <0.001	-0.77 <0.001	-0.77 <0.001	-0.73 <0.001	-0.78 <0.001	-0.76 <0.001	-0.80 <0.001								
SCWT Part 2	0.19 <0.001	0.31 <0.001	-0.63 <0.001	-0.61 <0.001	-0.55 <0.001	-0.62 <0.001	-0.49 <0.001	-0.53 <0.001	0.73 <0.001							
SCWT Part 3	0.15 <0.001	0.28 <0.001	-0.67 <0.001	-0.67 <0.001	-0.61 <0.001	-0.68 <0.001	-0.48 <0.001	-0.59 <0.001	0.71 <0.001	0.86 <0.001						
SCWT Part 4	0.29 <0.001	0.42 <0.001	-0.72 <0.001	-0.71 <0.001	-0.65 <0.001	-0.72 <0.001	-0.58 <0.001	-0.65 <0.001	0.78 <0.001	0.85 <0.001	0.87 <0.001					
SCWT Part 5	0.39 <0.001	0.50 <0.001	-0.80 <0.001	-0.75 <0.001	-0.71 <0.001	-0.78 <0.001	-0.69 <0.001	-0.74 <0.001	0.83 <0.001	0.81 <0.001	0.82 <0.001	0.88 <0.001				
Digit Span F.	-0.42 <0.001	-0.56 <0.001	0.73 <0.001	0.72 <0.001	0.74 <0.001	0.75 <0.001	0.72 <0.001	0.83 <0.001	-0.76 <0.001	-0.54 <0.001	-0.61 <0.001	-0.68 <0.001	-0.73 <0.001			
Digit Span B.	-0.50 <0.001	-0.64 <0.001	0.82 <0.001	0.79 <0.001	0.78 <0.001	0.82 <0.001	0.76 <0.001	0.84 <0.001	-0.80 <0.001	-0.64 <0.001	-0.68 <0.001	-0.75 <0.001	-0.82 <0.001	0.87 <0.001		
Corsi Span F.	-0.40 <0.001	-0.54 <0.001	0.73 <0.001	0.71 <0.001	0.75 <0.001	0.75 <0.001	0.71 <0.001	0.84 <0.001	-0.75 <0.001	-0.48 <0.001	-0.60 <0.001	-0.65 <0.001	-0.72 <0.001	0.85 <0.001	0.83 <0.001	
Corsi Span B.	-0.50 <0.001	-0.62 <0.001	0.77 <0.001	0.72 <0.001	0.76 <0.001	0.78 <0.001	0.75 <0.001	0.85 <0.001	-0.78 <0.001	-0.54 <0.001	-0.59 <0.001	-0.66 <0.001	-0.76 <0.001	0.84 <0.001	0.85 <0.001	0.85 <0.001

According to correlation analysis results;

- Reaction times for dominant and nondominant hands have high positive correlations. It means if a subject shows high performance with her dominant hand, she also shows high performance with her non-dominant hand too.
- Reaction times are negatively correlated with Purdue pegboard test responses. Since lower response variable value means higher performance for Reaction time tests: If a subject has higher performance (shorter time) for reaction time, she can show higher performance for Purdue pegboard tests and vice versa. Both of tests are used for observing motor functions of subjects, and two test results are significantly correlated.
- Reaction times are also negatively related to Raven test, digit span test and Corsi Span test responses. Since lower response variable value means higher performance for Reaction time tests: If a subject has higher performance for reaction time she can show higher performances for these tests, too.
- Reaction time test results and Stroop Color Word tests result are significantly and positively correlated.
- Purdue Pegboard test responses are highly correlated with Raven test, Digit Span test and Corsi Span test responses. It could be said that higher performance in motor functions test indicates higher performance for digit span, Corsi span and Raven test results and vice versa.
- Purdue Pegboard test has a negative correlation with Stroop Color Word test. Since lower response variable value means higher performance for Stroop Color Word tests, if a subject has higher performance for Purdue pegboard tests she can show higher performance for Stroop tests and vice versa.
- Purdue Pegboard task performances have significant positive correlation among themselves. Higher performance for one task indicates higher performance for other tasks.
- Raven test has a very strong positive correlation with Digit span and Corsi span test performances. Better performance for Raven test leads better

performance for Digit and Corsi span tests and vice versa. Raven test is used for determining intellectual functioning capacity and span tests are used for calculating memory and learning capacity of subjects. So these two capacities show positive relation according to correlation analysis.

- Stroop color word test responses are highly positively correlated among themselves. Higher performance for one task indicates higher performance for the other tasks.
- Stroop color word test tasks are negatively correlated with Digit span and Corsi span tests. Since for Stroop tests low response value means better performance this negative correlation shows us the subject who has lower performance for Stroop tests will have higher performance for Digit and Corsi span test with high probability and vice versa.
- Digit span and Corsi span test both used for determining memory and learning capacity of subjects. These two tests are significantly and positively correlated. If a subject shows high performance for one test, with great possibility he/she shows high performance for other test, too.

5.3.2. ANOVA Results

Although some response variables are not normally distributed and homogeneity of variance assumption is not fulfilled, given that ANOVA is robust for minor deviations from normality and constant variance, parametric ANOVA is used for the study. As a check non parametric ANOVA (Welch's ANOVA) method is also applied and the similar results were found.

Due to multicollinearity between education and income level, income level is excluded for ANOVA and regression analysis. For each test response variable, all factors are used for conducting ANOVA. After the first ANOVA test, if there is any factor or interaction factor which has no effect on response, they are eliminated. Then a second ANOVA is conducted for remaining factors. Final ANOVA results for each test response are shown in Table 5.13 through Table 5.29.

Table 5.13. ANOVA for Digit Span Forward test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	149.82	29.96	55.45	<0.001
Education	3	31.45	10.48	19.40	<0.001
Error	242	130.77	0.54		
Lack-of-Fit	13	14.37	1.10	2.17	0.01
Pure Error	229	116.40	0.501		
Total	250	406.14			

Table 5.14. ANOVA for Digit Span Backward test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	171.11	34.22	98.67	<0.001
Education	3	23.93	7.97	23.00	<0.001
Error	242	83.93	0.35		
Lack-of-Fit	13	10.21	0.78	2.44	<0.001
Pure Error	229	73.72	0.32		
Total	250	374.54			

Table 5.15. ANOVA for Corsi Span Forward test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	210.74	42.15	75.30	<0.001
Education	3	16.52	5.51	9.84	<0.001
Error	242	135.45	0.56		
Lack-of-Fit	13	17.68	1.36	2.64	<0.001
Pure Error	229	117.77	0.51		
Total	250	443.89			

Table 5.16. ANOVA for Corsi Span Backward test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	198.18	39.64	93.76	<0.001
Education	3	24.21	8.07	19.09	<0.001
Error	242	102.30	0.42		
Lack-of-Fit	13	14.77	1.14	2.97	<0.001
Pure Error	229	87.52	0.38		
Total	250	403.51			

Table 5.17. ANOVA for Raven test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	22264	4452.83	171.96	<0.001
Education	3	7052	2350.79	90.78	<0.001
Error	242	6267	25.90		
Lack-of-Fit	13	1288	99.07	4.56	<0.001
Pure Error	229	4979	21.74		
Total	250	49045			

Table 5.18. ANOVA for Stroop Color Word test part I.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	1466.54	293.31	68.91	<0.001
Education	3	80.38	26.79	6.29	<0.001
Error	242	1030.02	4.26		
Lack-of-Fit	13	142.44	10.96	2.83	<0.001
Pure Error	229	887.58	3.88		
Total	250	3660.99			

Table 5.19. ANOVA for Stroop Color Word test part II.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	3682.4	736.48	106.04	<0.001
Education	3	175.2	58.41	8.41	<0.001
Error	242	1680.7	6.95		
Lack-of-Fit	13	283.0	21.77	3.57	<0.001
Pure Error	229	1397.7	6.10		
Total	250	6888.3			

Table 5.20. ANOVA for Stroop Color Word test part III.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	3282.07	656.41	99.83	<0.001
Marital Status	1	40.27	40.27	6.12	0.01
Error	244	1604.36	6.57		
Lack-of-Fit	4	39.05	9.76	1.50	0.20
Pure Error	240	1565.31	6.52		
Total	250	4886.72			

Table 5.21. ANOVA for Stroop Color Word test part IV.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	11864	2372.86	138.01	<0.001
Error	245	4212	17.19		
Total	250	16077			

Table 5.22. ANOVA for Stroop Color Word test part V.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	40959	8191.73	342.29	<0.001
Error	245	5863	23.93		
Total	250	46822			

Table 5.23. ANOVA for Reaction Time dominant hand test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	297151	59430	12.86	<0.001
Error	245	1132544	4623		
Total	250	1429694			

Table 5.24. ANOVA for Reaction Time nondominant hand test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	231315	46263	14,31	<0.001
Education	3	36515	12172	3,77	0.011
Error	242	782225	3232		
Lack-of-Fit	13	114468	8805	3,02	<0.001
Pure Error	229	667757	2916		
Total	250	1185348			

Table 5.25. ANOVA for Purdue Pegboard dominant hand test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	1011.61	202.32	119.22	<0.001
Education	3	22.22	7.41	4.37	<0.001
Error	242	410.67	1.70		
Lack-of-Fit	13	47.71	3.67	2.32	0.01
Pure Error	229	362.96	1.58		
Total	250	1756.21			

Table 5.26. ANOVA for Purdue Pegboard non dominant hand test

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	829.95	165.99	64.28	<0.001
Education	3	33.16	11.05	4.28	0.01
Error	242	624.91	2.58		
Lack-of-Fit	13	67.17	5.17	2.12	0.01
Pure Error	229	557.75	2.44		
Total	250	1883.50			

Table 5.27. ANOVA for Purdue Pegboard both hand tests.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	410.26	82.052	36.61	<0.001
Education	3	68.67	22.891	10.21	<0.001
Error	242	542.32	2.241		
Lack-of-Fit	13	210.53	16.195	11.18	<0.001
Pure Error	229	331.79	1.449		
Total	250	1240.48			

Table 5.28. ANOVA for Purdue Pegboard total test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	6468.6	1293.72	91.47	<0.001
Education	3	325.0	108.35	7.66	<0.001
Error	242	3422.6	14.14		
Lack-of-Fit	13	757.1	58.24	5.00	<0.001
Pure Error	229	2665.5	11.64		
Total	250	12983.8			

Table 5.29. ANOVA for Purdue Pegboard assembly test.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Age	5	6036.5	1207.29	42.29	<0.001
Education	3	592.0	197.33	6.91	<0.001
Error	242	6909.0	28.55		
Lack-of-Fit	13	1959.2	150.71	6.97	<0.001
Pure Error	229	4949.8	21.61		
Total	250	17289.3			

Results of ANOVA can be summarized as follows:

- Age factor has a significant effect on all response variables.
- Education level significantly affects almost all test responses except Stroop Color Word test Part III, Stroop Color Word test Part IV, Stroop Color Word test Part V and Reaction Time Dominant Hand test.
- Smoking habit showed no significance on any response variable. Marital Status only affects Stroop Color Word Test Part III, for other test results this factor has no significant effect. This could be a random effect.
- Digit Span and Corsi Span tests are affected by Age and Education level of subjects. Raven and Purdue Pegboard Tests are affected by Age and Education level of subjects, as well.
- Stroop Color and Word Test Parts differs from each other: Part I and Part II are affected by Age and Education factor like other tests, but only Age and Marital status has significant effect on Part III. Part IV and Part V are affected by only Age of the subjects.
- Reaction time tests are affected by Age of the subjects; Reaction time non dominant hand also is affected by Education level of subjects. This could be a random effect, after Tukey test and regression analysis it could be interpreted.

According to ANOVA results no significant interactions could have been seen. ANOVA results shows that at least two groups differ from each other but it does not show us which group differ. So Multiple Comparison (Post-Hoc) tests are performed to determine which means amongst differ from the rest (Montgomery, 2005).

5.3.3. Post-Hoc Analyses (Pairwise Comparisons)

Tukey test is useful for comparing the difference between each pair of means with appropriate adjustment for the multiple testing (Olliveant, 1999). In this study, Tukey test has two assumptions: The observations have a normal distribution and the standard deviation is the same for each group. These two assumptions are tested for ANOVA. The results are shown in Table 5.30 through Table 5.35.

At the results of ANOVA test some independent variables do not have significant effect on some test responses. So those test results do not included at result tables, for instance; marital status factor has an effect on only Stroop Color Word test part III so Tukey test is conducted for only this test for this factor.

Table 5. 30. Tukey's test results for age group differences.

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value	
Digit Forward	Span	(31-40 years) - (18 -30 years)	-0.18	0.16	-1.11	0.88
		(41-50 years) - (18 -30 years)	-1.82	0.16	-11.18	< 0.001
		(51-60 years) - (18 -30 years)	-1.84	0.16	-11.31	< 0.001
		(61-70 years) - (18 -30 years)	-2.47	0.22	-11.04	< 0.001
		(70-92 years) - (18 -30 years)	-2.46	0.18	-13.47	< 0.001
		(41-50 years) - (31-40 years)	-1.64	0.16	-10.08	< 0.001
		(51-60 years) - (31-40 years)	-1.66	0.16	-10.2	< 0.001
		(61-70 years) - (31-40 years)	-2.29	0.22	-10.23	< 0.001
		(70-92 years) - (31-40 years)	-2.28	0.18	-12.49	< 0.001
		(51-60 years) - (41-50 years)	-0.02	0.16	-0.12	0.99
		(61-70 years) - (41-50 years)	-0.65	0.22	-2.9	0.04
		(70-92 years) - (41-50 years)	-0.64	0.18	-3.5	0.01
		(61-70 years) - (51-60 years)	-0.63	0.22	-2.81	0.06
		(70-92 years) - (51-60 years)	-0.62	0.18	-3.39	0.01
		(70-92 years) - (61-70 years)	0.01	0.24	0.04	0.99
Digit Backward	Span	(31-40 years) - (18 -30 years)	0.2	0.13	1.51	0.66
		(41-50 years) - (18 -30 years)	-1.6	0.13	-12.06	< 0.001
		(51-60 years) - (18 -30 years)	-1.68	0.13	-12.66	< 0.001
		(61-70 years) - (18 -30 years)	-2.46	0.18	-13.5	< 0.001
		(70-92 years) - (18 -30 years)	-2.44	0.15	-16.38	< 0.001
		(41-50 years) - (31-40 years)	-1.8	0.13	-13.56	< 0.001
		(51-60 years) - (31-40 years)	-1.88	0.13	-14.17	< 0.001
		(61-70 years) - (31-40 years)	-2.66	0.18	-14.6	< 0.001
		(70-92 years) - (31-40 years)	-2.64	0.15	-17.72	< 0.001
		(51-60 years) - (41-50 years)	-0.08	0.13	-0.6	0.99
		(61-70 years) - (41-50 years)	-0.86	0.18	-4.73	< 0.001
		(70-92 years) - (41-50 years)	-0.84	0.15	-5.62	< 0.001
		(61-70 years) - (51-60 years)	-0.78	0.18	-4.29	< 0.001
		(70-92 years) - (51-60 years)	-0.76	0.15	-5.09	< 0.001
		(70-92 years) - (61-70 years)	0.03	0.19	0.13	0.99
Corsi Forward	Span	(31-40 years) - (18 -30 years)	-0.28	0.16	-1.78	0.48
		(41-50 years) - (18 -30 years)	-2.3	0.16	-14.6	< 0.001
		(51-60 years) - (18 -30 years)	-2.18	0.16	-13.84	< 0.001
		(61-70 years) - (18 -30 years)	-2.56	0.22	-11.85	< 0.001
		(70-92 years) - (18 -30 years)	-2.45	0.18	-13.89	< 0.001
		(41-50 years) - (31-40 years)	-2.02	0.16	-12.82	< 0.001
		(51-60 years) - (31-40 years)	-1.9	0.16	-12.06	< 0.001
		(61-70 years) - (31-40 years)	-2.28	0.22	-10.55	< 0.001
		(70-92 years) - (31-40 years)	-2.17	0.18	-12.3	< 0.001
		(51-60 years) - (41-50 years)	0.12	0.16	0.76	0.97
		(61-70 years) - (41-50 years)	-0.26	0.22	-1.22	0.83
		(70-92 years) - (41-50 years)	-0.15	0.18	-0.87	0.95
		(61-70 years) - (51-60 years)	-0.38	0.22	-1.78	0.48
		(70-92 years) - (51-60 years)	-0.27	0.18	-1.55	0.63
		(70-92 years) - (61-70 years)	0.11	0.23	0.48	0.99

Table 5.30. Tukey's test results for age group differences (cont.).

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value	
Corsi Backward	Span	(31-40 years) - (18 -30 years)	0.02	0.14	0.14	0.99
		(41-50 years) - (18 -30 years)	-2.1	0.14	-14.61	< 0.001
		(51-60 years) - (18 -30 years)	-2.02	0.14	-14.06	< 0.001
		(61-70 years) - (18 -30 years)	-2.33	0.2	-11.81	< 0.001
		(70-92 years) - (18 -30 years)	-2.23	0.16	-13.82	< 0.001
		(41-50 years) - (31-40 years)	-2.12	0.14	-14.75	< 0.001
		(51-60 years) - (31-40 years)	-2.04	0.14	-14.19	< 0.001
		(61-70 years) - (31-40 years)	-2.35	0.2	-11.91	< 0.001
		(70-92 years) - (31-40 years)	-2.25	0.16	-13.94	< 0.001
		(51-60 years) - (41-50 years)	0.08	0.14	0.56	0.99
		(61-70 years) - (41-50 years)	-0.23	0.2	-1.18	0.85
		(70-92 years) - (41-50 years)	-0.13	0.16	-0.79	0.97
		(61-70 years) - (51-60 years)	-0.31	0.2	-1.59	0.61
		(70-92 years) - (51-60 years)	-0.21	0.16	-1.29	0.79
		(70-92 years) - (61-70 years)	0.11	0.21	0.5	0.99
Reaction Time Dominant Hand	-	(31-40 years) - (18 -30 years)	-33.3	13.6	-2.45	0.14
		(41-50 years) - (18 -30 years)	42.7	13.6	3.14	0.02
		(51-60 years) - (18 -30 years)	23.6	13.6	1.73	0.51
		(61-70 years) - (18 -30 years)	32.4	18.7	1.73	0.51
		(70-92 years) - (18 -30 years)	76.7	15.2	5.03	< 0.001
		(41-50 years) - (31-40 years)	76	13.6	5.59	< 0.001
		(51-60 years) - (31-40 years)	56.8	13.6	4.18	< 0.001
		(61-70 years) - (31-40 years)	65.7	18.7	3.51	0.01
		(70-92 years) - (31-40 years)	110	15.2	7.21	< 0.001
		(51-60 years) - (41-50 years)	-19.2	13.6	-1.41	0.72
		(61-70 years) - (41-50 years)	-10.4	18.7	-0.55	0.99
		(70-92 years) - (41-50 years)	34	15.2	2.23	0.23
		(61-70 years) - (51-60 years)	8.8	18.7	0.47	0.99
		(70-92 years) - (51-60 years)	53.2	15.2	3.49	0.01
		(70-92 years) - (61-70 years)	44.4	19.9	2.23	0.23
Reaction Time Nondominant Hand	-	(31-40 years) - (18 -30 years)	-28.3	11.6	-2.45	0.14
		(41-50 years) - (18 -30 years)	45.3	11.6	3.92	< 0.001
		(51-60 years) - (18 -30 years)	33.9	11.6	2.94	0.04
		(61-70 years) - (18 -30 years)	64.6	15.9	4.07	< 0.001
		(70-92 years) - (18 -30 years)	90.3	13	6.97	< 0.001
		(41-50 years) - (31-40 years)	73.7	11.6	6.37	< 0.001
		(51-60 years) - (31-40 years)	62.3	11.6	5.39	< 0.001
		(61-70 years) - (31-40 years)	93	15.9	5.85	< 0.001
		(70-92 years) - (31-40 years)	118.7	13	9.15	< 0.001
		(51-60 years) - (41-50 years)	-11.4	11.6	-0.98	0.92
		(61-70 years) - (41-50 years)	19.3	15.9	1.22	0.83
		(70-92 years) - (41-50 years)	45	13	3.47	0.01
		(61-70 years) - (51-60 years)	30.7	15.9	1.93	0.38
		(70-92 years) - (51-60 years)	56.4	13	4.35	< 0.001
		(70-92 years) - (61-70 years)	25.7	16.9	1.52	0.65

Table 5.30. Tukey's test results for age group differences (cont.).

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Purdue Pegboard - Dominant Hand	(31-40 years) - (18 -30 years)	0.98	0.27	3.69	< 0.001
	(41-50 years) - (18 -30 years)	-3.26	0.27	-12.26	< 0.001
	(51-60 years) - (18 -30 years)	-3.67	0.27	-13.8	< 0.001
	(61-70 years) - (18 -30 years)	-5.52	0.37	-15.11	< 0.001
	(70-92 years) - (18 -30 years)	-4.74	0.3	-15.9	< 0.001
	(41-50 years) - (31-40 years)	-4.24	0.27	-15.95	< 0.001
	(51-60 years) - (31-40 years)	-4.65	0.27	-17.49	< 0.001
	(61-70 years) - (31-40 years)	-6.5	0.37	-17.8	< 0.001
	(70-92 years) - (31-40 years)	-5.72	0.3	-19.18	< 0.001
	(51-60 years) - (41-50 years)	-0.41	0.27	-1.54	0.64
	(61-70 years) - (41-50 years)	-2.26	0.37	-6.19	< 0.001
	(70-92 years) - (41-50 years)	-1.48	0.3	-4.96	< 0.001
	(61-70 years) - (51-60 years)	-1.85	0.37	-5.07	< 0.001
	(70-92 years) - (51-60 years)	-1.07	0.3	-3.59	0.01
(70-92 years) - (61-70 years)	0.78	0.39	2.01	0.34	
Purdue Pegboard - Nondominant Hand	(31-40 years) - (18 -30 years)	0.02	0.33	0.06	0.99
	(41-50 years) - (18 -30 years)	-3.51	0.33	-10.71	< 0.001
	(51-60 years) - (18 -30 years)	-3.69	0.33	-11.26	< 0.001
	(61-70 years) - (18 -30 years)	-5.87	0.45	-13.02	< 0.001
	(70-92 years) - (18 -30 years)	-5.36	0.37	-14.59	< 0.001
	(41-50 years) - (31-40 years)	-3.53	0.33	-10.77	< 0.001
	(51-60 years) - (31-40 years)	-3.71	0.33	-11.32	< 0.001
	(61-70 years) - (31-40 years)	-5.89	0.45	-13.06	< 0.001
	(70-92 years) - (31-40 years)	-5.38	0.37	-14.64	< 0.001
	(51-60 years) - (41-50 years)	-0.18	0.33	-0.55	0.99
	(61-70 years) - (41-50 years)	-2.36	0.45	-5.23	< 0.001
	(70-92 years) - (41-50 years)	-1.85	0.37	-5.04	< 0.001
	(61-70 years) - (51-60 years)	-2.18	0.45	-4.83	< 0.001
	(70-92 years) - (51-60 years)	-1.67	0.37	-4.55	< 0.001
(70-92 years) - (61-70 years)	0.5	0.48	1.05	0.9	
Purdue Pegboard - Both Hand	(31-40 years) - (18 -30 years)	0.12	0.32	0.38	0.99
	(41-50 years) - (18 -30 years)	-2.76	0.32	-8.74	< 0.001
	(51-60 years) - (18 -30 years)	-2.8	0.32	-8.87	< 0.001
	(61-70 years) - (18 -30 years)	-4.31	0.43	-9.92	< 0.001
	(70-92 years) - (18 -30 years)	-3.3	0.35	-9.31	< 0.001
	(41-50 years) - (31-40 years)	-2.88	0.32	-9.12	< 0.001
	(51-60 years) - (31-40 years)	-2.92	0.32	-9.25	< 0.001
	(61-70 years) - (31-40 years)	-4.43	0.43	-10.2	< 0.001
	(70-92 years) - (31-40 years)	-3.42	0.35	-9.65	< 0.001
	(51-60 years) - (41-50 years)	-0.04	0.32	-0.13	0.99
	(61-70 years) - (41-50 years)	-1.55	0.43	-3.56	0.01
	(70-92 years) - (41-50 years)	-0.54	0.35	-1.52	0.65
	(61-70 years) - (51-60 years)	-1.51	0.43	-3.47	0.01
	(70-92 years) - (51-60 years)	-0.5	0.35	-1.41	0.72
(70-92 years) - (61-70 years)	1.01	0.46	2.18	0.25	

Table 5.30. Tukey's test results for age group differences (cont.).

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Purdue Pegboard - Total	(31-40 years) - (18 -30 years)	1.12	0.78	1.43	0.71
	(41-50 years) - (18 -30 years)	-9.53	0.78	-12.18	< 0.001
	(51-60 years) - (18 -30 years)	-10.16	0.78	-12.99	< 0.001
	(61-70 years) - (18 -30 years)	-15.69	1.08	-14.6	< 0.001
	(70-92 years) - (18 -30 years)	-13.4	0.88	-15.28	< 0.001
	(41-50 years) - (31-40 years)	-10.65	0.78	-13.62	< 0.001
	(51-60 years) - (31-40 years)	-11.28	0.78	-14.42	< 0.001
	(61-70 years) - (31-40 years)	-16.81	1.08	-15.64	< 0.001
	(70-92 years) - (31-40 years)	-14.52	0.88	-16.55	< 0.001
	(51-60 years) - (41-50 years)	-0.63	0.78	-0.81	0.97
	(61-70 years) - (41-50 years)	-6.16	1.08	-5.73	< 0.001
	(70-92 years) - (41-50 years)	-3.87	0.88	-4.41	< 0.001
	(61-70 years) - (51-60 years)	-5.53	1.08	-5.15	< 0.001
	(70-92 years) - (51-60 years)	-3.24	0.88	-3.7	< 0.001
(70-92 years) - (61-70 years)	2.29	1.15	2	0.34	
Purdue Pegboard - Assembly	(31-40 years) - (18 -30 years)	-3.92	1.11	-3.54	0.01
	(41-50 years) - (18 -30 years)	-9.74	1.11	-8.8	< 0.001
	(51-60 years) - (18 -30 years)	-11.57	1.11	-10.46	< 0.001
	(61-70 years) - (18 -30 years)	-15.24	1.52	-10.02	< 0.001
	(70-92 years) - (18 -30 years)	-19.18	1.24	-15.46	< 0.001
	(41-50 years) - (31-40 years)	-5.82	1.11	-5.26	< 0.001
	(51-60 years) - (31-40 years)	-7.65	1.11	-6.91	< 0.001
	(61-70 years) - (31-40 years)	-11.32	1.52	-7.44	< 0.001
	(70-92 years) - (31-40 years)	-15.26	1.24	-12.3	< 0.001
	(51-60 years) - (41-50 years)	-1.83	1.11	-1.65	0.56
	(61-70 years) - (41-50 years)	-5.5	1.52	-3.62	< 0.001
	(70-92 years) - (41-50 years)	-9.44	1.24	-7.61	< 0.001
	(61-70 years) - (51-60 years)	-3.67	1.52	-2.41	0.15
	(70-92 years) - (51-60 years)	-7.61	1.24	-6.13	< 0.001
(70-92 years) - (61-70 years)	-3.94	1.62	-2.43	0.15	
Raven Test	(31-40 years) - (18 -30 years)	-7.5	1.47	-5.09	< 0.001
	(41-50 years) - (18 -30 years)	-26.18	1.47	-17.75	< 0.001
	(51-60 years) - (18 -30 years)	-26.48	1.47	-17.96	< 0.001
	(61-70 years) - (18 -30 years)	-27.09	2.03	-13.37	< 0.001
	(70-92 years) - (18 -30 years)	-31.01	1.65	-18.75	< 0.001
	(41-50 years) - (31-40 years)	-18.68	1.47	-12.67	< 0.001
	(51-60 years) - (31-40 years)	-18.98	1.47	-12.87	< 0.001
	(61-70 years) - (31-40 years)	-19.59	2.03	-9.66	< 0.001
	(70-92 years) - (31-40 years)	-23.51	1.65	-14.22	< 0.001
	(51-60 years) - (41-50 years)	-0.3	1.47	-0.2	0.99
	(61-70 years) - (41-50 years)	-0.91	2.03	-0.45	0.99
	(70-92 years) - (41-50 years)	-4.83	1.65	-2.92	0.04
	(61-70 years) - (51-60 years)	-0.61	2.03	-0.3	0.99
	(70-92 years) - (51-60 years)	-4.53	1.65	-2.74	0.07
(70-92 years) - (61-70 years)	-3.92	2.16	-1.82	0.46	

Table 5.30. Tukey's test results for age group differences (cont.).

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Stroop Color Word Test - Part I	(31-40 years) - (18 -30 years)	1.44	0.43	3.38	0.01
	(41-50 years) - (18 -30 years)	3.19	0.43	7.48	< 0.001
	(51-60 years) - (18 -30 years)	3.94	0.43	9.25	< 0.001
	(61-70 years) - (18 -30 years)	9.06	0.59	15.48	< 0.001
	(70-92 years) - (18 -30 years)	9.42	0.48	19.74	< 0.001
	(41-50 years) - (31-40 years)	1.74	0.43	4.1	< 0.001
	(51-60 years) - (31-40 years)	2.5	0.43	5.87	< 0.001
	(61-70 years) - (31-40 years)	7.62	0.59	13.01	< 0.001
	(70-92 years) - (31-40 years)	7.98	0.48	16.72	< 0.001
	(51-60 years) - (41-50 years)	0.75	0.43	1.77	0.49
	(61-70 years) - (41-50 years)	5.87	0.59	10.03	< 0.001
	(70-92 years) - (41-50 years)	6.24	0.48	13.07	< 0.001
	(61-70 years) - (51-60 years)	5.12	0.59	8.74	< 0.001
	(70-92 years) - (51-60 years)	5.49	0.48	11.49	< 0.001
(70-92 years) - (61-70 years)	0.37	0.62	0.59	0.99	
Stroop Color Word Test - Part II	(31-40 years) - (18 -30 years)	0.4	0.55	0.72	0.98
	(41-50 years) - (18 -30 years)	3.01	0.55	5.46	< 0.001
	(51-60 years) - (18 -30 years)	3.74	0.55	6.8	< 0.001
	(61-70 years) - (18 -30 years)	11.6	0.76	15.33	< 0.001
	(70-92 years) - (18 -30 years)	12.69	0.62	20.56	< 0.001
	(41-50 years) - (31-40 years)	2.61	0.55	4.74	< 0.001
	(51-60 years) - (31-40 years)	3.34	0.55	6.07	< 0.001
	(61-70 years) - (31-40 years)	11.2	0.76	14.8	< 0.001
	(70-92 years) - (31-40 years)	12.3	0.62	19.92	< 0.001
	(51-60 years) - (41-50 years)	0.73	0.55	1.33	0.77
	(61-70 years) - (41-50 years)	8.59	0.76	11.35	< 0.001
	(70-92 years) - (41-50 years)	9.69	0.62	15.69	< 0.001
	(61-70 years) - (51-60 years)	7.85	0.76	10.38	< 0.001
	(70-92 years) - (51-60 years)	8.95	0.62	14.5	< 0.001
(70-92 years) - (61-70 years)	1.1	0.81	1.36	0.75	
Stroop Color Word Test - Part III	(31-40 years) - (18 -30 years)	0.01	0.52	0.01	0.99
	(41-50 years) - (18 -30 years)	3.52	0.52	6.8	< 0.001
	(51-60 years) - (18 -30 years)	3.52	0.52	6.78	< 0.001
	(61-70 years) - (18 -30 years)	9.34	0.71	13.12	< 0.001
	(70-92 years) - (18 -30 years)	10.03	0.58	17.26	< 0.001
	(41-50 years) - (31-40 years)	3.52	0.52	6.79	< 0.001
	(51-60 years) - (31-40 years)	3.51	0.52	6.77	< 0.001
	(61-70 years) - (31-40 years)	9.34	0.71	13.11	< 0.001
	(70-92 years) - (31-40 years)	10.03	0.58	17.25	< 0.001
	(51-60 years) - (41-50 years)	-0.01	0.52	-0.02	0.99
	(61-70 years) - (41-50 years)	5.82	0.71	8.17	< 0.001
	(70-92 years) - (41-50 years)	6.51	0.58	11.2	< 0.001
	(61-70 years) - (51-60 years)	5.83	0.71	8.18	< 0.001
	(70-92 years) - (51-60 years)	6.52	0.58	11.22	< 0.001
(70-92 years) - (61-70 years)	0.69	0.76	0.91	0.94	

Table 5.30. Tukey's test results for age group differences (cont.).

Test	Age Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Stroop Color Word Test - Part IV	(31-40 years) - (18 -30 years)	0.25	0.83	0.3	0.99
	(41-50 years) - (18 -30 years)	5.76	0.83	6.95	< 0.001
	(51-60 years) - (18 -30 years)	5.92	0.83	7.14	< 0.001
	(61-70 years) - (18 -30 years)	16.59	1.14	14.55	< 0.001
	(70-92 years) - (18 -30 years)	19.93	0.93	21.43	< 0.001
	(41-50 years) - (31-40 years)	5.51	0.83	6.64	< 0.001
	(51-60 years) - (31-40 years)	5.67	0.83	6.83	< 0.001
	(61-70 years) - (31-40 years)	16.33	1.14	14.33	< 0.001
	(70-92 years) - (31-40 years)	19.67	0.93	21.16	< 0.001
	(51-60 years) - (41-50 years)	0.16	0.83	0.19	0.99
	(61-70 years) - (41-50 years)	10.83	1.14	9.5	< 0.001
	(70-92 years) - (41-50 years)	14.17	0.93	15.23	< 0.001
	(61-70 years) - (51-60 years)	10.67	1.14	9.36	< 0.001
	(70-92 years) - (51-60 years)	14.01	0.93	15.06	< 0.001
	(70-92 years) - (61-70 years)	3.34	1.21	2.75	0.07
Stroop Color Word Test - Part V	(31-40 years) - (18 -30 years)	-0.31	0.98	-0.32	0.99
	(41-50 years) - (18 -30 years)	7.52	0.98	7.69	< 0.001
	(51-60 years) - (18 -30 years)	10.94	0.98	11.18	< 0.001
	(61-70 years) - (18 -30 years)	34.62	1.34	25.75	< 0.001
	(70-92 years) - (18 -30 years)	34.29	1.1	31.25	< 0.001
	(41-50 years) - (31-40 years)	7.83	0.98	8	< 0.001
	(51-60 years) - (31-40 years)	11.25	0.98	11.5	< 0.001
	(61-70 years) - (31-40 years)	34.93	1.34	25.98	< 0.001
	(70-92 years) - (31-40 years)	34.6	1.1	31.54	< 0.001
	(51-60 years) - (41-50 years)	3.42	0.98	3.49	0.01
	(61-70 years) - (41-50 years)	27.1	1.34	20.15	< 0.001
	(70-92 years) - (41-50 years)	26.77	1.1	24.4	< 0.001
	(61-70 years) - (51-60 years)	23.68	1.34	17.61	< 0.001
	(70-92 years) - (51-60 years)	23.35	1.1	21.28	< 0.001
	(70-92 years) - (61-70 years)	-0.33	1.43	-0.23	0.99

Table 5.31. Tukey's test results for education group differences.

Test	Education Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Digit Span Forward	(6-12 years) - (0-5 years)	0.84	0.26	3.29	0.01
	(13-16 years) - (0-5 years)	2.13	0.26	8.09	< 0.001
	(17 + years) - (0-5 years)	1.89	0.28	6.81	< 0.001
	(13-16 years) - (6-12 years)	1.29	0.16	8	< 0.001
	(17 + years) - (6-12 years)	1.05	0.18	5.73	< 0.001
	(17 + years) - (12-16 years)	-0.24	0.2	-1.23	0.61
Digit Span Backward	(6-12 years) - (0-5 years)	1.1	0.24	4.51	< 0.001
	(13-16 years) - (0-5 years)	2.23	0.25	8.87	< 0.001
	(17 + years) - (0-5 years)	2.07	0.26	7.81	< 0.001
	(13-16 years) - (6-12 years)	1.13	0.15	7.35	< 0.001
	(17 + years) - (6-12 years)	0.97	0.18	5.55	< 0.001
	(17 + years) - (12-16 years)	-0.16	0.19	-0.86	0.82
Corsi Span Forward	(6-12 years) - (0-5 years)	0.91	0.28	3.23	0.01
	(13-16 years) - (0-5 years)	1.97	0.29	6.75	< 0.001
	(17 + years) - (0-5 years)	1.81	0.31	5.87	< 0.001
	(13-16 years) - (6-12 years)	1.06	0.18	5.92	< 0.001
	(17 + years) - (6-12 years)	0.89	0.2	4.39	< 0.001
	(17 + years) - (12-16 years)	-0.17	0.22	-0.77	0.87
Corsi Span Backward	(6-12 years) - (0-5 years)	0.74	0.26	2.82	0.03
	(13-16 years) - (0-5 years)	1.91	0.27	7	< 0.001
	(17 + years) - (0-5 years)	1.72	0.29	6	< 0.001
	(13-16 years) - (6-12 years)	1.16	0.17	6.98	< 0.001
	(17 + years) - (6-12 years)	0.98	0.19	5.16	< 0.001
	(17 + years) - (12-16 years)	-0.19	0.2	-0.93	0.79
Stroop Color Word Test - Part I	(6-12 years) - (0-5 years)	-5	0.76	-6.58	< 0.001
	(13-16 years) - (0-5 years)	-7.84	0.79	-9.99	< 0.001
	(17 + years) - (0-5 years)	-7.05	0.83	-8.53	< 0.001
	(13-16 years) - (6-12 years)	-2.84	0.48	-5.91	< 0.001
	(17 + years) - (6-12 years)	-2.05	0.55	-3.76	< 0.001
	(17 + years) - (12-16 years)	0.79	0.58	1.36	0.53
Stroop Color Word Test - Part II	(6-12 years) - (0-5 years)	-8.08	1.11	-7.26	< 0.001
	(13-16 years) - (0-5 years)	-9.58	1.15	-8.32	< 0.001
	(17 + years) - (0-5 years)	-7.54	1.21	-6.22	< 0.001
	(13-16 years) - (6-12 years)	-1.49	0.7	-2.12	0.15
	(17 + years) - (6-12 years)	0.54	0.8	0.68	0.91
	(17 + years) - (12-16 years)	2.03	0.85	2.39	0.08
Reaction Time Nondominant Hand	(6-12 years) - (0-5 years)	-51.2	15.3	-3.35	0.01
	(13-16 years) - (0-5 years)	-92.6	15.8	-5.85	< 0.001
	(17 + years) - (0-5 years)	-76.3	16.7	-4.58	< 0.001
	(13-16 years) - (6-12 years)	-41.31	9.68	-4.27	< 0.001
	(17 + years) - (6-12 years)	-25.1	11	-2.28	0.1
	(17 + years) - (12-16 years)	16.3	11.7	1.39	0.51

Table 5.31. Tukey's test results for education group differences (cont.).

Test	Education Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Purdue Pegboard - Nondominant Hand	(6-12 years) - (0-5 years)	2.43	0.58	4.19	< 0.001
	(13-16 years) - (0-5 years)	4.61	0.6	7.69	< 0.001
	(17 + years) - (0-5 years)	3.54	0.63	5.6	< 0.001
	(13-16 years) - (6-12 years)	2.18	0.37	5.93	< 0.001
	(17 + years) - (6-12 years)	1.1	0.42	2.64	0.04
	(17 + years) - (12-16 years)	-1.07	0.44	-2.42	0.07
Purdue Pegboard - Both Hand	(6-12 years) - (0-5 years)	1.62	0.47	3.45	< 0.001
	(13-16 years) - (0-5 years)	3.38	0.49	6.96	< 0.001
	(17 + years) - (0-5 years)	3.21	0.51	6.29	< 0.001
	(13-16 years) - (6-12 years)	1.76	0.3	5.92	< 0.001
	(17 + years) - (6-12 years)	1.59	0.34	4.72	< 0.001
	(17 + years) - (12-16 years)	-0.16	0.36	-0.46	0.97
Purdue Pegboard - Total	(6-12 years) - (0-5 years)	6.12	1.51	4.05	< 0.001
	(13-16 years) - (0-5 years)	11.93	1.56	7.64	< 0.001
	(17 + years) - (0-5 years)	10.12	1.65	6.15	< 0.001
	(13-16 years) - (6-12 years)	5.81	0.96	6.07	< 0.001
	(17 + years) - (6-12 years)	4	1.09	3.68	< 0.001
	(17 + years) - (12-16 years)	-1.81	1.16	-1.57	0.4
Purdue Pegboard - Assembly	(6-12 years) - (0-5 years)	6.78	1.73	3.92	< 0.001
	(13-16 years) - (0-5 years)	13.52	1.79	7.56	< 0.001
	(17 + years) - (0-5 years)	12.55	1.88	6.66	< 0.001
	(13-16 years) - (6-12 years)	6.74	1.09	6.16	< 0.001
	(17 + years) - (6-12 years)	5.77	1.24	4.64	< 0.001
	(17 + years) - (12-16 years)	-0.97	1.32	-0.74	0.88

Table 5.32. Tukey's test results for marital status group differences.

Test	Marital Status Group Difference	Difference of Means	Std. Error	t-Value	p-Value
Stroop Color Word Test - Part III	Married - Single	-0.09	0.72	-0.12	0.90

Table 5.33. Tukey test results for age factor.

Test and Response Variables	Grouping Information Using the Tukey Method			
	Factor	N	Mean	Grouping
Digit Span Forward (number of digits)	(18-30 years)	50	6.58	A
	(31-40 years)	50	6.4	A
	(41-50 years)	50	4.76	B
	(51-60 years)	50	4.74	B C
	(61-70 years)	33	4.12	C D
	(71-92 years)	18	4.11	C D
Digit Span Backward (number of digits)	(31-40 years)	50	5.94	A
	(18-30 years)	50	5.74	A
	(41-50 years)	50	4.14	B
	(51-60 years)	50	4.06	B
	(71-92 years)	33	3.3	C
	(61-70 years)	18	3.28	C
Corsi Span Forward (length of sequence)	(31-40 years)	50	6.12	A
	(18-30 years)	50	5.84	A
	(51-60 years)	50	3.94	B
	(41-50 years)	50	3.82	B
	(71-92 years)	33	3.67	B
	(61-70 years)	18	3.56	B
Corsi Span Backward (length of sequence)	(31-40 years)	50	5.52	A
	(18-30 years)	50	5.5	A
	(51-60 years)	50	3.48	B
	(41-50 years)	50	3.4	B
	(71-92 years)	33	3.27	B
	(61-70 years)	18	3.17	B
Raven Test (number of correct answers)	(18-30 years)	50	50.92	A
	(31-40 years)	50	43.42	B
	(41-50 years)	50	24.74	C
	(51-60 years)	50	24.44	C
	(61-70 years)	18	23.83	C D
	(71-92 years)	33	19.91	D
Reaction Time Dominant Hand (completion time)	(71-92 years)	33	159.5	A
	(51-60 years)	50	155.57	A
	(41-50 years)	50	154.09	A B
	(61-70 years)	18	129.1	A B
	(18-30 years)	50	119.77	B
	(31-40 years)	50	51.34	C
Reaction Time Non Dominant Hand (completion time)	(71-92 years)	33	175.8	A
	(61-70 years)	18	172	A
	(41-50 years)	50	153.55	A
	(51-60 years)	50	150.17	A
	(18-30 years)	50	103.21	A B
	(31-40 years)	50	47.62	C
Stroop Color Word Test Part I (completion time)	(71-92 years)	33	17.9	A
	(61-70 years)	18	17.53	A
	(51-60 years)	50	12.41	B
	(41-50 years)	50	11.66	C
	(31-40 years)	50	9.91	D
	(18-30 years)	50	8.47	E

*Groups not sharing the same letter are significantly different.

Table 5.33. Tukey test results for age factor (cont.).

Test and Response Variables	Grouping Information Using the Tukey Method			
	Factor	N	Mean	Grouping
Stroop Color Word Test Part II (completion time)	(71-92 years)	33	21.89	A
	(61-70 years)	18	20.8	A
	(51-60 years)	50	12.94	B
	(41-50 years)	50	12.21	B
	(31-40 years)	50	9.6	C
	(18-30 years)	50	9.2	C
Stroop Color Word Test Part III (completion time)	(71-92 years)	33	20.45	A
	(61-70 years)	18	19.76	A
	(41-50 years)	50	13.94	B
	(51-60 years)	50	13.94	B
	(31-40 years)	50	10.43	C
	(18-30 years)	50	10.42	C
Stroop Color Word Test Part IV (completion time)	(71-92 years)	33	32.91	A
	(61-70 years)	18	29.58	A
	(51-60 years)	50	18.91	B
	(41-50 years)	50	18.75	B
	(31-40 years)	50	13.24	C
	(18-30 years)	50	12.99	C
Stroop Color Word Test Part V (completion time)	(61-70 years)	18	56.24	A
	(71-92 years)	33	55.91	A
	(51-60 years)	50	32.55	B
	(41-50 years)	50	29.14	C
	(18-30 years)	50	21.62	D
	(31-40 years)	50	21.31	D
Purdue Pegboard Dominant Hand (number of pins)	(31-40 years)	50	15.78	A
	(18-30 years)	50	14.8	B
	(41-50 years)	50	11.54	C
	(51-60 years)	50	11.13	C
	(71-92 years)	33	10.06	D
	(61-70 years)	18	9.28	D
Purdue Pegboard Non Dominant Hand (number of pins)	(31-40 years)	50	14.58	A
	(18-30 years)	50	14.56	A
	(41-50 years)	50	11.05	B
	(51-60 years)	50	10.87	B
	(71-92 years)	33	9.2	C
	(61-70 years)	18	8.69	C
Purdue Pegboard Both Hand (number of pins)	(31-40 years)	50	13.01	A
	(18-30 years)	50	12.89	A
	(41-50 years)	50	10.13	B
	(51-60 years)	50	10.09	B
	(71-92 years)	33	9.59	B
	(61-70 years)	18	9.28	B
Purdue Pegboard Total (number of pins)	(31-40 years)	50	43.37	A
	(18-30 years)	50	42.25	A
	(41-50 years)	50	32.72	B
	(51-60 years)	50	32.09	B
	(71-92 years)	33	28.85	C
	(61-70 years)	18	26.56	C
Purdue Pegboard Assembly (number of washers, collars, pins)	(18-30 years)	50	41.85	A
	(31-40 years)	50	37.93	B
	(41-50 years)	50	32.11	C
	(51-60 years)	50	30.28	C D
	(61-70 years)	18	26.61	D E
	(71-92 years)	33	22.67	E

*Groups not sharing the same letter are significantly different.

Table 5.34. Tukey test results for education factor

Test	Grouping Information Using the Tukey Method			
	Factor	N	Mean	Grouping
Digit Span Forward (number of digits)	(13-16 years)	75	6.08	A
	(17+ years)	50	5.84	A
	(6-12 years)	105	4.79	B
	(0-5 years)	21	3.95	C
Digit Span Backward (number of digits)	(13-16 years)	75	5.32	A
	(17+ years)	50	5.16	A
	(6-12 years)	105	4.19	B
	(0-5 years)	21	3.1	C
Corsi Span Forward (length of sequence)	(13-16 years)	75	5.31	A
	(17+ years)	50	5.14	A
	(6-12 years)	105	4.25	B
	(0-5 years)	21	3.33	C
Corsi Span Backward (length of sequence)	(13-16 years)	75	4.91	A
	(17+ years)	50	4.72	A
	(6-12 years)	105	3.74	B
	(0-5 years)	21	3	C
Stroop Color Word Test Part I (completion time)	(0-5 years)	21	17.91	A
	(6-12 years)	105	12.91	B
	(17+ years)	50	10.85	C
	(13-16 years)	75	10.07	C
Stroop Color Word Test Part II (completion time)	(0-5 years)	21	20.87	A
	(17+ years)	50	13.33	B
	(6-12 years)	105	12.79	B
	(13-16 years)	75	11.29	B
Raven Test (number of correct answers)	(13-16 years)	75	42.4	A
	(17+ years)	50	41.06	A
	(6-12 years)	105	24.95	B
	(0-5 years)	21	19.48	C
Reaction Time Non Dominant Hand (number of pins)	(0-5 years)	21	190	A
	(6-12 years)	105	144.15	B
	(17+ years)	50	108.18	C
	(13-16 years)	75	94.56	C
Purdue Pegboard Non Dominant Hand (number of pins)	(13-16 years)	75	13.513	A
	(17+ years)	50	12.44	A
	(6-12 years)	105	11.338	B
	(0-5 years)	21	8.905	C
Purdue Pegboard Both Hand (number of pins)	(13-16 years)	75	12.11	A
	(17+ years)	50	11.95	A
	(6-12 years)	105	10.36	B
	(0-5 years)	21	8.74	C
Purdue Pegboard Total (number of pins)	(13-16 years)	75	39.45	A
	(17+ years)	50	37.64	A
	(6-12 years)	105	33.64	B
	(0-5 years)	21	27.52	C
Purdue Pegboard Assembly (number of collars, washers, pins)	(13-16 years)	75	37.35	A
	(17+ years)	50	36.38	A
	(6-12 years)	105	30.61	B
	(0-5 years)	21	23.83	C

*Groups not sharing the same letter are significantly different.

Table 5.35. Tukey test results for marital status factor

Test	Grouping Information Using the Tukey Method			
	Factor	N	Mean	Grouping
Stroop Color Word Test Part III (completion time)	Married	204	13.83	A
	Single	47	13.74	A

*Groups not sharing the same letter are significantly different.

5.3.4. Paired t Test for Hand Preference Factor

In this study, for Reaction Time (Dominant Hand and Nondominant Hand) and Purdue Pegboard (Dominant Hand and Nondominant Hand) tests are examined for the effects of hand preference on results. For analyzing if hand preference of subject has an effect on test response paired t test is used.

Table 5.36. Descriptive statistics for t test.

Sample	N	Mean	StDev	SE Mean
Reaction time dominant hand test	251	340.31	75.62	4.77
Reaction time nondominant hand test	251	351.60	68.86	4.35
Purdue Pegboard dominant hand test	251	12.59	2.65	0.17
Purdue Pegboard nondominant hand test	251	12.00	2.74	0.17

Paired t test results for Reaction Time Dominant and Nondominant Hand tests;

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

$t = -5.77$ and $p < 0.001$

Since $p < 0.05$ we do not accept the null hypothesis; there is significant difference between two sample means. This means hand preference has significant effect on reaction time test. People show better performance while they are using their dominant hand.

For Purdue Pegboard test, the results of Dominant Hand test and Nondominant Hand parts are compared by using paired t test.

Paired t test results for Reaction Time Dominant and Non-dominant Hand tests;

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

$t = 7.48$ and $p < 0.001$

Since $p < 0.05$ we do not accept the null hypothesis; there is significant difference between two sample means. This means hand preference has significant effect on Purdue pegboard test. People show better performance while they are using their dominant hand.

5.3.5. Regression

ANOVA analysis shows that the interactions between independent variables are non-significant for this study. Therefore, a no-interaction multiple linear regression model was determined as a suitable model for the analysis. Stepwise approach was adopted during the statistical analysis. Stepwise regression approach is a method which systematically adds the most significant variable to the model and removes the least significant variable in each step. 0.01 was selected for the level of significance. The general form of the multiple regression equation is as the following (Montgomery, 2005):

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots + \beta_k x_k + \varepsilon \quad (5.2)$$

where, y is the response, β_0 is constant, β_1, β_2, \dots , are the regression coefficients for independent variables, x_1, x_2, \dots , are the regression variables and ε is the error term.

For regression analysis all factors either used as linear variable or quadratic variable according to results from scatter plots. Also categorical variables are coded as dummy variables for calculations.

Developed regression models are calculated as follows;

- Model for Digit Span Forward test;

$$y = 7.771 - 0.1189 * \text{Age} + 0,0899 * \text{Education} + 0.000779 * \text{Age}^2 \quad (5.3)$$

$$R^2_{\text{adj}} = 0.5768$$

y: Number of digits

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Digit Span Backward test;

$$y = 6.990 - 0.0995 * \text{Age} + 0.0737 * \text{Education} + 0.000537 * \text{Age}^2 \quad (5.4)$$

$$R^2_{\text{adj}} = 0.6435$$

y: Number of digits

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Corsi Span Forward test;

$$y = 8.524 - 0.1647 * \text{Age} + 0.0685 * \text{Education} + 0.001190 * \text{Age}^2 \quad (5.5)$$

$$R^2_{\text{adj}} = 0.5807$$

y: Length of sequence

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Corsi Span Backward test;

$$y = 7.665 - 0.15 * \text{Age} + 0.0702 * \text{Education} + 0.001071 * \text{Age}^2 \quad (5.6)$$

$$R^2_{\text{adj}} = 0.5752$$

y: Length of sequence

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Raven test;

$$y = 41.89 - 0.4929 * \text{Age} + 1.081 * \text{Education} \quad (5.7)$$

$$R^2_{\text{adj}} = 0.6693$$

y: Number of correct answers

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Stroop Color Word Test Part I;

$$y = 9.20 + 0.14739 \text{ Age} - 0.446 \text{ Education} + 0.00934 * \text{Education}^2 \quad (5.8)$$

$$R^2_{\text{adj}} = 0.6747$$

y: Time in seconds

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Stroop Color Word Test Part II:

$$y = 6.330 + 0.002477 * \text{Age}^2 + 0.0454 * \text{Education} \quad (5.9)$$

$$R^2_{\text{adj}} = 0.6682$$

y: Time in seconds

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Stroop Color Word Test Part III;

$$y = 8.888 * X_1 + 9.517 * X_2 + 0.001921 * \text{Age}^2 \quad (5.10)$$

$$R^2_{\text{adj}} = 0.584$$

y: Time in seconds

Age: Age of the participant in years

X_1 , X_2 : Indicator (dummy) variables for Marital Status

Marital Status	X ₁	X ₂
Married	1	0
Single	0	1

- Model for Stroop Color Word Test Part IV;

$$y = 14.71 + 0.006046 * \text{Age}^2 + 0.2272 * \text{Age} \quad (5.11)$$

$$R^2_{\text{adj}} = 0.7347$$

y: Time in seconds

Age: Age of the participant in years

- Model for Purdue Pegboard Dominant Hand;

$$y = 16.738 - 0.10717 * \text{Age} + 0.0680 * \text{Education} \quad (5.12)$$

$$R^2_{\text{adj}} = 0.5674$$

y: Number of pins

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Pegboard Non Dominant Hand;

$$y = 15.993 - 0.10692 * \text{Age} + 0.0834 * \text{Education} \quad (5.13)$$

$$R^2_{\text{adj}} = 0.5474$$

y: Number of pins

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Purdue Pegboard Both Hand;

$$y = 12.052 - 0.06034 * \text{Age} + 0.1408 * \text{Education} \quad (5.14)$$

$$R^2_{\text{adj}} = 0.4096$$

y: Number of pins

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Purdue Pegboard Total;

$$y = 44.72 - 0.2744 * \text{Age} + 0.2921 * \text{Education} \quad (5.15)$$

$$R^2_{\text{adj}} = 0.5662$$

y: Number of pins

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Purdue Pegboard Assembly;

$$y = 43.91 - 0.3287 * \text{Age} + 0.3614 * \text{Education} \quad (5.16)$$

$$R^2_{\text{adj}} = 0.6167$$

y: Number of pins, collars, washers

Age: Age of the participant in years

Education: Number of education years of participant

- Model for Reaction Time Dominant Hand;

$$y = 259.8 + 1.715 * \text{Age} \quad (5.17)$$

$$R^2_{\text{adj}} = 0.1656$$

y: Time in milliseconds

Age: Age of the participant in years

- Model for Reaction Time Non Dominant Hand;

$$y = 257.3 + 2.007 * \text{Age} \quad (5.18)$$

$$R^2_{\text{adj}} = 0.2504$$

y: Time in milliseconds

Age: Age of the participant in years

6. DISCUSSION

In this section, results of the study were discussed. The effects of the factors on the test results were examined and the reasons of the results were questioned. Also, results of the current study were compared with the results of the other studies in the literature.

6.1. Discussion on the Results

The discussions about results and effects of factors can be found in the sections below. In general the results of this study are consistent with a number of studies in the literature.

6.1.1. Age Effect

As a result from correlation analysis, it could be said that age level of the subject and results of all tests are significantly correlated. ANOVA test results support this conclusion as well. All test performances are negatively affected by age level of the subjects. On general, after age of 40, test performance of subjects start to decrease for all tests.

Negative effect of age factor on all cognitive and motor test performances is supported by other studies from literature (e.g., Moering, et al., 2004; Monaco, et al., 2012; Elst *et al.*, 2006; Regla *et al.* 2013). So age effect on cognitive capacity has been confirmed once more by the present study for the population of Turkey.

It is clear that age was the most important variable of neuropsychological performance in this study. It is probably due to the effect of ageing on brain functions. Aging causes cognitive slowing down, reduced visual capacity and reduced inhibitory control on people (Regla *et al.*, 2013).

6.1.2. Education Effect

Education level is studied in this study, subjects from education level of 0 years to 22 years and more are performed all tests. As a result from correlation analysis, it could be said that education level has positive effect on test performances.

For Reaction Time tests this correlation is weak. ANOVA test results support this conclusion generally. However according to ANOVA Reaction time dominant hand test and Stroop color word test part III, part IV and part V test performances do not impacted by education level of subjects. As interpretation of Tukey test, after education level of 8 years, test performance starts to be affected by education for Digit span, Corsi span, Raven, Purdue pegboard, Reaction time nondominant hand, Stroop color word test part I and part II. After education of 12 years subjects starts to show similar results. So it could be stated, in general education level has positive effect on cognitive and motor capacity of subjects.

Positive effect of education factor on cognitive and motor test performances of Stroop color word test, Digit and Corsi span test, Reaction Time test is supported by other studies from literature (e.g. Monaco, *et al.*, 2012; Rognonia, *et al.*, 2013; Elst *et al.*, 2006; Regla *et al.* 2013, Dyck *et al.*, 2008). So education effect on cognitive capacity and motor functions has been confirmed once more by the present study for the population of Turkey.

Effect of education on test performance could be the result of genetic; people without high education level may lack the cognitive and motor functions needed to acquire academic knowledge. Also subjects of this study could have different accessibility to education at their childhood; especially elderly subjects could have low education level because of difficulty of accessing education.

6.1.3. Income Level Effect

In this study, income level is correlated with education level of subjects, so this factor is excluded for factor effect analysis.

6.1.4. Smoking Habit Effect

As statistical analysis provided in this study suggests, smoking habit has no significant effect on test performance and cognitive capacity and motor functions of subjects.

6.1.5. Marital Status Effect

This factor show no significant correlation for test results, but at ANOVA analysis marital status is significantly affect test performance of Stroop color word test part III. But for Tukey test single subjects and married subjects group have similar means. Regression analysis does not include marital status factor, as a result it could be said that marital status has no significant effect on test performance and cognitive capacity and motro funcitons of subjects

6.1.6. Hand Preference Effect

According to paired t test results, dominant hand test results and nondominant hand test results significantly differs and dominant hand test results have higher mean, so subjects show better performance when they use their dominant hand for Reaction time and Purdue Pegboard tests. People generally feel more comfortable with their dominant hand; this effect could be explained with this.

6.1.7. Relation of Test Results with Each Other

Raven test, Digit Span test and Corsi Span test results are positively correlated with Purdue Pegboard test results and Reaction time tests. This shows us higher performance in memory abilities tests leads higher performance for motor functions test and vice versa.

Raven test is used for determining intellectual functioning capacity and span tests are used for determining memory and learning capacity of subjects. And according to

correlation analysis these two capacities show positive relation according to correlation analysis. Also the subject who has lower performance for Stroop tests will have higher performance for Digit and Corsi span test with high probability and vice versa.

According to correlation analysis between six test responses; subjects who have higher performance in motor functions test have higher performance for memory, learning and intellectual capacity. Also subjects who have higher performance in intellectual capacity have higher performance for memory and learning tests. And subjects who are better at attention, concentration and speed, also better at memory and learning.

6.2. Comparison with Other Studies

The last objective of the study was to compare the cognitive capacity of population of Turkey with some of the available international normative data. In literature, there is not a single study that considered all these 6 tests that are included in this study. For assessing an accurate comparison independent variable groups should be matched between studies.

Unfortunately, in the literature there are different independent variables and their levels so in this study the age-range and education level factors are tried to be matched as much as possible with the compared.

For comparing results the mean of sample, standard deviation and sample size of the study are used for t-tests and mean values are compared. $p < 0.05$ indicates significance. Also % difference is calculated by using the formula at below:

$$\% \text{ difference} = 100 \times (\text{mean of population of Turkey} - \text{mean for comparison nationality}) / \text{mean of population of Turkey} \quad (6.1)$$

The comparison results are shown in Table 6.1 through Table 6.7.

Table 6.1. Comparisons between population of Turkey and other nationalities for Digit Span test.

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff	t value	p value
Hsieh and Tori (2007)	China	Forward	30-40	all	50	142	7.85	1.21	-22.66	8.27	<0.001
		Backward					4.40	1.44	25.93	-8.93	<0.001
		Forward	50-60	all	50	71	7.55	1.05	-59.28	15.24	<0.001
		Backward					4.06	1.24	0.00	0.00	0.990
		Forward	60-70	all	50	43	7.40	1.03	-80.05	10.79	<0.001
		Backward					3.42	1.45	-4.27	0.57	0.572
Chan <i>et al.</i> (2009)	China	Forward	Overall (mean:70.7)	all	251	90	7.87	1.14	-48.21	16.84	<0.001
Choi <i>et al.</i> (2013)	Korea	Forward	60-70	4-9	10	167	4.93	2.02	-29.74	1.76	0.08
				10+	7	116	6.86	2.02	-54.85	3.16	0.002
			71+	4-9	22	53	4.58	2.17	-22.46	1.78	0.08
				10+	14	28	6.25	2.84	-36.46	2.14	0.039
		Backward	60-70	4-9	10	167	4.12	1.46	-32.90	2.20	0.029
				10+	7	116	5.05	1.54	-41.46	2.53	0.013
			71+	4-9	22	53	3.94	1.46	-22.74	2.30	0.024
				10+	14	28	4.96	1.88	-41.71	2.84	0.007
Jorm <i>et al.</i> (2004)	Australia	Backward	20-24	all	27	1241	5.23	2.26	8.90	-3.38	0.002
			40-44		15	1338	5.10	2.23	-10.87	0.87	0.386
Wongupparaja <i>et al.</i> (2017)	British	Forward	Overall (mean:36.8)	all	251	742	6.11	7.22	-15.07	-2.89	<0.001
		Backward	Overall (mean:41.3)	all	251	594	4.51	9.88	2.59	0.29	0.77
Woods <i>et al.</i> (2010)	New Zealand	Forward	Overall (mean: 46.5)	all	251	749	6.35	1.15	-19.59	11.90	<0.001
		Backward			251	749	4.61	1.22	0.43	-0.26	0.795

Table 6.1. Comparisons between population of Turkey and other nationalities for Digit Span test (cont.).

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff	t value	p value
Monaco <i>et al.</i> (2013)	Italy	Forward	20-30	all	48	50	6.47	0.94	0.00	0.00	0.990
			31-40		50	58	6.38	1.09	0.31	-0.10	0.917
			41-50		50	50	6.12	1.15	-29.11	6.63	<0.001
			51-60		50	50	5.80	0.95	-22.36	5.67	<0.001
			61-70		18	54	5.70	0.92	-38.69	6.87	<0.001
			71-80		27	50	5.39	0.86	-33.42	6.84	<0.001
			81-90		5	50	4.92	0.81	-2.50	0.31	0.760
		Backward	20-30		48	50	5.07	1.25	11.67	-3.34	0.001
			31-40		50	58	5.16	1.04	13.13	-4.19	<0.001
			41-50		50	50	4.68	1.04	-13.04	3.31	0.001
			51-60		50	50	4.66	1.24	-14.78	2.94	0.004
			61-70		18	54	4.15	0.91	-26.52	3.88	<0.001
			71-80		27	50	3.92	0.98	-24.44	5.36	<0.001
			81-90		5	50	3.60	0.67	5.26	-0.65	0.518
Kessels <i>et al.</i> (2008)	Holland	Forward	50-59	all	50	37	6.10	1.30	-28.69	5.72	<0.001
			60-69		18	112	5.70	1.20	-38.69	5.51	<0.001
			70-79		27	81	5.50	1.10	-36.14	6.40	<0.001
			80+		12	16	5.60	1.10	-29.33	3.16	0.004
		Backward	50-59		50	37	4.80	1.30	-18.23	3.36	0.001
			60-69		18	112	4.30	1.20	-31.10	3.55	0.001
			70-79		27	81	4.00	1.20	-26.98	3.59	0.001
			80+		12	16	4.30	1.10	-20.11	2.10	0.046

Table 6.2. Comparisons between population of Turkey and other nationalities for Corsi Span test.

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff	t value	p value
Monaco <i>et al.</i> (2013)	Italy	Forward	20-30	all	48	50	6	1.09	1.96	-0.65	0.52
			31-40		50	58	5.94	1.06	-1.71	0.53	0.60
			41-50		50	50	5.5	1.02	-43.98	10.21	<0.001
			51-60		50	50	5.56	1.02	-41.12	8.46	<0.001
			61-70		18	54	5.17	0.98	-45.22	6.21	<0.001
			71-80		27	50	5.02	0.75	-37.91	7.61	<0.001
			81-90		5	50	4.42	0.89	-21.43	2.73	0.10
		Backward	20-30		48	50	5.24	0.9	4.73	-1.66	0.10
			31-40		50	58	5.38	1.14	2.54	-0.69	0.49
			41-50		50	50	4.7	0.91	-38.24	8.73	<0.001
			51-60		50	50	5.04	1.05	-44.83	8.70	<0.001
			61-70		18	54	4.66	0.95	-47.00	4.96	<0.001
			71-80		27	50	4.43	0.84	-36.73	6.71	<0.001
			81-90		5	50	3.5	1	3.85	-0.43	0.67
Kessels <i>et al.</i> (2008)	Holland	Forward	50-59	all	50	37	5.3	0.7	-34.52	7.70	<0.001
			60-69		18	112	5	0.8	-40.45	7.02	<0.001
			70-79		27	81	5.2	0.8	-42.86	9.14	<0.001
			80+		12	16	4.8	0.8	-30.79	4.00	<0.001
		Backward	50-59		50	37	5.5	1.1	-58.05	10.39	<0.001
			60-69		18	112	5.1	1.1	-60.88	7.25	<0.001
			70-79		27	81	4.9	1.1	-51.23	8.00	<0.001
			80+		12	16	4.6	0.9	-34.90	3.64	0.00
Pagulayan <i>et al.</i> (2007)	America	Forward	18-30	all	50	91	7.1	1	-16.01	6.11	<0.001

Table 6.3. Comparisons between population of Turkey and other nationalities for Corsi Span test (cont.).

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff	t value	p value
Chan <i>et al.</i> (2009)	China	Forward	Overall (mean:70.65)	all	251	90	7.28	1.30	-54.89	15.53	<0.001
Wongupparaja <i>et al.</i> , (2017)	British	Forward	Overall (mean:29.31)	all	251	307	5.25	6.35	-11.70	-1.52	0.13
		Backward	Overall (mean:43.06)		251	111	4.74	4.81	-12.32	-1.14	0.26

Table 6.4. Comparisons between population of Turkey and other nationalities for Reaction Time test

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff.	t value	p value
Jorm <i>et al.</i> (2004)	Australia	Dominant	20-24	all	27	1241	223.67	35.68	31.94	-13.53	<0.001
			40-44		15	1338	237.21	39.21	32.93	-11.34	<0.001
			60-64		2	1232	266.78	68.79	11.40	-0.71	0.48
Nissan <i>et al.</i> (2013)	Scotland	Dominant	18-25	all	32	50	230.8	31.2	29.23	-12.32	<0.001
			45-60		89	50	276.2	50.3	21.97	-8.06	<0.001
			65-80		42	50	270.7	47.7	27.06	-5.49	<0.001
Jacopsen <i>et al.</i> (2010)	Denmark	Dominant	Overall	all	251	74	242	31	28.89	-16.44	<0.001
Cinaz <i>et al.</i> (2012)	German	Dominant	18-30	all	50	20	321.4	25.7	0.46	-0.16	0.88

Table 6.5. Comparisons between population of Turkey and other nationalities for Purdue Pegboard test.

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff.	t value	p value
Chan <i>et al.</i> (2009)	China	Both Hand	Overall (mean:70.65)	all	251	91	9.41	1.89	14.92	-6.29	<0.001
Corti <i>et al.</i> (2017)	Australia	Dominant Hand	18–30	all	50	30	16.93	1.36	-12.72	-6.11	<0.001
			60–69		17	9	13	0.01	-40.09	-14.22	<0.001
			70–79		27	9	10	1.85	-6.72	-0.98	0.35
		Both Hand	18–30		50	30	13.77	1.96	-6.82	-2.26	0.03
			60–69		17	9	11.5	0.71	-34.03	-7.29	<0.001
			70–79		27	9	8	2.14	4.53	0.5	0.62
		Assembly	18–30		50	30	43.37	2.48	-3.63	-1.83	0.07
			60–69		17	9	26	5.56	2.29	0.26	0.79
			70–79		27	9	20.5	8.66	17.63	1.47	0.17
Mccury <i>et al.</i> (2001)	America (Japanese)	Dominant	70-79	all	27	120	13.7	2	-46.21	16.76	<0.001
			80+		12	80	12.5	2.3	-11.61	1.85	0.07
		Non Dominant	70-79		27	120	12.7	2.3	-49.41	9.19	<0.001
			80+		12	80	11.3	1.9	-5.61	1.01	0.32
Hamm and Curtis (1980)	America	Dominant	<35	all	75	102	15.18	2.41	0.85	-0.45	0.65
			35+		176	62	14.08	2.22	-23.08	7.95	<0.001
		Non-Dominant	<35		75	102	14.49	2.13	1.36	-0.68	0.50
			35+		176	62	15.14	4.19	-39.41	7.65	<0.001
		Both Hand	<35		75	102	12.24	1.83	6.06	5.96	<0.001
			35+		176	62	11.33	1.6	-10.86	3.87	<0.001
		Total	<35		75	102	40.32	14.68	6.32	-1.81	0.07
			35+		176	62	40.13	10.23	-23.40	5.53	<0.001
		Assembly	<35		75	102	36.19	6.99	10.88	5.96	<0.001
			35+		176	62	31.76	4.84	-5.69	1.69	0.09

Table 6.6. Comparisons between population of Turkey and other nationalities for Stroop Color Word test.

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff.	t value	p value
Moering <i>et al.</i> (2004)	America (African Americans)	Part I	60 -71	all	18	57	24,02	5,66	-37,02	4,47	<0,0001
			71+		39	71	21,7	5,46	-21,64	3,77	<0,0001
		Part III	60 -71		18	57	38,33	13,55	-93,98	9,42	<0,0001
			71+		39	71	30,69	11,01	-51,05	7,08	<0,0001
		Part V	60 -71		18	57	79,02	11,94	-40,50	7,51	<0,0001
			71+		39	71	69,04	14,94	-22,68	4,82	<0,0001
Martins <i>et al.</i> (2013)	Portuguese	Part I	50-65	5-9	21	72	31	9	-112,96	13,18	<0,0001
				9+	48	71	32	9	-155,77	17,48	<0,0001
			65+	5-9	21	59	22	8	-11,70	1,85	0,068
				9+	16	44	26	9	-64,63	4,71	<0,0001
		Part II	50-65	5-9	21	72	57	12	-323,19	25,56	<0,0001
				9+	48	71	59	13	-332,45	27,55	<0,0001
			65+	5-9	21	59	51	12	-134,89	17,06	<0,0001
				9+	16	44	53	11	-149,13	16,75	<0,0001
		Part V	50-65	5-9	21	72	80	15	-103,06	11,27	<0,0001
				9+	48	71	85	15	-155,23	25,63	<0,0001
			65+	5-9	21	59	78	15	-31,16	5,88	<0,0001
				9+	16	44	83	13	-60,92	9,63	<0,0001

Table 6.6. Comparisons between population of Turkey and other nationalities for Stroop Color Word test (cont.).

Population of Turkey vs.	Country	Type	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff.	t value	p value
Karakas <i>et al.</i> (1999)	Turkey	Part I	20-54	5 -8	16	100	12.13	6.29	-1.84	0.3	0.768
				9+	158	100	8.81	1.76	13.56	-6.20	<0.001
		Part II		5 -8	16	100	13.61	7.41	-20.86	2.71	0.008
				9+	158	100	9.43	2.52	11.22	-3.45	0.001
		Part III		5 -8	16	100	17.46	9.60	-36.07	3.93	<0.001
				9+	158	100	12.32	2.71	-3.96	1.36	0.174
		Part IV		5 -8	16	100	28.07	13.85	-56.95	6.86	<0.001
				9+	158	100	16.95	6.70	-9.94	2.08	0.039
		Part V		5 -8	16	100	40.57	24.24	-41.04	4.36	<0.001
				9+	158	100	26.38	12.29	-5.77	1.11	0.270
		Part I	55-74	5 -8	28	100	13.51	5.49	23.82	-3.75	<0.001
				9+	22	95	10.09	3.71	24.22	-3.8	<0.001
		Part II		5 -8	28	100	16.47	6.76	7.47	-0.96	0.338
				9+	22	95	11.63	5.41	30.01	-4.02	<0.001
		Part III		5 -8	28	100	24.45	13.36	-30.81	3.60	<0.001
				9+	22	95	15.93	4.06	-1.19	0.20	0.839
		Part IV		5 -8	28	100	38.39	18.52	-41.14	4.90	<0.001
				9+	22	95	24.87	10.94	-11.72	1.07	0.288
		Part V		5 -8	28	100	47.93	20.82	4.02	-0.48	0.633
				9+	22	95	35.96	16.23	7.57	-0.81	0.418

Table 6.7. Comparisons between population of Turkey and other nationalities for Raven test.

Population of Turkey vs.	Country	Age Group	Education Group	n (current study)	n (considered study)	Mean	SD	% Diff.	t value	p value
Dutton <i>et al.</i> (2018)	Sub-Saharan Africans	18	all	2	46	20.54	7.06	55.35	4.18	0.15
Hsieh and Tori (2007)	China	30-40	all	50	74	42.38	11.47	2.40	-0.51	0.61

6.2.1. Digit Span Test

- Digit span forward test results of female population of Turkey are similar to digit span forward results of population of Italy for age between 20 – 40 and 81-90 (Monaco *et al.*,2013). For age range 41-80 there are significant differences between two populations. Females of Turkey have lower value. For Backward test, 20 to 40 years age range; Italian females have lower response values than females in Turkey. After that until age of 80 population of Turkey have lower response values than population of Italy. Finally age range 81 and more these two populations have similar results.
- A Comparison with the population of Korean (Choi *et al.* ,2013) shows that for higher education level, these two populations has similar results but for lower education level there is significant difference and population of Turkey has lower means than Korean For both education levels (high and low), digit span backward test results show no significant difference.
- For the comparable samples, Digit Span Forward test result of female population of Turkey is significantly different than Digit Span Forward test result of population of China (Chan *et al.*, 2009). Especially for age range 60-70, results of population of China were significantly greater than females of Turkey. Generally speaking, for all age groups, population of China shows better results. For digit span backward test results for age group between 30 and 40 years old female population of Turkey has better results than population of China (Hsieh and Tori, 2007). At age range 50-60 two population show no significant differences, after age of 60 population of China have slightly better results.
- A comparison of female population of Turkey and population of Netherland for Digit span forward test shows that there are significant differences between two study results (Kessels *et al.* ,2008). Population of Turkey has lower values. Also for Digit span backward test results again female population of Turkey has lower values.

- Comparison of study from New Zealand (Woods *et al.*, 2010) indicates that female in Turkey has lower digit span forward test capacity. But for digit span backward test, these two populations are similar.
- Comparison of female population in Turkey and in Australia shows that the populations are not significantly different for age between 20 and 44 for digit span backward test (Jorm *et al.*, 2004).
- Finally, comparing population of British (Wongupparaja *et al.* ,2017) and Turkey shows that, digit forward scores are similar but at digit backward test results population of Turkey has better results than British population.

6.2.2. Corsi Span Test

- Comparison of female population in Turkey and in China (Chan *et al.*, 2009) for Corsi span forward test shows that the populations are significantly different and population of China has greatly higher response values than female in Turkey Also population of America has slightly higher response values than female in Turkey (Pagulayan *et al.*, 2007).
- Comparison of female population in Turkey and British population (Wongupparaja *et al.*,2017) for Corsi span forward and backward tests shows that the populations are significantly different and British people have greatly higher response values than female in Turkey.
- For the comparable samples Corsi span forward test result of female population of Turkey is significantly different than results of population of Holland percent (Kessels *et al.*, 2008). From age 50 to 80 and more people from Holland have higher responses than this study. For backward version for Corsi test these two populations show different means until age of 81 and more, after that results are not significantly different. The difference range is up to 60.
- Corsi span forward and backward test results of female population of Turkey are similar to Corsi span forward and backward test results of population of Italy (Monaco *et al.* ,2013) for age range 20 – 40 and 81- 90. But for middle age

range between 41 and 80, population of Italy has higher performance than population of Turkey.

6.2.3. Reaction Time Test

- Only Reaction time test for dominant hand version could be compared to the literature.
- Female population of Turkey has similar response values for reaction time dominant hand test to population of Germany (Cinaz *et al.*, 2012).
- Both populations of Scotland and Denmark (Nissan *et al.*, 2013; Jacopsen *et al.*, 2010) have significantly lower mean values than population of Turkey. Since in this test lower mean value indicates higher performance, these two countries have higher performance than Turkey.
- Comparison of female population in Turkey and population in Australia (Jorm *et al.*, 2004) for reaction time dominant hand test shows that the populations are significantly different and population of Australia has greatly higher response values than female in Turkey for age range 20-44. But for older age range 60-64 there is similarity between results.

6.2.4. Purdue Pegboard Test

- For Purdue pegboard both hand part, for the comparable samples of female population of Turkey is significantly different than results of population of China (Chan *et al.*, 2009). Turkey has better results than China.
- Comparison of female population of Turkey and population of Japanese Americans (Mccury *et al.*, 2001) indicates that for both Purdue Pegboard dominant hand test and nondominant hand these two populations are significantly differs for subjects whose age are between 70-79. Population of Turkey has lower performance than Japanese American population. But after age of 80 and more there is not any significant difference.

- Under age of 35, female population of Turkey show similar performance to population of USA (Hamm and Curtis, 1980) for Purdue pegboard dominant hand, nondominant hand and total tests. After age of 35, population of USA shows higher performance than Turkey for all there test parts. Purdue pegboard total test part results for two populations differ significantly, under age of 35 population of Turkey has higher results but over age of 35 population of USA has higher results. Finally for assembly task; under age 35 again population of Turkey has higher results, but after age of 35 two population shows similar results to each other.
- For Purdue pegboard dominant hand part, for the comparable samples of female population of Turkey is significantly different than results of population of Australia (Corti *et al.*, 2017). Australia has better results than Turkey after age of 70. Before that two populations have similar results. For both hand part again until age 70, two populations have similar results after that population f Turkey has better results. Finally for assembly part at all age ranges population of Turkey has higher results than population of Australia.

6.2.5. Raven Test

- Comparison of female population of Turkey and population of China (Hsieh and Tori, 2007) for Raven test results show that the populations have similar results and performance.
- For the comparable samples of female population of Turkey is significantly different than results of population of Sub Saharan Africans (Dutton *et al.*, 2018). Population of Turkey has better results.

6.2.6. Stroop Color Word Test

- For Stroop color word test part I, III and V for the comparable samples of female population of Turkey is significantly different than results of population of

African Americans (Moering *et al.*, 2004) for age range 60 to 71 and more. Population of Turkey has lower mean than population of African Americans. Since at this test lower response value means higher performance it could be said that female population of Turkey has higher performance than population of African Americans for age range 60 to 71 and more for their parts of Stroop color word test.

- Comparison of female population of Turkey and population of Portuguese (Martins *et al.*, 2013) indicates that for Stroop color word test part I, II and V these two population are significantly differs for subjects whose age are between 50 – 65 and more. Only there is an exception for Stroop color word test part I, for low education group (5-9 years) two countries show similar results. But for Stroop color word test part I for higher education group and other test parts (part II and part V) for all education levels two countries' results differ. Population of Turkey has lower mean than population of Portuguese. Since at this test lower response value means higher performance it could be said that female population of Turkey has higher performance than population of Portuguese.
- Also there is a comparison with previous studies of population of Turkey for Stroop color word test. Results from previous study are compared to results from this study. For part I; Results of subjects whose age are between 20-54 years old and education level is between 5 to 8 years are similar for two studies. But results for same age range and education level 9 years and more differs 13.56 percent. Karakaş *et al.* (1999) indicates lower response values and better performance. For age range 55 to 74 years Karakaş *et al.* (1999) indicates lower response values and better performance for both education levels.
- For part II; subjects in this study from age range between 20 -54 years and from low education group (5-9 years) shows lower response values and better performance. But subjects in this study from age range between 20 -54 years and from high education group (9 and more years) shows higher response values so subjects from study of Karakaş *et al.*(1999) show better performance. For age range 55-74 and low education level (5 -9 years) level two studies indicates similar results. However for same age range and high education level (9 and

more years) two studies indicates significantly different results, previous study have lower results and better performance.

- For part III and part IV; for lower education level for age range 20 to 74 years two studies show different results this study indicates lower response values and better performance. For higher education level two studies indicates similar results.
- For part V; for lower education level for age range 20 to 54 years two studies show different results this study indicates lower response values and better performance. At same age range and higher education group two studies indicates similar results. Also for age range between 55 -74 and for both low and high education level two studies show similar results.

7. CONCLUSIONS

The main objection of the study was establishing cognitive and motor capabilities of adult female population of Turkey by using most popular neuropsychological tests. The data is obtained from 251 female participants who live in city of Istanbul and its surrounding areas from different age and education level. These subjects are conducted 6 different tests; Digit Span Test, Corsi Span Test, Raven Test, Reaction Time Test, Stroop Color-Word Test and Purdue Pegboard Test. Effects of independent factors; age, education, smoking habit, marital status and income level; on test performance are examined. Statistical analyses were performed for this purpose. Finally, comparisons were made with some studies on other nationalities in the literature. For adult female population of Turkey, cognitive capacity database consisting of six cognitive test performances is developed. Based on the results of this study the following conclusions can be drawn:

- (i) Estimations of cognitive capabilities and motor functions of adult female population of Turkey were made.
- (ii) Cognitive capacity and motor functions of female population of Turkey in general significantly decreases with age after age of 40. After that, age 40 and 60 interval shows similar results. After age of 60 again it decreases. Also it increases with education until 12 years of education. After that education shows no significant effect on test performances.
- (iii) Marital status and smoking habit show no significant effect of cognitive capacity of participants of this study.
- (iv) Hand preference of subjects effects the results of Reaction time test and Purdue Pegboard dominant and nondominant hand parts; People show better results while they are using their dominant hand.
- (v) According to correlation analysis between 6 test responses; subjects who have higher performance in motor functions test have higher performance for memory, learning and intellectual capacity. Also subjects who have higher performance in intellectual capacity have higher performance for memory and learning tests. And subjects who are better at attention, concentration and speed, also better at memory and learning.

- (vi) When compared to results of other nationalities: normative data for cognitive capacity of female population of Turkey, for memory and learning tests female population of Turkey have similar results with Italy, New Zealand and Australia; lower results than China and Korea. For motor function performance; Turkey is similar to Germany, lower than Australia and Japanese-Americans, and greater than Scotland and Denmark. In concern of attention, concentration and speed female population of Turkey have higher performance than Portuguese and African American population. Finally, for intellectual property test (Raven Test), this study has similar results to population of China and better results than Africans.

7.1.Contributions and Recommendations to Practitioners

The established cognitive capacity and motor functions database through this study can serve as a reference for many applications including cognitive work design, human-technological interaction designs, human-computer interaction and product designs. The data can also be used in clinical practices as reference values.

7.2.Limitations of the Current Study

Current study has the following limitations:

- The subjects participated in this study live in the city of Istanbul and its surrounding areas, although family roots of the participants included every region of Turkey. So, the effects of living environment of the subjects were assumed negligible.
- Subjects younger than 18 years old and older than 92 years old were not considered in this study.

REFERENCES

- Abdi, H. and L.J. , Williams, *Newman-Keuls Test and Tukey Test. Encyclopedia of Research Desig.*, CA: Sage, Thousand Oaks, 2010.
- Anstey, K., A. Macka, S. Li, C. Reglade-Meslin, J. Maller, R. Kumar, K. Dear, S. Eastaerl, and P. Sachder, "Corpus callosum size, reaction time speed and variability in mild cognitive disorders and in a normative sample", *Neuropsychologia*, pp. 1911-1920, 2007.
- Arancivaa, F., M. Casals-Colla, G. Sánchez-Benavide, M. Quintanaa, R.M. Manerob, T. Rognonia, L. Calvoa, R. Palomo, F. Tamayoa, and J. Peñna-Casanovab, "Spanish normative studies in a young adult population (NEURONORMA young adults project): Norms for the Boston Naming Test and the Token Test", *Neurologia* 27 (7), pp. 394-399, 2012.
- Arnsten, "Striatal dopamine transporters correlate with simple reaction time in elderly subjects", *Neurobiology of Aging*, pp. 1237-1246, 2008.
- Bass, N., *The Raven's Coloured Progressive Matrices Test*, Rhodes University, South Africa, 2000.
- Bayard, S., J. Erkes, and C. Moroni, "Victoria Stroop Test: Normative Data in a Sample Group of Older People and the Study of Their Clinical Applications in the Assessment of Inhibition in Alzheimer's Disease", *Clinical Neuropsychology* (26), pp. 653–661, 2011.
- Brown, J. D., "Statistics Corner: Questions and answers about language testing statistics: Point-biserial correlation coefficients", *JLT Testing & Evlution SIG Newsletter* 5 (3) pp. 13-17, 2001.

- Buckner, R. L., M. E. Raichle, F.M., Miezin, and S.E., Petersen, "Functional anatomic studies of memory retrieval for auditory words and visual pictures" , *Journal of Neuroscience* 16(19), pp. 6219-6235, 1996.
- Busch, R., K. Farrell, K. Lisdahl-Medina, and R. Krikorian, "Corsi Block-Tapping Task Performance as a Function of Path Configuration", *Journal of Clinical and Experimental Neuropsychology* (27), pp. 127–134, 2005.
- Cangoz, B., E. Karakoc, and K. Selekler, "Trail Making Test: Normative data for Turkish elderly population by age, sex and education", *Journal of the Neurological Sciences*, pp. 73-78, 2009.
- Carpenter, P. A., M. Just , and P. Shell, "What one intelligence test measures: A theoretical account of the processing in the Raven progressive matrices test", *Psychological Review* (97), pp. 404-431, 1990.
- Casanova, J., S. Quinones-Ubedab, M. Quintana-Apariciob, M. Aguilarc, D. Badenesc, J. Molinuevod, L. Tornerd, *et al.* "Spanish Multicenter Normative Studies (NEURONORMA Project): Norms for Verbal Span, Visuospatial Span, Letter and Number Sequencing, Trail Making Test, and Symbol Digit Modalities Test." *Archives of Clinical Neuropsychology* (24), pp. 321–341, 2009.
- Chan, C., A. Wong, T. Lee, and I. Chi. "Modified automatic teller machine prototype fo r older adults:A case study of participative approach to inclusive design", *Applied Ergonomics* (40), pp. 151-160, 2009.
- Choi, H. , D. Lee, E. Seo, M. Jo, B. Sohn , Y. Choe, M. Byun, *et al.*, "A Normative Study of the Digit Span in an Educationally Diverse Elderly Population", *Korean Neuropsychiatric Association*, pp. 311-315, 2013.
- Cinaz, B., C. Vogt, B. Arnrich, and G. Tröster, "Implementation and evaluation of wearable reaction time tests", *Pervasive and Mobile Computing*, pp. 813-821, 2012.

- Corti, E., A. Johnson, H. Riddle, N. Gasson, R. Kane, and A. Loftus, "The relationship between executive function and fine motor control in young and older adults", *Human Movement Science*, pp. 41-50, 2017.
- Dan, E., and A. Ijeoma, "Statistical analysis methods of detecting outliers in a univariate data in a regression analysis model", *International Journal of Education and Research*, 2013.
- Davidson, D. J., R. T. Zacks, and C. C. Williams, "Stroop Interference, practice and aging", *Aging Neuropsychology and Cognition* (10), pp. 85-98, 2003.
- Dobrea, A., J. Raven, M. Comsa, C. Rusu, and R. Balazsi, "Romanian Standardization Of Raven's Standard Progressive Matrices", *WebPsychEmpiricist*, 2005.
- Dugbartey, A., B. Townes, and R. Mahurin, "Equivalence of the Color Trails Test and Trail Making Test in Nonnative English-Speakers", *Archives of Clinical Neuropsychology*, pp. 425-431, 2000.
- Dutton, E., D. Becker, H. Osman, S. Bakhiet, Y. A. Essa, H. Ali, S. M. Alqafari, A. H. Hamdi, and A. S. Alfaleh, "The Raven's test performance of South Sudanese samples: A validation of criticisms of the utility of Raven's among Sub-Saharan Africans", *Personality and Individual Differences*, pp. 122-126, 2018.
- Eby, D., L. Molnar, A. D. Nation, J. T. Shope, and L. P. Kostyniuk, "Development and Testing of an Assessment Battery for Older Drivers", U.S.A: The University of Michigan Transportation Research Institute, 2006.
- Elst, W., M. Boxtel, G. J. P. Breukelen, and J. Jolles, "The Stroop Color-Word Test: Influence of Age, Sex, and Education; and Normative Data for a Large Sample Across the Adult Age Range", *Assessment* (13), pp. 62-79, 2006.

- Fine, E., J. H. Kramer, L. Lui, and K. Yaffe, "Normative Data in Women Aged 85 and Older: Verbal Fluency, Digit Span, and the CVLT-II Short Form", *The Clinical Neuropsychologist*, pp. 18-30, 2012.
- Gardner, R. A., and M. Broman, "The Purdue Pegboard: Normative data on 1334 school children", *Journal of Clinical Child Psychology*, pp. 156-162, 1979.
- Gastwirth, J. L., Y.R., Gel, and W., Miao, "The Impact of Levene's Test of Equality of Variances on Statistical Theory and Practice", *Statistical Science* (24) 3, pp.343–360, 2009.
- Gentier, I., M. Augustijn, B. Deforche, A. Tanghe, I. Bourdeaudhuij, M. Lenoir, and E. D'Hondt, "A comparative study of performance in simple and choice reaction time tasks between obese and healthy-weight children.", *Research in Developmental Disabilities*, pp. 2635-2641, 2013.
- Golden, C. J., "A Group Version of the Stroop Color and Word Test", *Personality Assessment*, pp. 386-388, 1975.
- Gonzalez, C., "Learning to Make Decisions in Dynamic Environments: Effects of Time Constraints and Cognitive Abilities", *Human Factors: The Journal of the Human Factors and Ergonomics Society*, pp. 449-459, 2004.
- Gonzalez, C., "Task Workload and Cognitive Abilities in Dynamic Decision Making." *Human Factors*, 2005.
- Grigsby, J., K., Kaye, J., Baxter, S.,M., Shetterly and R.F., Hamman, " Executive cognitive abilities and functional status among community-dwelling older persons in the San Luis Valley Health and Aging Study", *J Am Geriatr Soc* , pp.590-600,1998.
- Gunner, J., A. Miele, J. K. Lynch, and R. J. McCaffrey, "Performance of Non-neurological Older Adults on the Wisconsin Card Sorting Test and the Stroop Color–Word Test:

- Normal Variability or Cognitive Impairment?", *Clinical Neuropsychology*, pp. 398-405, 2012.
- Hamm, N., and D. Curtis, "Normative data for Purdue Pegboard on a sample of adult candidates for vocational rehabilitation", *Journal Sage*, pp. 309-310, 1980.
- Hauke, J. and T., Kossowski, "Comparison of Values of Pearson's and Spearman's Correlation Coefficients on The Same Sets of Data", *Quaestiones Geographicae*. 30(2), pp.87-93, 2011.
- Hebb, D., "Distinctive features of learning in the higher animal", *Delafresnaye JF (ed) Brain mechanisms and learning*, pp. 37-46, 1961.
- Hofgren, C. , *Screening of cognitive functions Evaluation of methods and their applicability in neurological rehabilitation*, Institute of Neuroscience and Physiology, the Sahlgrenska Academy at the University of Gothenburg, Göteborg, 2009.
- Howley, S. , S. Prasad, N. Pender, and K. C. Murphy, "Relationship between reaction time, fine motor control, and visual-spatial perception on vigilance and visual-motor tasks in 22q11.2 Deletion Syndrome", *Research in Developmental Disabilities*, pp. 1495-1502, 2012.
- Hsieh, S., and C. Tori, "Normative data on cross-cultural neuropsychological tests obtained from Mandarin-speaking adults across the life span", *Archives of Clinical Neuropsychology* (22), pp. 283-296, 2007.
- Ivnik, R. J., J. F. Malec, G. E. Smith, and E. G. Tangalos, "Neuropsychological test norms above age 55: COWAT, BNT, MAE Token, WRAT-R Reading, AMMART, Stroop, TMT, and JLO", *The Clinical Neuropsychologist* (10), pp. 262-278, 1996.

- Jakobsen, L. H., J. M. Sorensen, I. K. Rask, B. S. Jensen, and J. Kondrup, "Validation of reaction time as a measure of cognitive function and quality of life in healthy subjects and patients", *Nutrition*, pp. 561-570, 2011.
- John, J., F. Lishout, E. Gusareva, and K. Steen, "A robustness study of parametric and non-parametric tests in model-based multifactor dimensionality reduction for epistasis detection", *Bio Data Mining*, April 25, pp. 6-9, 2013.
- Jorm, A. F., K. J. Anstey, H. Christensen, and B. Rodgers, "Gender differences in cognitive abilities: The mediating role of health state and health habits" *Intelligence* (32), pp. 7-23, 2004.
- Karakaş, S., E. Erdoğan, L. Sak, A. Ş. Soysal, T. Ulusoy, and İ. Ulusoy, "Stroop Testi TBAG Formu: Türk Kültürüne Standardizasyon Çalışmaları, Güvenirlik ve Geçerlik", *Klinik Psikiyatri* (2), pp. 75-88, 1999.
- Karakaş, S., *Stroop Testi TBAG Formu Araştırma Geliştirme Çalışmaları ve Kullanım Kılavuzu*, Ayrıntı basım Yayım ve Matbaacılık Ltd. Şti, Ankara, Çankaya, 2011.
- Karakaş, S., A. Yalın, M. Irak, and U. Erzenin, "Digit Span Changes From Puberty to Old Age Under Different Levels of Education", *Developmental Neuropsychology* (22), pp. 423-453, 2002.
- Kayri, M., "The multiple comparison (post-hoc) techniques to determine the difference between groups in researches", *Journal of Social Science*, pp. 51-64, 2009.
- Keith, T., *Multiple regression and beyond*, 4th edition, Pearson, 2006.
- Kessels, R., E. Berg, C. Ruis, and A. Brands, "The Backward Span of the Corsi Block-Tapping Task and Its Association With the WAIS-III Digit Span", *Assessment* (15), pp. 426-434, 2008.

- Kolb, B., and I. Q., Whishaw, *Fundamentals of Human Neuropsychology*, Worth Publishers, New York, 2003.
- Koç, H., and L. Aydos, "Compare the reaction times of Turkish national team wrestlers", *European Journal of Physical Education and Sport Science*, pp. 63-69, 2018.
- Krieg, E., D. W. Chrislip, and J. M. Russo, "A Mathematical Model of Performance on a Simple Reaction Time Test", *Neurotoxicology and Teratology*, pp. 587-593, 1996.
- Larrabee, G., and R. L. Kane, "Reversed digit repetition involves visual and verbal processes", *International Journal of Neuroscience* (30), pp. 11–15, 1986.
- Lee, T., K. Yuen, and C. C. H. Chan, "Normative Data for Neuropsychological Measures of Fluency, Attention, and Memory Measures for Hong Kong Chinese", *Clinical and Experimental Neuropsychology*, pp. 615-632, 2010.
- Letie, J., M. Lourdes, V. A. Satorli, and R. Andreatini, "The Video Recorded Stroop Color Word Test As a New Model Of Experimentally-Incuded Anxiety", *Neuro-Psychopharmacology*, pp. 809-822, 1999.
- Lezak, M. D. , *Neuropsychological assessment (3rd ed.)*. Oxford University Press, New York, 1995.
- Lezak, M. D., D. B. Howieson, and D. W. Loring, *Neuropsychological assessment*, 4th edition, Oxford University Press, New York, 2004.
- Llina`s-Regla, J., J. Vilalta-Franch, S. Lopez-Pousa , L. Calvo-Perxas, and J. Garre-Olmo, "Demographically Adjusted Norms for Catalan Older Adults on the Stroop Color and Word Test", *Archives of Clinical Neuropsychology* (28), pp. 282–296, 2013.
- Ludwig, C., E. Borella, M. Tettamanti, and A. de Ribaupierre, "Adult age differences in the Color Stroop Test: A comparison between an Item-by-item and a Blocked version", *Gerontology and Geriatrics*, pp. 135-142, 2010.

- Lynn, R., and P. Irwing, "Sex differences in mental arithmetic, digit span, and g defined as working memory capacity", *Intelligence*, pp. 226-235, 2008.
- Mackintosh, N., and E.S. Bennett, "What do Raven's Matrices measure? An analysis in terms of sex differences", *Intelligence*, pp. 663-674, 2005.
- Males, J. F., "Neuropsychological Assessment", *Journal of Neurology*, 2009.
- Martins, I., C. Maruta, V. Freitas , and I. Mares, "Executive Performance in Older Portuguese Adults With Low Education", *The Clinical Neuropsychologist* (27), pp. 410–425, 2013.
- McBride, S. E., W. A. Rogers, and A. D. Fisk, "Understanding the effect of workload on automation use for younger and older adults", *Human Factors*, pp. 672-686, 2011.
- Mccurry, S. M., L. E. Gibbons, J. M. Uomoto, M. LouThompson, A. B. Graves, S. D. Edland, J. Bowen, W. C. McCormick, and E. B. Larson, "Neuropsychological test performance in a cognitively intact sample of Japanese American adults", *Clinical Neuropsychology*, pp. 447-459, 2001.
- Michael, W. S., J. Sharit, S. J. Czaja, "Human Factors and Ergonomics Society", *Aging, Motor Control, and the Performance of Computer Mouse Tasks*, 1999.
- Milham, M. P. , "Competition for priority in processing increases prefrontal cortex's", *Cognitive brain research* 17(2), p. 212, 2003.
- Milner, B., "Interhemispheric differences in the localization of psychological processes in man", *British Medical Bulletin* (27), pp. 272–277, 1971.
- Mitrushina, M., K. B. Boone, J. Razani, and L. F. D'Elia, *Handbook of Normative Data for Neuropsychological Assessment*, 2th edition, Oxford Univesity Press, New York, 2005.

- Moering, R. G., J. A. Schinka, J. A. Mortimer, and A. Graves, "Normative data for elderly African Americans for the Stroop Color and Word Test", *Clinical Neuropsychology*, pp. 61-71, 2004.
- Monaco, M., A. Costa, C. Caltagirone, and G. A. Carlesimo, "Forward and backward span for verbal and visuo-spatial data", *Neurol Science*, pp. 749–754, 2012.
- Montgomery, D. C., *Design and analysis of experiments*, 3th edition, John Wiley & Sons, 2005.
- Nissan, J., D. Liewald, and I. J. Deary, "Reaction time and intelligence: Comparing associations based on two response modes", *Intelligence*, pp. 622-630, 2013.
- Nordstokke, D.W. and B.D. , Zumbo, "A New Nonparametric Levene Test for Equal Variances", *Psicológica (31)*, pp. 401-430, 2010.
- O'Brien, M. A., W. A. Rogers, A. D. Fisk, and M. Richman, "Assessing Design Features of Virtual Keyboards for Text Entry", *The Journal of the Human Factors and Ergonomics Society*, pp. 680-698, 2008.
- Ollevent, N. A. , "Tukey Multiple Comparison test, Blackwell Science Ltd", *Journal of Clinical Nursing*, pp. 299-304, 1999.
- Osborne, J. W., and E. Waters, "Four Assumptions Of Multiple Regression That Researchers Should Always Test", *Practical Assessment, Research & Evaluation*, 2002.
- Padilla-Medina, A., J., Prado-Olivarez, N., Amador-Licon, M., Cardona-Torres, L., DeliaGalicia-Resendiz, and J., Diaz-Carmona, "Study on simple reaction and choice times in patients with type I diabetes", *Computers in Biology and Medicine*, pp.368-376, 2013.

- Pagulayan, K. F. , R. M. Busch, K. L. Medina, J. A. Bartok, and R. Krikoria, "Developmental Normative Data for the Corsi Block-Tapping Task", *Journal of Clinical and Experimental Neuropsychology* (28), pp. 1043–1052, 2007.
- Piccardi, L., G. Iaria, M. Ricci, F. Bianchini, L. Zompanti, and C. Guariglia, "Walking in the Corsi test: Which type of memory do you need?", *Neuroscience Letters* (432), pp. 127–131, 2008.
- Postma, A., G. Jager, R. P.C. Kessels, H. Koppeschaar, and J. V. Honk, "Sex differences for selective forms of spatial memory", *Brain and Cognition* (54), pp. 24–34, 2004.
- Rand, G., S. Wapner, H. Werner, and J. H. McFarland, "Age differences in performance on the Stroop-Color Word Test," pp. 535-557, 1963.
- Raven, J., "The Raven's Progressive Matrices: Change and Stability over Culture and Time", *Cognitive Psychology*, pp. 1-48, 2000.
- Raven, J., M., Comsa, C., Rusu, and R., Balazsi, "Romanian Standardization Of Raven's Standard Progressive Matrices", *Web PsychEmpiricist*, pp.113 -126, 2005.
- Rayner, J.C.W. and D.J. , Best, "Extended ANOVA and Rank Transform Procedures. Australian & New Zealand Journal of Statistics", pp.305-319, 2013.
- Razali, N. M., and Y. B. Wah, "Power Comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling Tests", *Journal of Statistical Modeling and Analytics*, 2, pp.21-33, 2011.
- Ritesh, K., and G. Tejas, "Comparative study of simple and choice visual reaction time on medical students of Bhavnagar Region", *International Research Journal of Pharmacy*, pp. 334-335, 2012.
- Rregard, M. *Cognitive rigidity and flexibility: Unpublished Ph.D. dissertatio.*, University of Victoria, British Columbia, 1981.

- Rogers, W. A., and A. D. Fisk, "An analysis of ability-performance relationships as a function of practice and age", *Human Factors and Ergonomics Society*, 1991.
- Rognoni, T., M. Casals-Coll, G. Sánchez-Benavides, M. Quintana, R.M. Manero, L. Calvo, R. Palomo, F. Aranciva, F. Tamayo, and J. Pena-Casanova, "Spanish normative studies in young adults: Norms for Stroop Color—Word Interference and Tower of London-Drexel University tests", *Neurologia*, pp. 73-80, 2013.
- Rushton, P., and J. Cvorovic, "Data on Raven's Standart Progressive Matrices from four Serbian samples", *Personality and Individual Differences*, pp. 483-486, 2009.
- Seo, E. , D. Lee, H. Choo, S. G. Kim, K. W. Kim, J. C. Youn, J. H. Jhoo, and J. I. Woo, "Normative study of the Stroop Color and Word Test in an educationally diverse elderly population", *International Journal of Geriatric Psychiatry* (23), pp. 1020–1027, 2008.
- Shadmehr, A., and S. Amiri, "Design and construction of a computerized based system for reaction time test and anticipation skill estimation", *Journal of Bioscience, Biochemistry and Bioinformatics*, pp. 429-432, 2012.
- Stevens, J., *Applied multivariate statistics for the social sciences*, Routledge, New York: 2009.
- Strauss, E., E. M. S. Sherman, and O. Spreen, *A compendium of neuropsychological tests. Administration, norms, and commentary*, 5th edition, Oxford University Press, New York, 2006.
- Smith, M. W., J., Sharit, and S. J., Czaja, “ Aging, Motor Control, and the Performance of Computer Mouse Tasks”, *Human Factors and Ergonomics Society*, pp. 389-396, 1999.
- Tiffin, J., and E. J. Asher, "The Purdue Pegboard: Norms and studies of reliability and validity", *Applied Psychology*, pp. 234-247, 1948.

- Tomaszewska, M., M. Wilkosc, and A. Borkowska, "Validation and normalisation data for the Stroop, TMT and N-back", pp. 192-303, 2008.
- Villanueva, N., A. Petenate, and M. Silva, "Performance of three affective methods and diagnosis of the ANOVA model", *Food Quality and Preference*, pp. 363-370, 2000.
- Wechsler, D., *Wechsler Adult Intelligence Scale Administration and Scoring Manual. (WAIS®-III)*, Pearson Education, New York, 1997.
- Wongupparaj, P., R. Wongupparaj, V. Kumari, and R. Morris, "The Flynn effect for verbal and visuospatial short-term and working memory : A cross-temporal meta-analysis", *Intelligence*, pp. 71-80, 2017.
- Woods, D., M. Kishiyama, W. Yund, T. Herron, B. Edwards, and O. Poliva, "Improving digit span assessment of short-term verbal memory", *Journal of Clinical and Experimental Neuropsychology*, pp. 101-111, 2010.
- Van Dyck, C. H., R. A., Avery, M. G., MacAvoy, K. L., Marek, D. M., Quinlan, R. M., Baldwin, and A. F., Arnsten, "Striatal dopamine transporters correlate with simple reaction time in elderly subjects", *Neurobiology of Aging*, pp.1237-1246, 2008.
- Yang, C. , C. Kao, T. Cheng, C. Yang, W. Wang, R. Yu, Y. Hsu, and M. Hua, "Cross-cultural Effect on Suboptimal Effort Detection: An Example of the Digit Span Subtest of the WAIS-III in Taiwan", *Archives of Clinical Neuropsychology* (27), pp. 869–878, 2012.
- Yount, R., "Correlation Coefficients." , *In Research Design and Statistical Analysis in Christian Ministry*, 4th edition, pp. 1-10, Fort Worth, Teksas, 2006.
- Yu , M., and C. Gonzalez, "Stopping Decisions: Information Order Effects on Nonfocal Evaluations", *Human Factors: The Journal of the Human Factors and Ergonomics Society*, pp. 732-745, 2013.

Zalonis, I. , F. Christidi, A. Bonakis, Ev. Kararizou, N. I. Triantafyllou, Ge. Paraskevas, E. Kapaki, and D. Vasilopoulos, "The Stroop Effect in Greek Healthy Population: Normative Data for the Stroop Neuropsychological Screening Test", *Archives of Clinical Neuropsychology* (24), pp. 81–88, 2009.

APPENDIX A: FORMS

A.1. Health Survey and Personal Consent Form

A.1.1. Brief Medical History Form

Mark (×) if answer is “yes” only; otherwise leave 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 an 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:

A.1.2. Tıbbi Geçmiş Formu

Cevabınız evet ise (×) işaretleyiniz. Diğerlerini boş bırakabilirsiniz.

	İşitsel bir probleminiz var mı?
	Görme ile ilgili bir sorunuz var mı?
	Renkleri ayırt etme ile ilgili bir sorunuz 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 kullandığımız ilaçları sıralayınız.

Boyunuz ve Kilonuz:

A.1.3. Personal Consent Form

In this thesis study, the aim is to determine the cognitive capacity statistics of Turkish female 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 females in the daily life and industrial life.

If you decided to participate, please take into consideration the issues below.

- 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.
- 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.
- 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 Ece Emirleroglu 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:

A.1.4. Kişisel Onay Formu

Bu tez çalışmasını amacı Türkiye kadın nüfusunun bilişsel kapasitesinin belirlenmesidir. Sizin bu deney çalışmasına katılımınızı olumsuz etkileyecek ciddi bir sağlık sorununuz bulunmamaktadır.

Bu çalışmadan elde edilecek verilerin Türkiye kadın nüfusuna uygun ürünlerin, teknolojik fonksiyonların ve kullanıcı ara yüzlerin tasarımında kullanılması planlanmaktadır.

Katılmaya karar vermeniz durumunda aşağıda belirtilenleri dikkate almanızı rica ediyoruz.

- 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.
- 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.
- 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 Ece Emirleroğlu 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:

A.1.5. Personal Data Form

Participant No:

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	

A.1.6. Kişisel Bilgi Formu

Katılımcı No:

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.2. Test Record Forms

A.2.1. Test Kayıt Formu

The participant sits comfortably in a quiet room.

Katılımcı rahat ve sessiz bir ortamda, oturur pozisyonda olmalı.

The tester should sit opposite to the participant.

Uygulayıcı katılımcının karşısında oturmalı.

Rest breaks can be taken after every 30 minute sessions (or as needed).

30 dakikada bir ara verilebilir. Katılımcıya istediği zaman ara verilebileceği belirtilmeli

Drinking water is made available.

Ortamda su bulundurulmalı

Personal Data form is filled as the first step.

Öncelikle Katılımcı bilgi formu doldurulmalı.

The test starts afterwards.

Ardından Uygulamalara geçilir.

Participant No:	Test Type	Date
	Digit Span Test	/ /
	Corsi Span Test	/ /
	Stroop Color Word Test	/ /
	Purdue Pegboard Test	/ /
	Reaction Time Test	/ /
	Raven Standard Progressive Matrices	/ /

Tester Name:

Test Place:

A.2.2. Digit Span Record Form

Participant 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	

The longest sequence of digits:

A.2.3. Corsi Span Record Form

Participant 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			

The longest length of sequence:

A.2.4. Stroop Color Word Test Record Form

Participant No:

KAYIT FORMU

Adı Soyadı : Uygulayıcının Adı Soyadı :

Doğum Tarihi :/...../..... Uygulama Tarihi :/...../.....

Yaşı : Uygulama Yeri :

Cinsiyeti : Eğitim Düzeyi :

Bölüm I: Siyah Basılmış Renk İsmi Okuma				Bölüm II: Renkli Basılmış Renk İsmi Okuma			
M	S	K	Y	M	S	K	Y
Y	M	S	K	Y	M	S	K
Y	K	M	S	Y	K	M	S
K	Y	S	M	K	Y	S	M
S	K	Y	M	S	K	Y	M
K	M	S	Y	K	M	S	Y

Bölüm III: Şekil Rengi Söyleme				Bölüm IV: Renk İsmi Olmayan Kelime Rengi Söyleme			
Y	M	S	K	Y	M	S	K
S	K	Y	M	S	K	Y	M
M	Y	S	K	M	Y	S	K
M	S	K	Y	M	S	K	Y
K	Y	M	S	K	Y	M	S
S	Y	M	K	S	Y	M	K

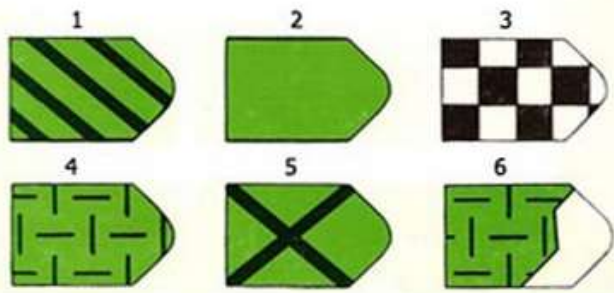
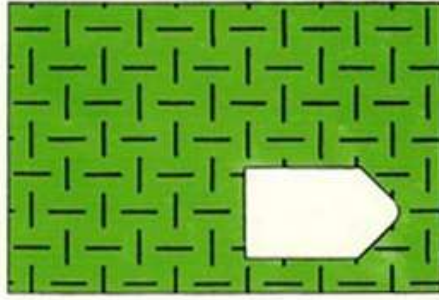
	TOPLAM SÜRE	HATA SAYISI
BÖLÜM I		
BÖLÜM II		
BÖLÜM III		
BÖLÜM IV		
BÖLÜM V		

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

A.2.5. Raven's Standard Progressive Matrices Record Form

Participant No:

“Bu şekilde resmi tamamlayacak olan element aşağıdaki 6 seçenekten hangisidir? “



Number of correct answers:

A.2.6. Purdue Pegboard Record Form

Participant No: _____

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.2.7. Reaction Time Record Form

<http://cognitivefun.net/test/1>

Participant No:

TRIAL	RIGHT HAND	LEFT HAND
1		
2		
3		
4		
5		

Average:

A.2.8. Test Procedures in Turkish

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 dokuz 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 için 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 sonlandırılır. 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 katılımcıları gösterilen sıralamayı tersten tekrar etmesi beklenir. Maksimum 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 geçmelisiniz”

- (i) Kart 1 katılımcıya gösterilir ve bilgi verilir; “Bu karttaki kelimeleri olabildiğince hızlı olarak okumanızı istiyorum, buradan başlayarak devam etmelisiniz. (Uygulayıcı 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.” (Uygulayıcı 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.” (Uygulayıcı eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.) şeklinde bilgi verilir.
- (iv) Dördüncü kart gösterilir ve “Şimdi kartta gördüğünüz kelimelerin yazılı olduğu renkleri söylemenizi istiyorum, olabildiğince hızlı olmalısınız ve buradan

başlayarak devam etmelisiniz.” (Uygulayıcı eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.) 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.” (Uygulayıcı eliyle ilk satırdaki en soldaki ilk kelimeyi gösterir.) Lütfen kelimeleri okumayın, yazılı olduğu mürekkepe 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. Katılımcı istediği eli ile başlar.

- (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 klavyede istediğiniz tuşa basınız.’
- (ii) ‘Her iki el için de 5 deneme yapacağız. Denemeler arasında molaya ihtiyacınız olursa haber verebilirsiniz.’
- (iii) Kullanıcıya ‘Hazır olduğunuzda tuşa 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.

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.

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.

Üçüncü bölümde kullanıcıya aynı talimatlar verilir fakat bu sefer kullanıcıya iki elini kullanarak pimleri dizmesi gerektiği söylenir. Katılımcı iki elini aynı anda kullanmalıdır, iki eliyle aynı anda pimleri almalı ve aynı anda yan yana iki deliğe yerleştirmelidir. Kullanıcı ‘Başla’ talimatı ile başlar ve zamanın dolduğu bildirilince durur. Dizilen pimler sayılır ve kaydedilir.

Dördüncü bölüm gerçek bir test değildir. Bu bölüm ilk üç bölümün toplamından oluşan bir skordur. Beşinci (son) bölüm montaj görevini içerir. Kullanıcıya aşağıdaki talimat verilir: ‘Kaptan baskın elinizle bir pim alın ve istediğiniz 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.’

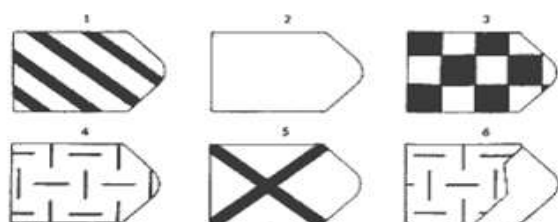
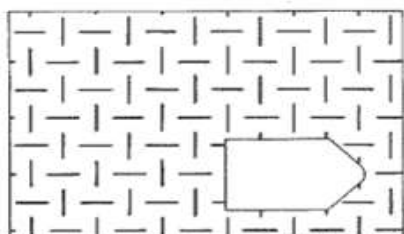
Raven Test Prosedürü:

Kullanıcıya testle ilgili bilgi verilir ve hazır olduğunda teste başlanır. Testteki toplam doğru sayısı test skoru olarak kaydedilir. Kullanıcıya aşağıdaki talimatlar verilir: ‘Bu test 60 soru içermektedir. Her soru çoktan seçmeli olup eksik parçayı bulman istenmektedir. İstedikğin sorudan başlayabilirsin. Testi bitirmek için 40 dakikanız var; zaman dolunca kağıtları gelip sizden alacağım.’

APPENDIX B: QUESTIONS FOR RAVEN TEST

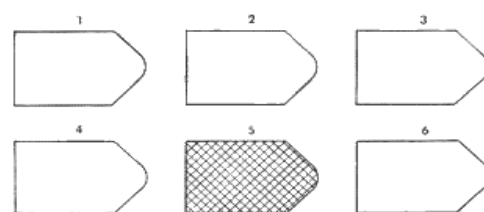
Raven progressive matrices

1



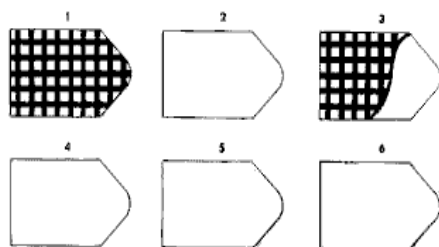
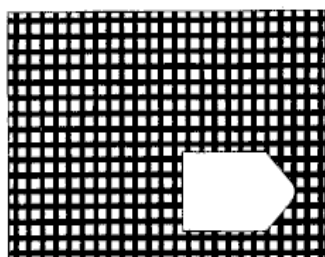
1 2 3 4 5 6

2



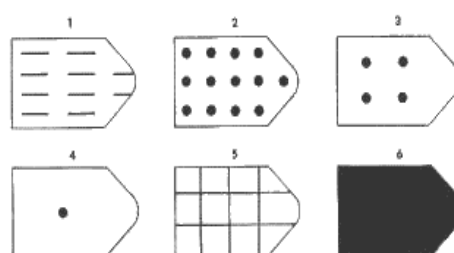
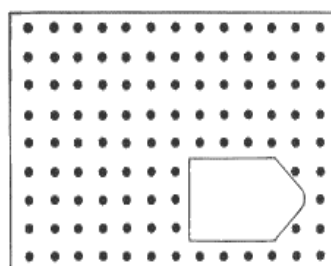
1 2 3 4 5 6

3



1 2 3 4 5 6

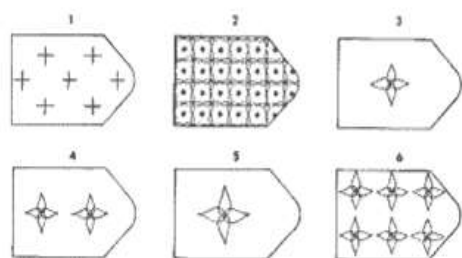
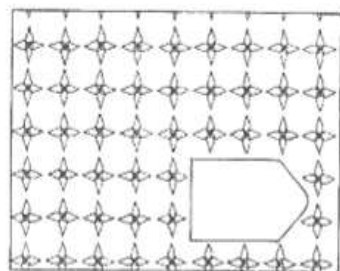
4



1 2 3 4 5 6

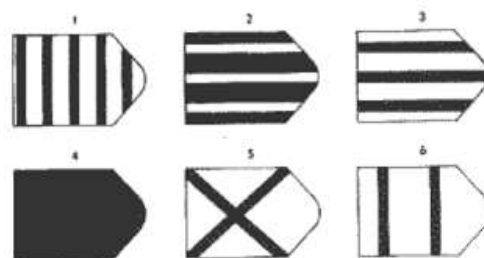
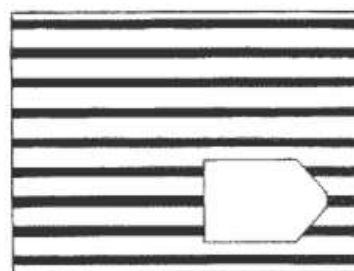
Figure B 1. Questions of Raven Test.

5



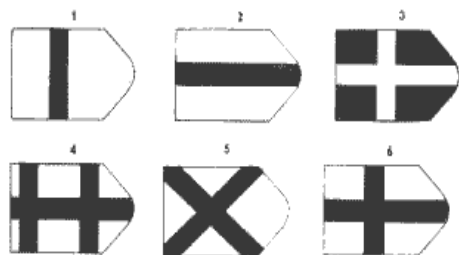
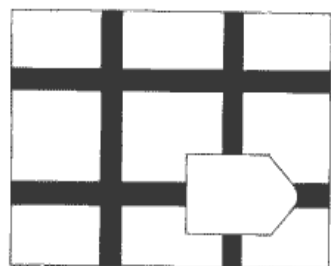
1 2 3 4 5 6

6



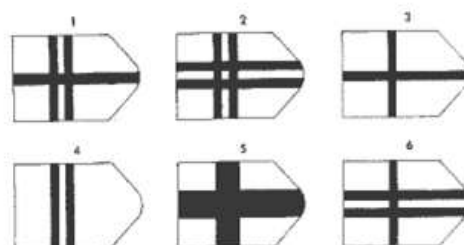
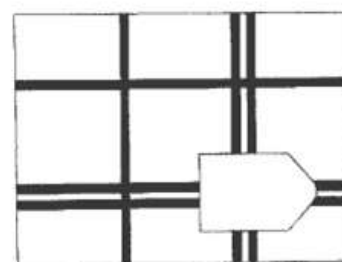
1 2 3 4 5 6

7



1 2 3 4 5 6

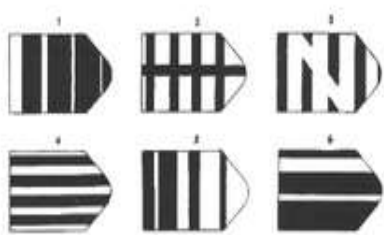
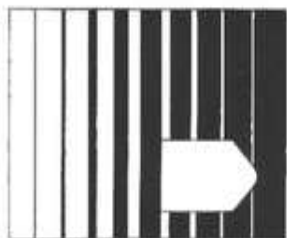
8



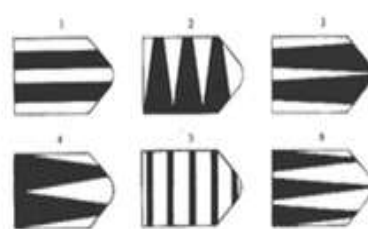
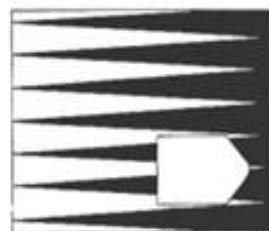
1 2 3 4 5 6

Figure B 2. Questions of Raven Test (cont.).

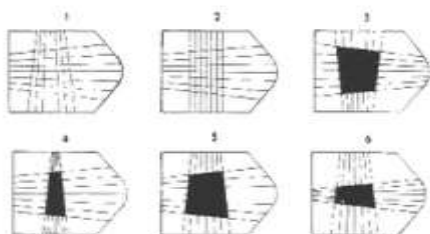
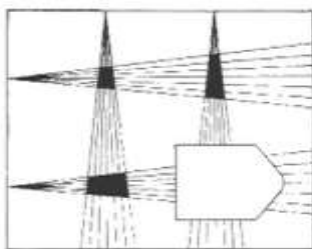
9


 1 2 3 4 5 6

10


 1 2 3 4 5 6

11



12

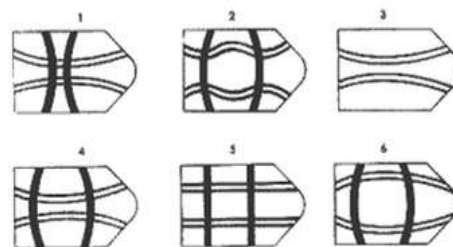
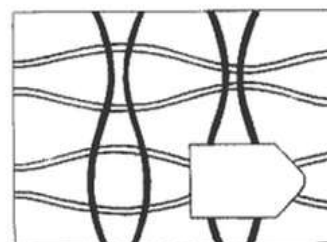
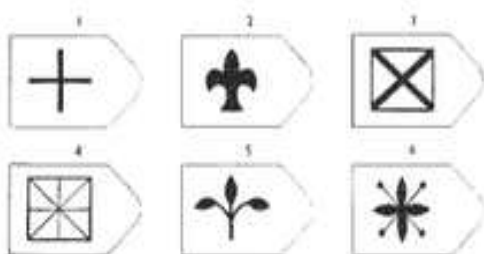
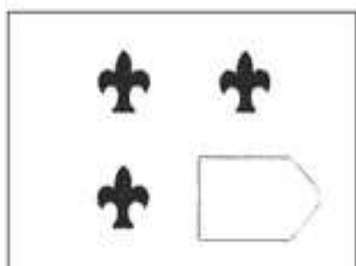
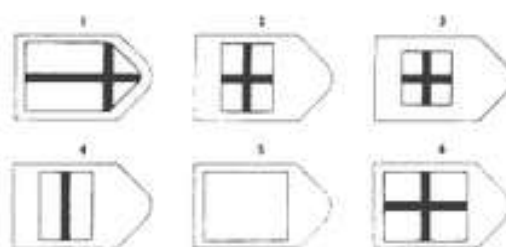
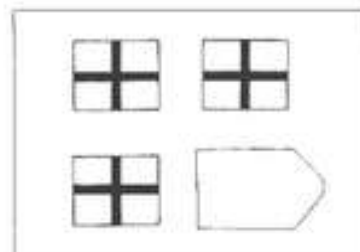


Figure B 3. Questions of Raven Test (cont.).

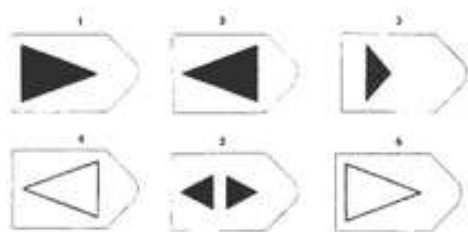
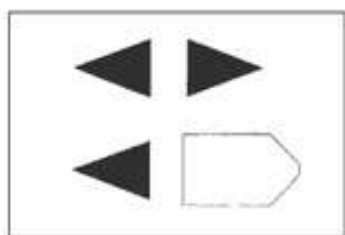
13



14



15



16

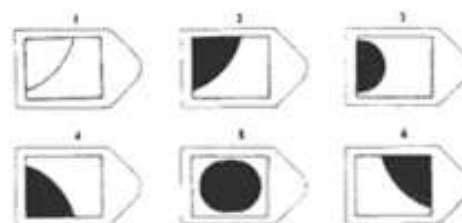
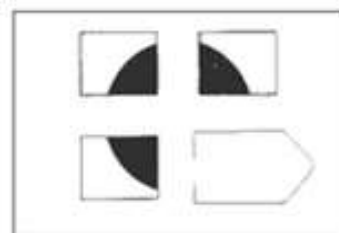
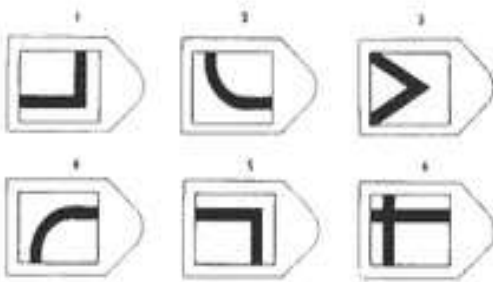
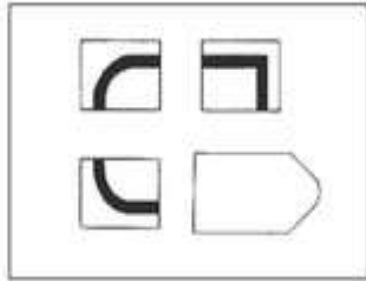
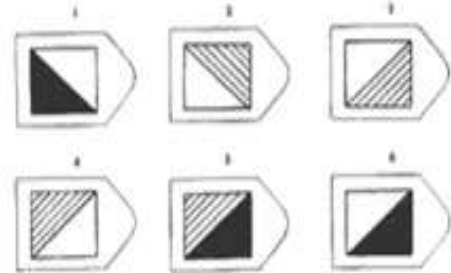
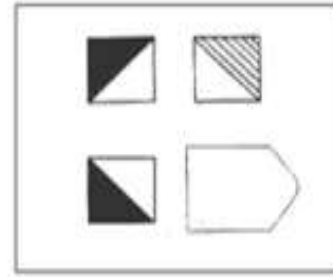


Figure B 4. Questions of Raven Test (cont.).

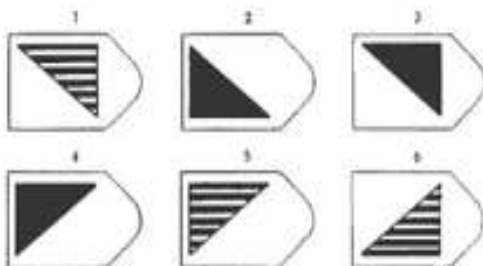
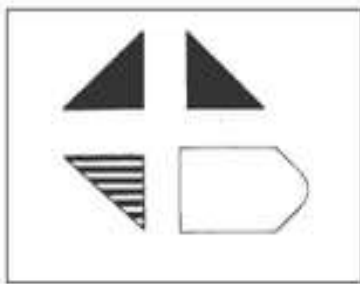
17



18



19



20

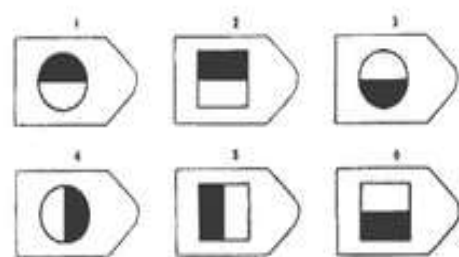
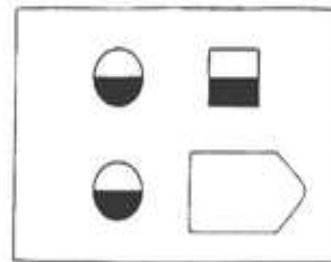
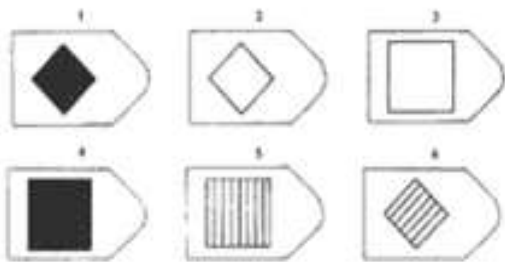
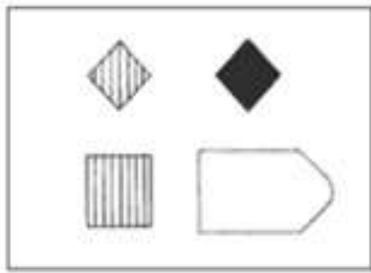
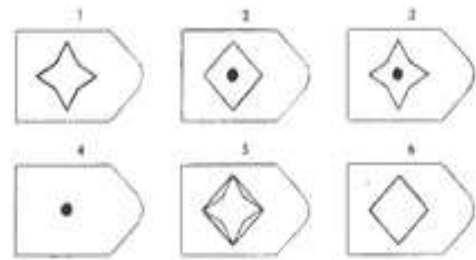
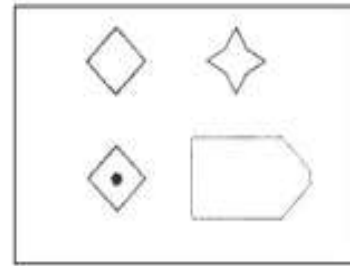


Figure B 5. Questions of Raven Test (cont.).

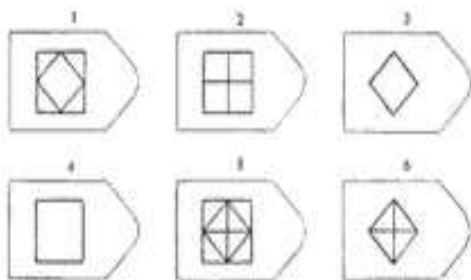
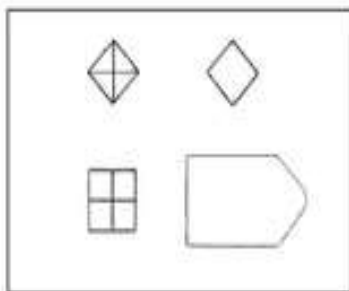
21



22



23



24

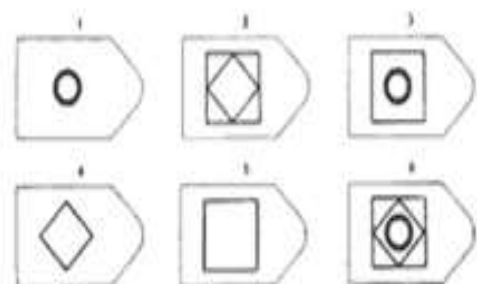
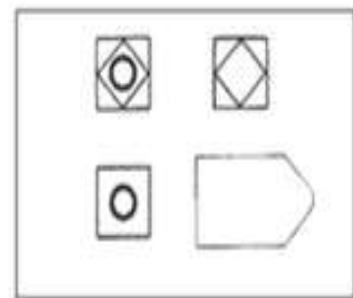
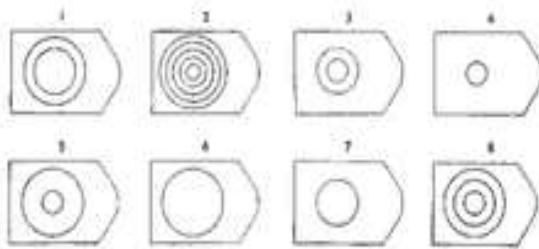
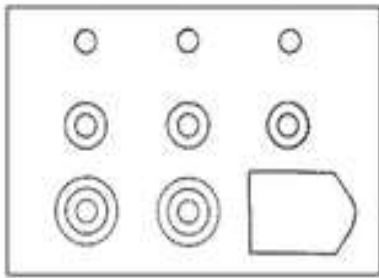
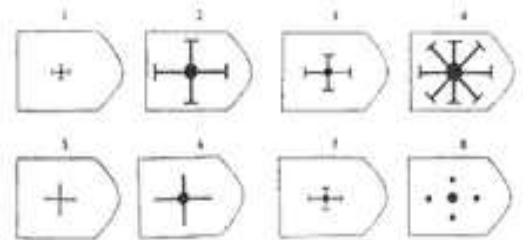
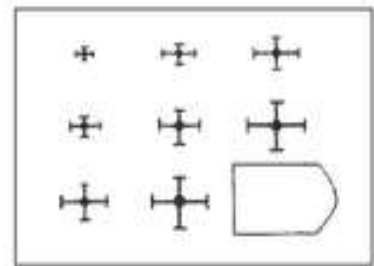


Figure B 6. Questions of Raven Test (cont.).

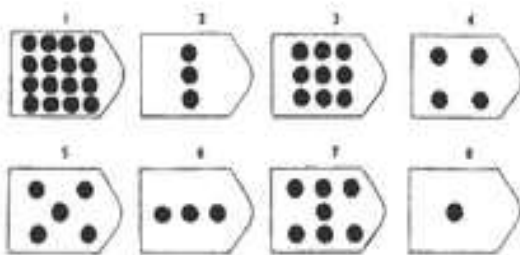
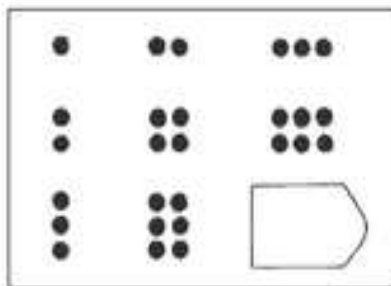
25



26



27



28

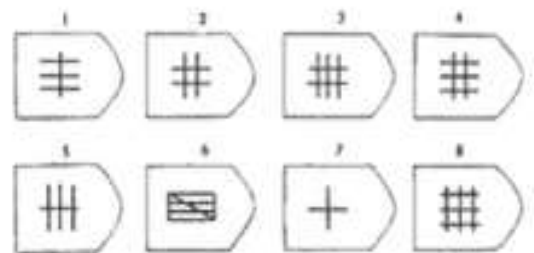
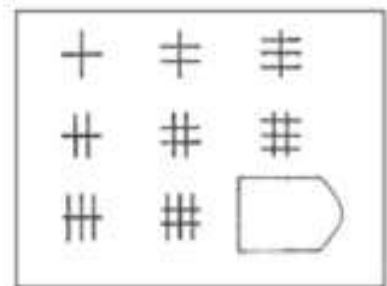
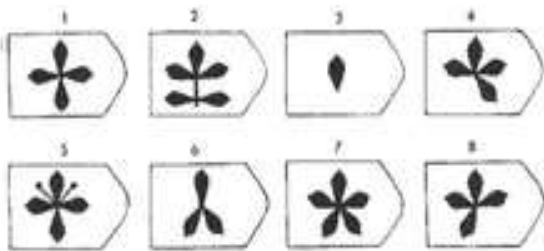
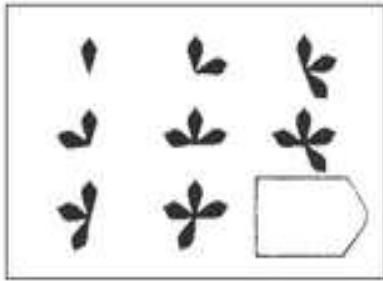
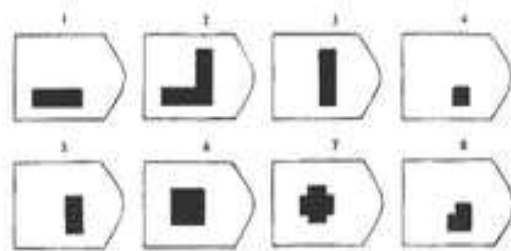
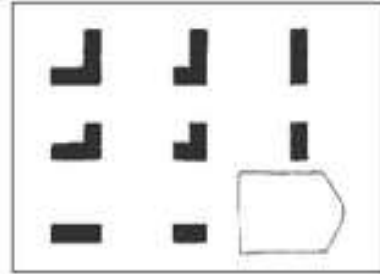


Figure B 7. Questions of Raven Test (cont.).

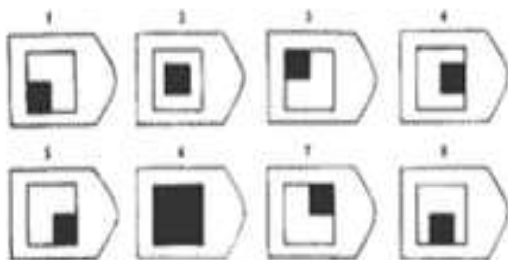
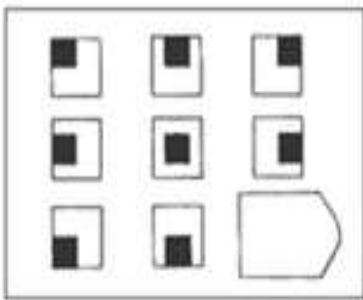
29



30



31



32

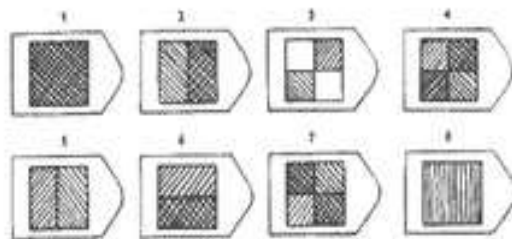
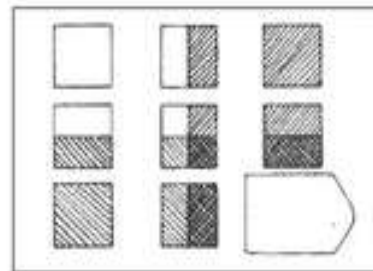
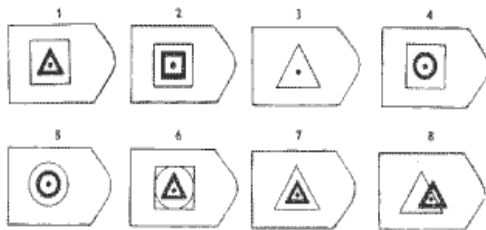
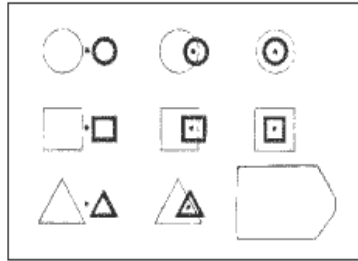
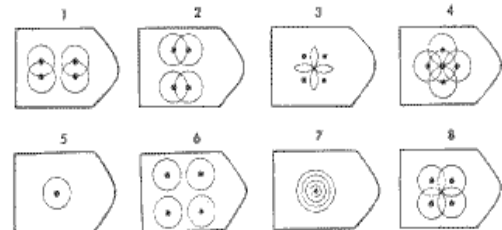
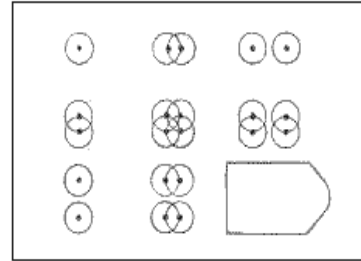


Figure B 8. Questions of Raven Test (cont.).

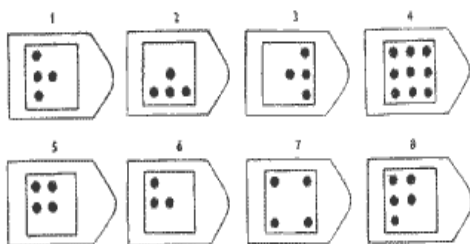
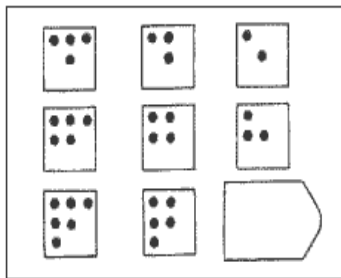
33



34



35



36

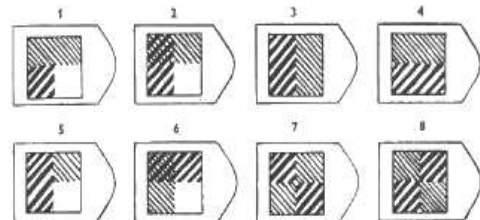
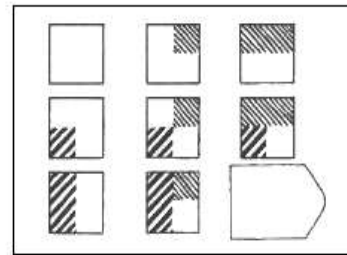
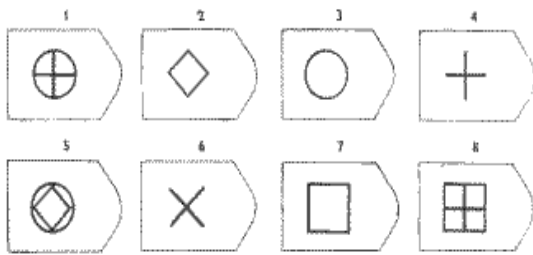
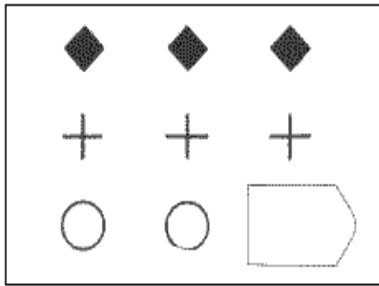
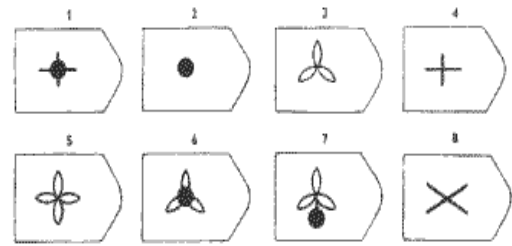
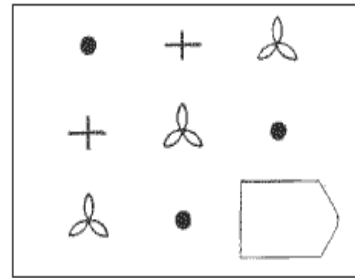


Figure B 9. Questions of Raven Test (cont.).

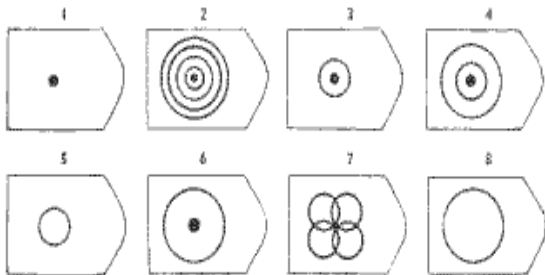
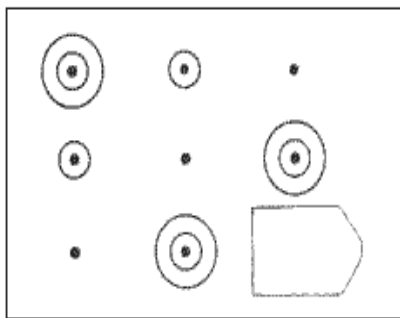
37



38



39



40

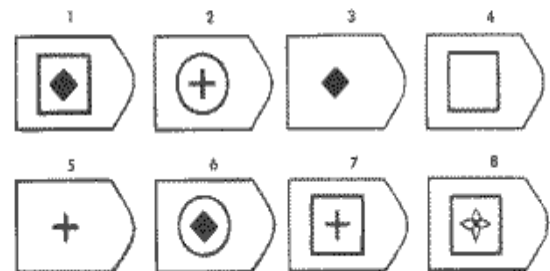
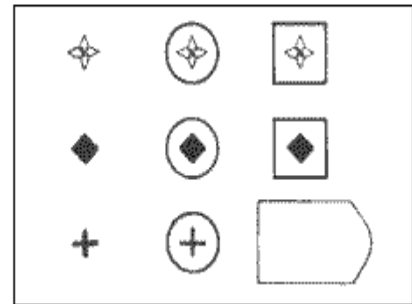
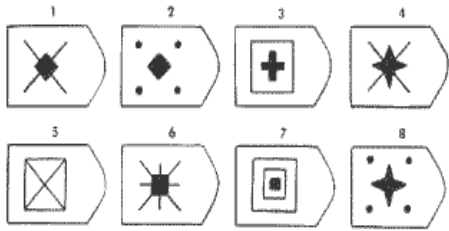
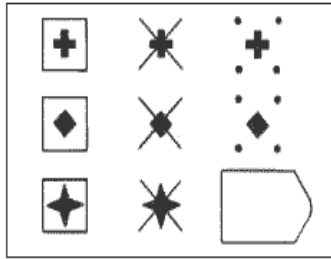
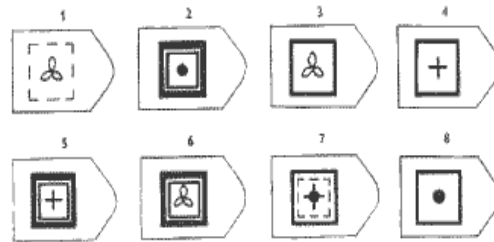
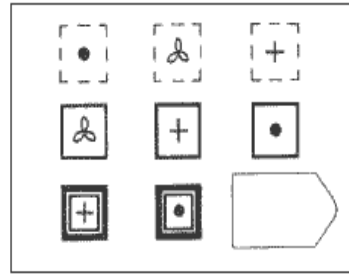


Figure B 10. Questions of Raven Test (cont.).

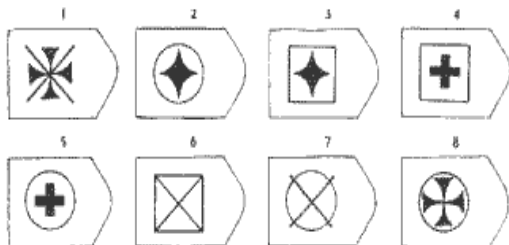
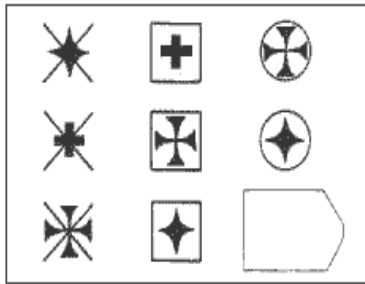
41



42



43



44

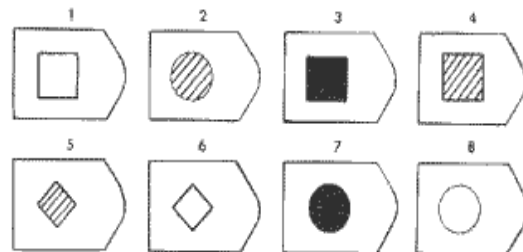
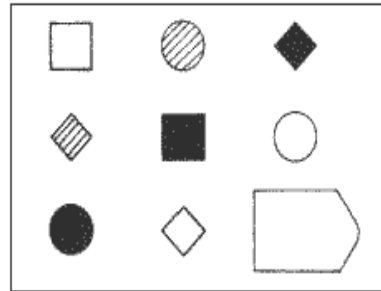
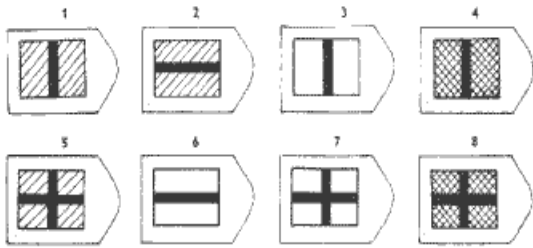
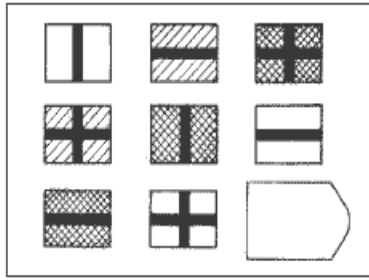
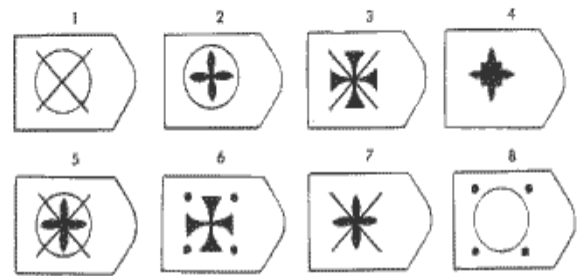
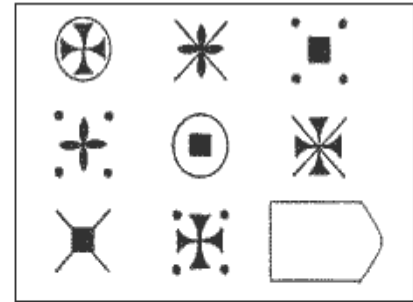


Figure B 11. Questions of Raven Test (cont.).

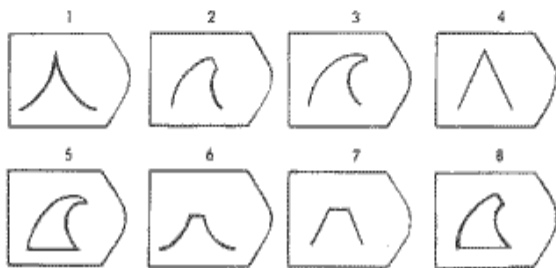
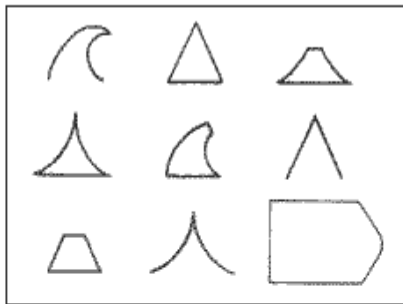
45



46



47



48

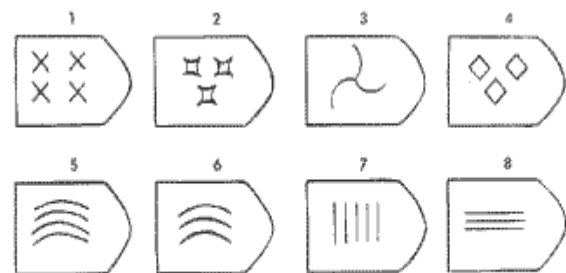
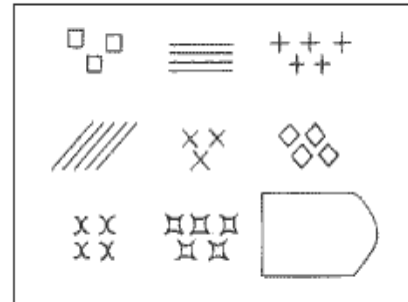
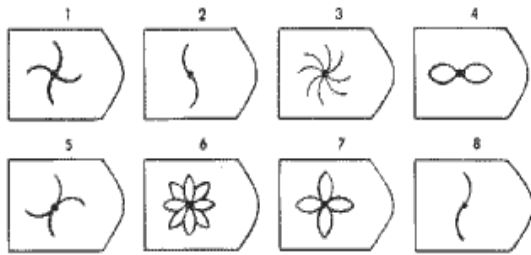
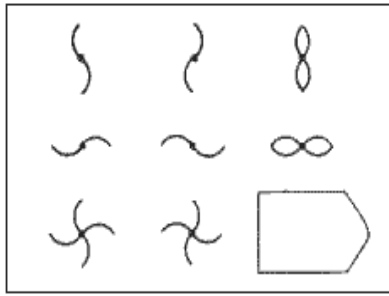
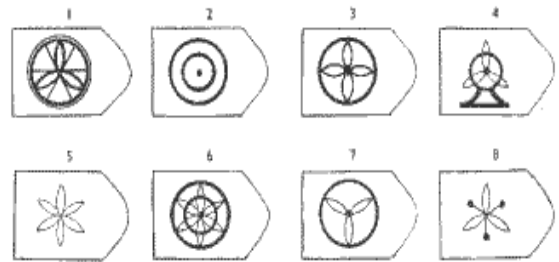
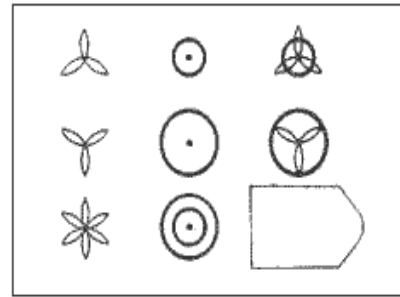


Figure B 12. Questions of Raven Test (cont.).

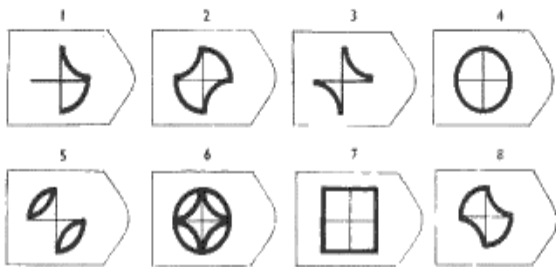
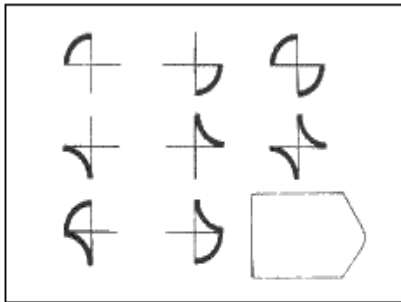
49



50



51



52

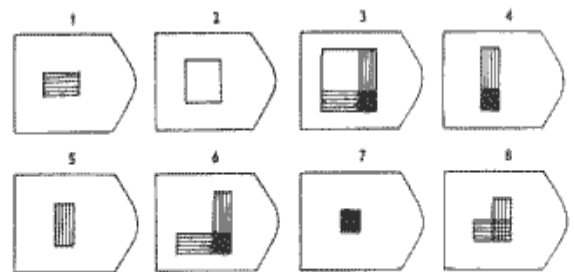
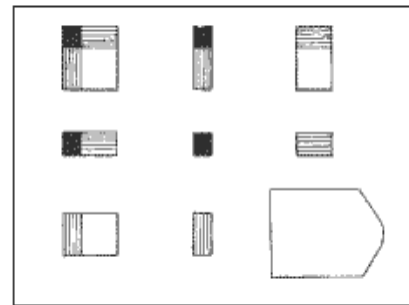
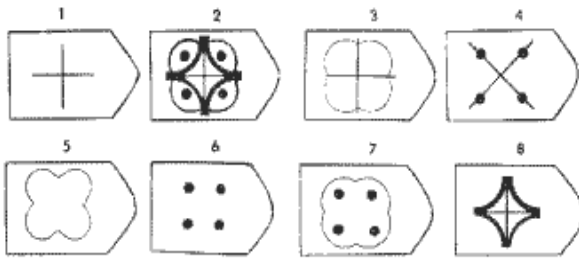
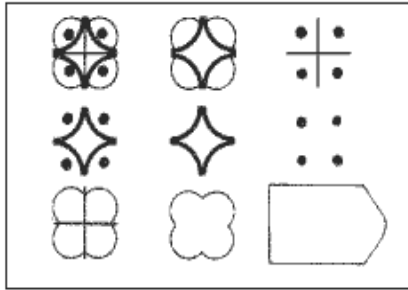
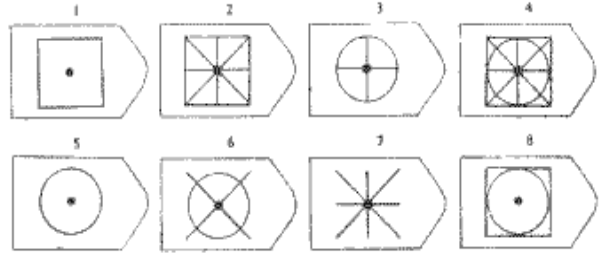
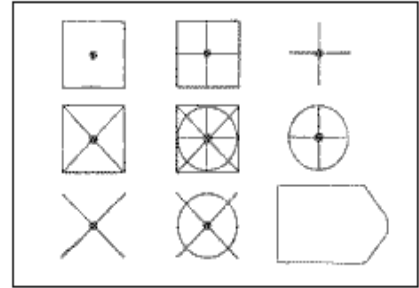


Figure B 13. Questions of Raven Test (cont.).

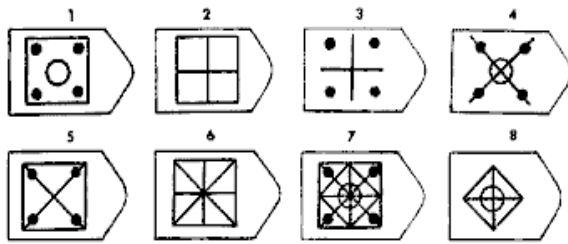
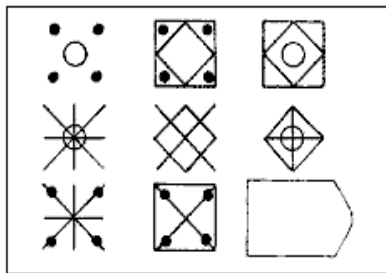
53



54



55



56

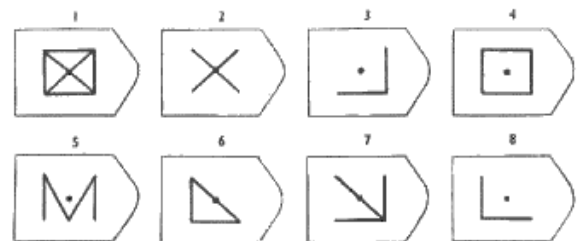
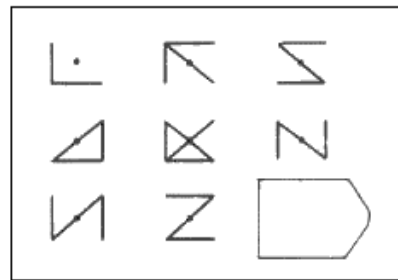
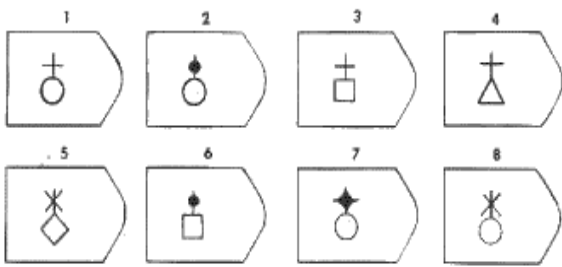
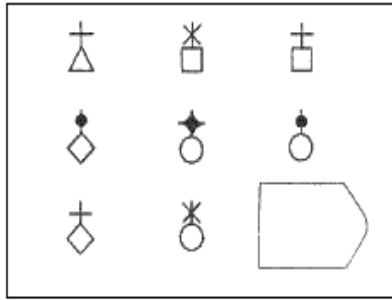
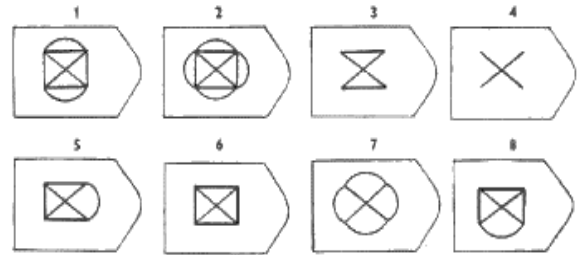
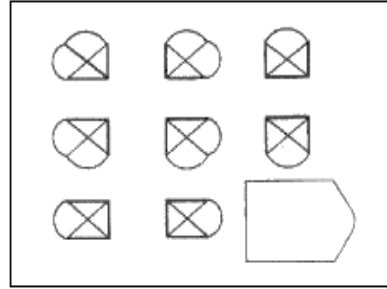


Figure B 14. Questions of Raven Test (cont.).

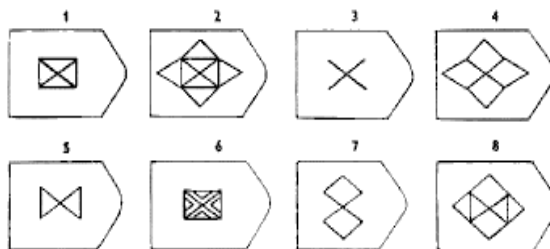
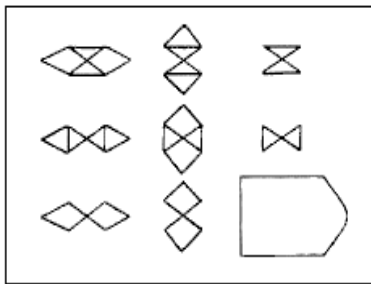
57



58



59



60

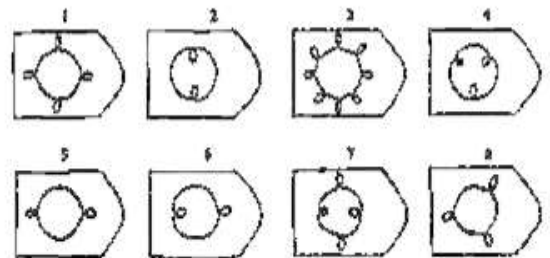
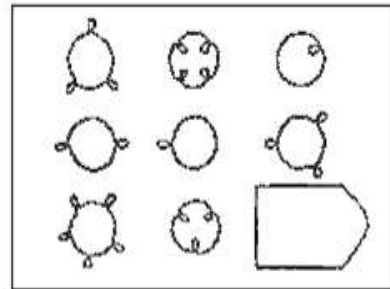


Figure B 15. Questions of Raven Test (cont.).

APPENDIX C: GRAPHS

C.1. Residual plots for Response Variables

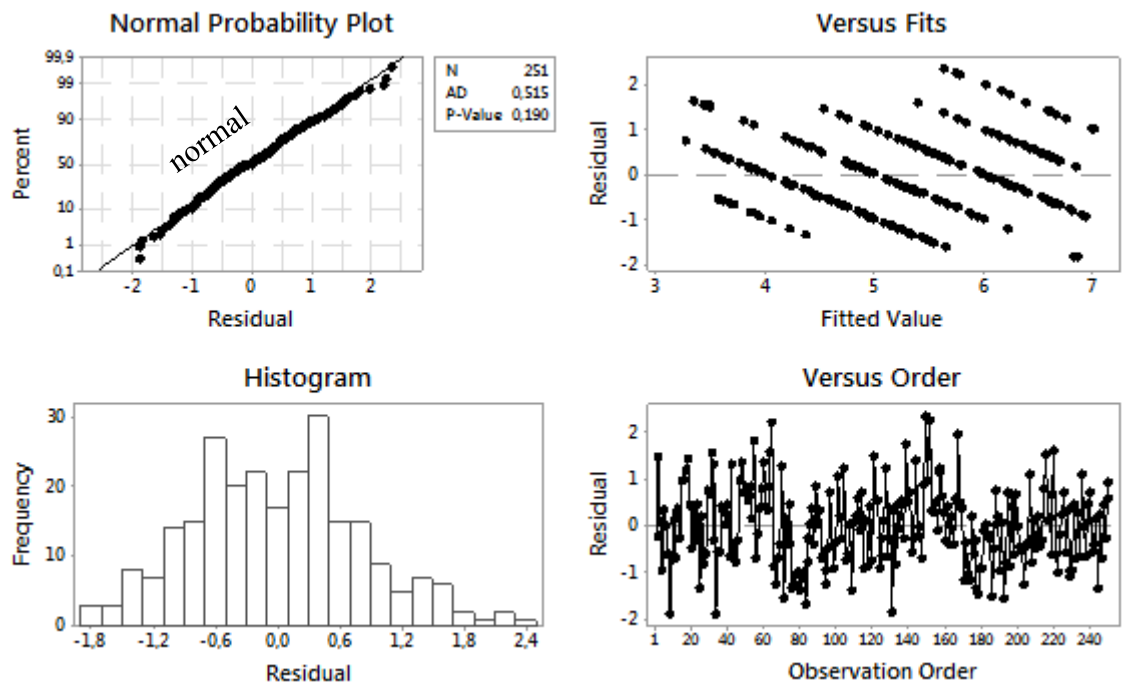


Figure C.1. Residual plots for Digit forward result.

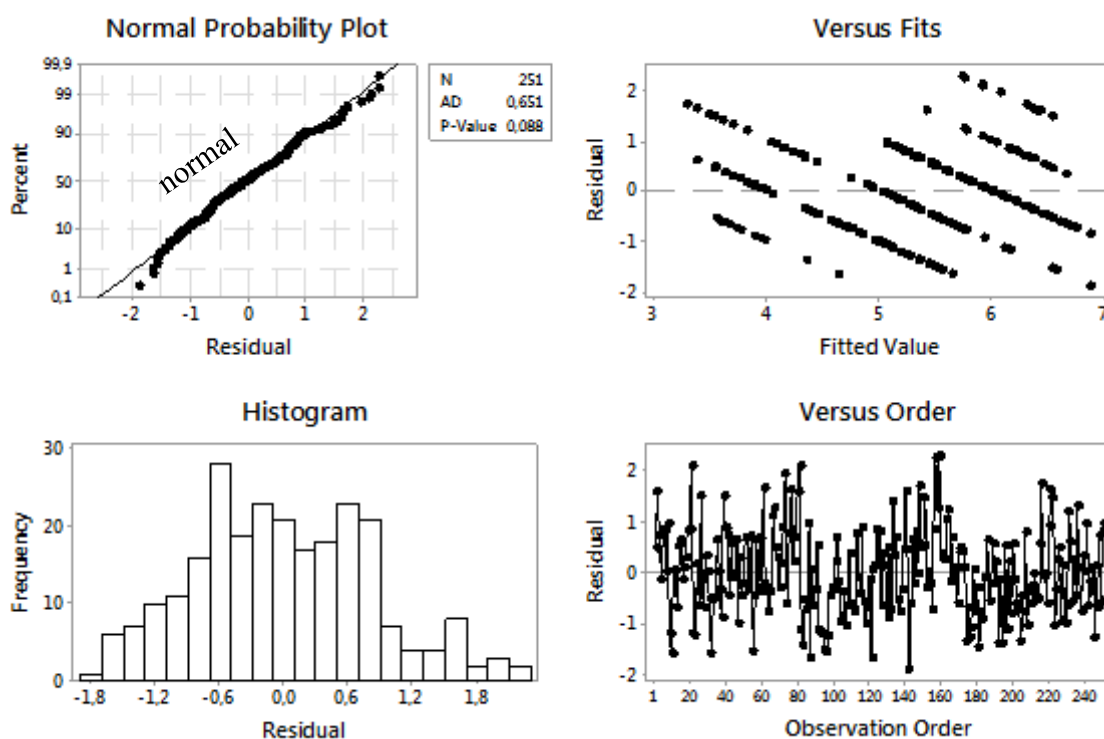


Figure C.2. Residual plots for Digit backward result.

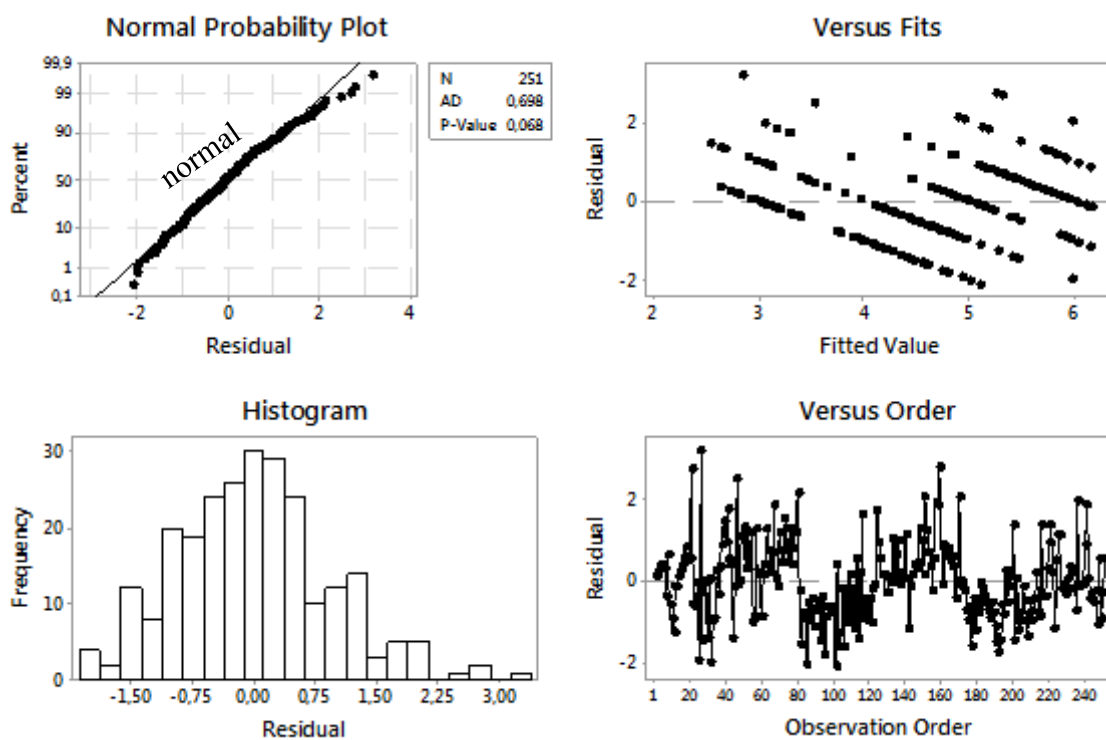


Figure C.3. Residual plots for Corsi forward result.

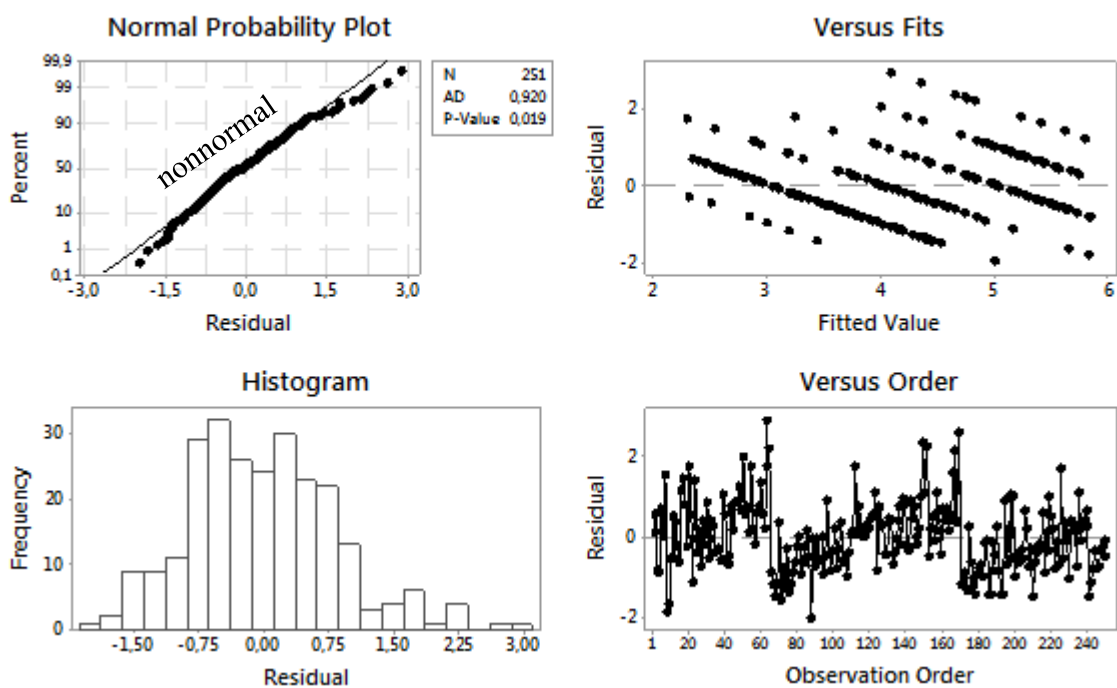


Figure C.4. Residual plots for Corsi backward result.

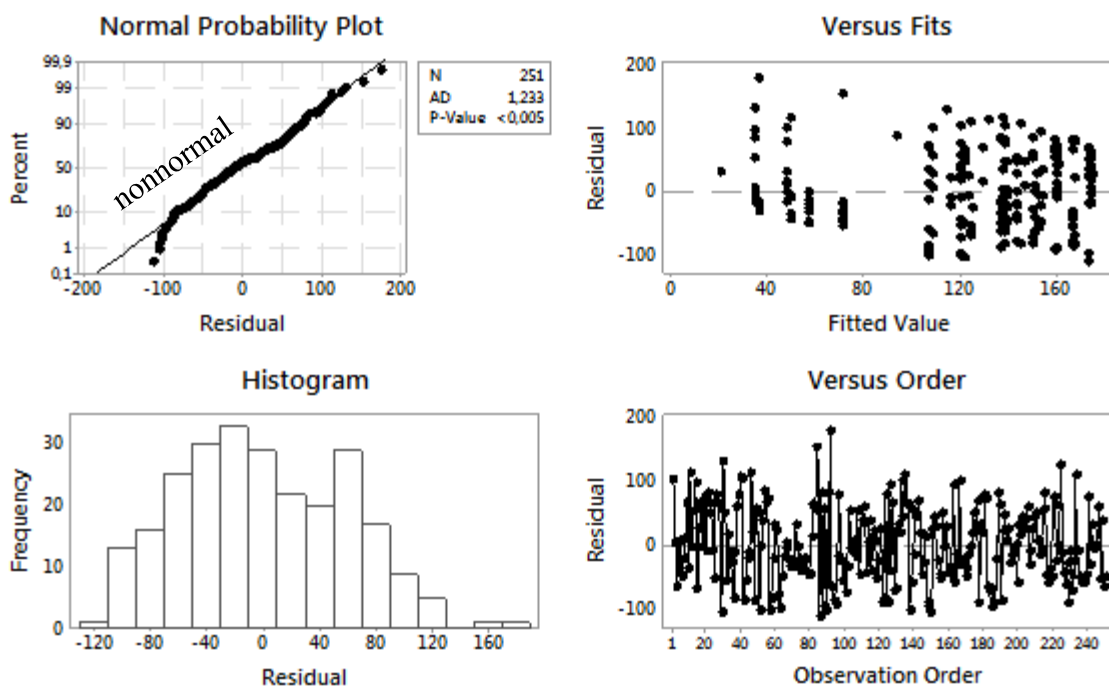


Figure C.5. Residual plots for Reaction time dominant hand result.

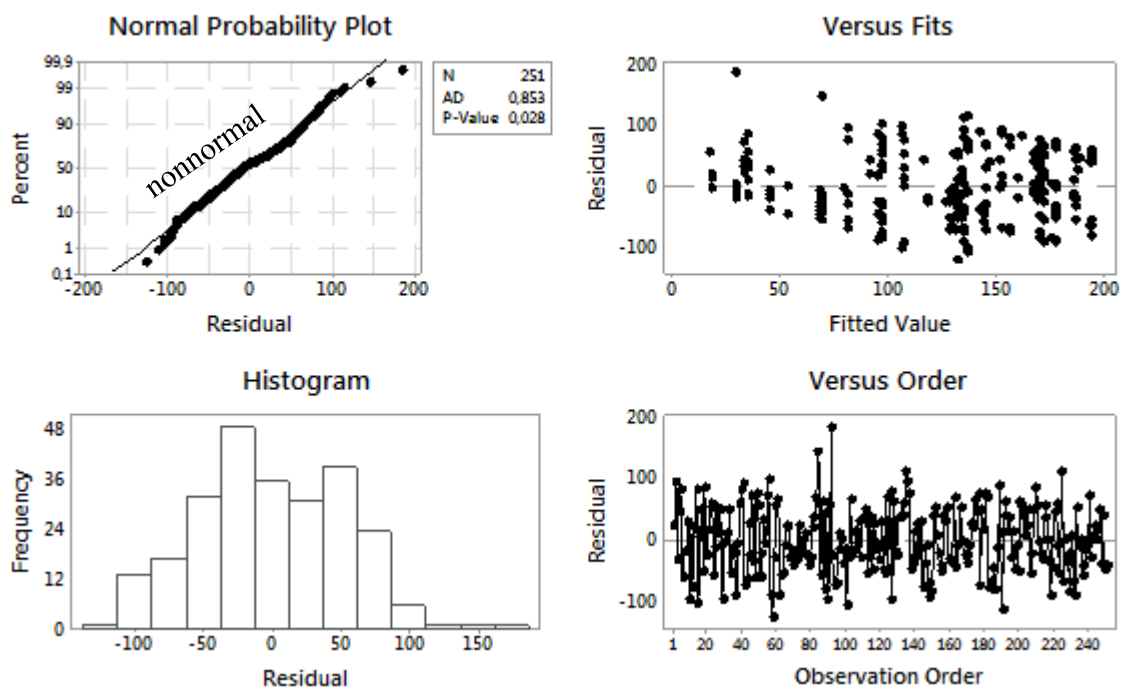


Figure C.6. Residual plots for Reaction time nondominant hand result.

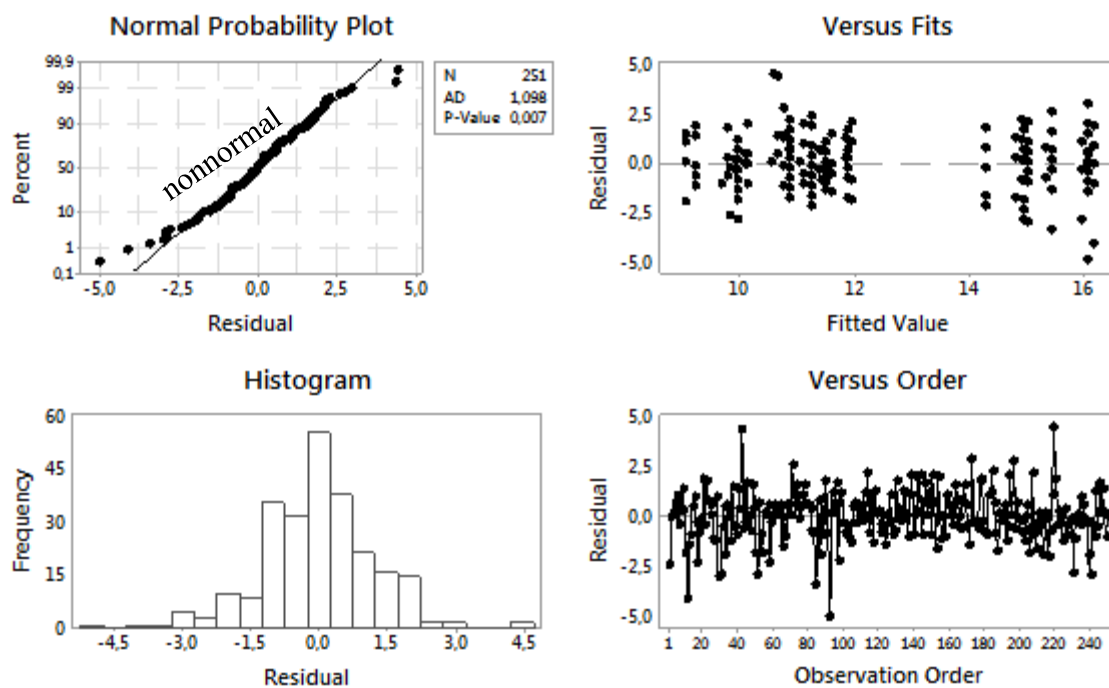


Figure C.7. Residual plots for Purdue Pegboard dominant hand result.

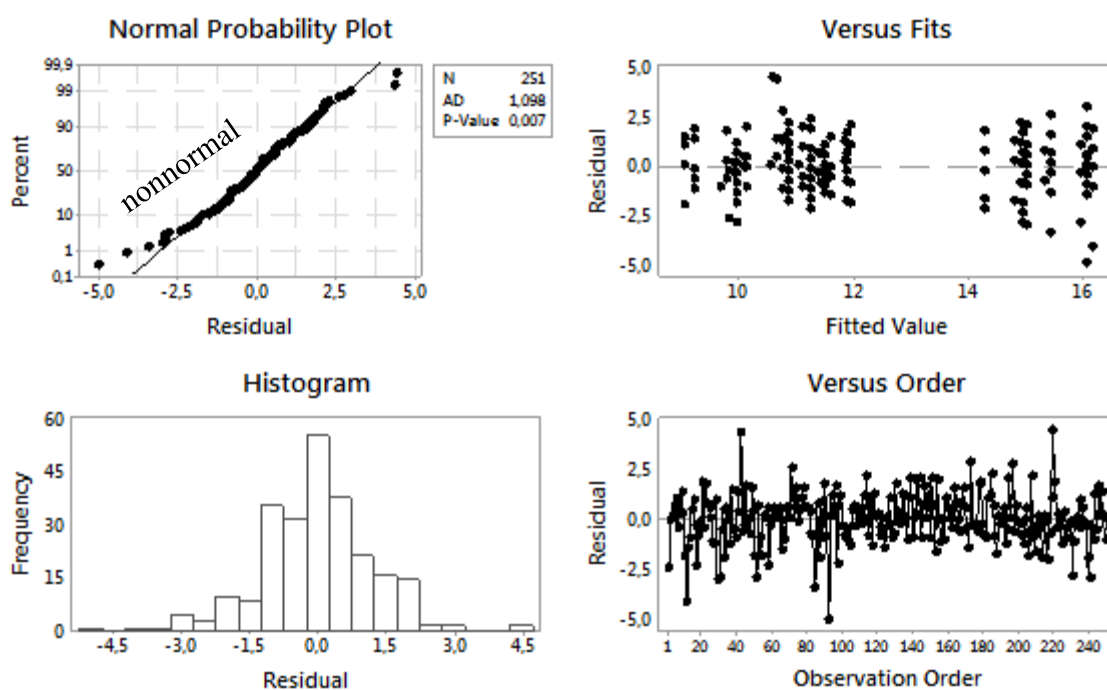


Figure C.8. Residual plots for Purdue Pegboard nondominant hand result.

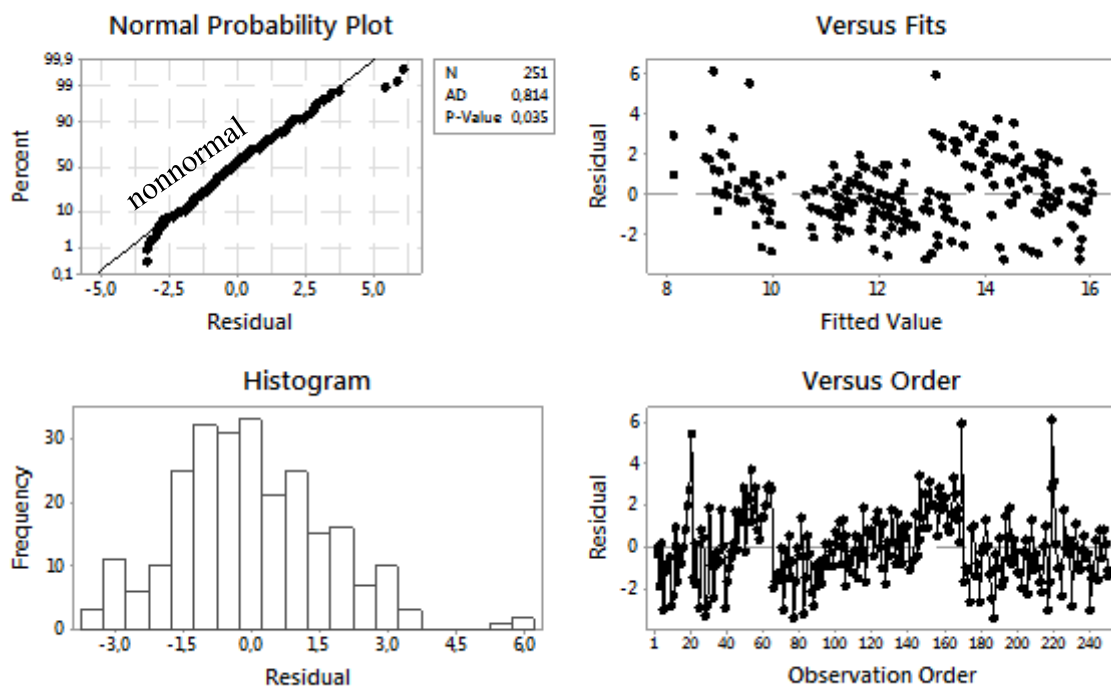


Figure C.9. Residual plots for Purdue Pegboard both hand result.

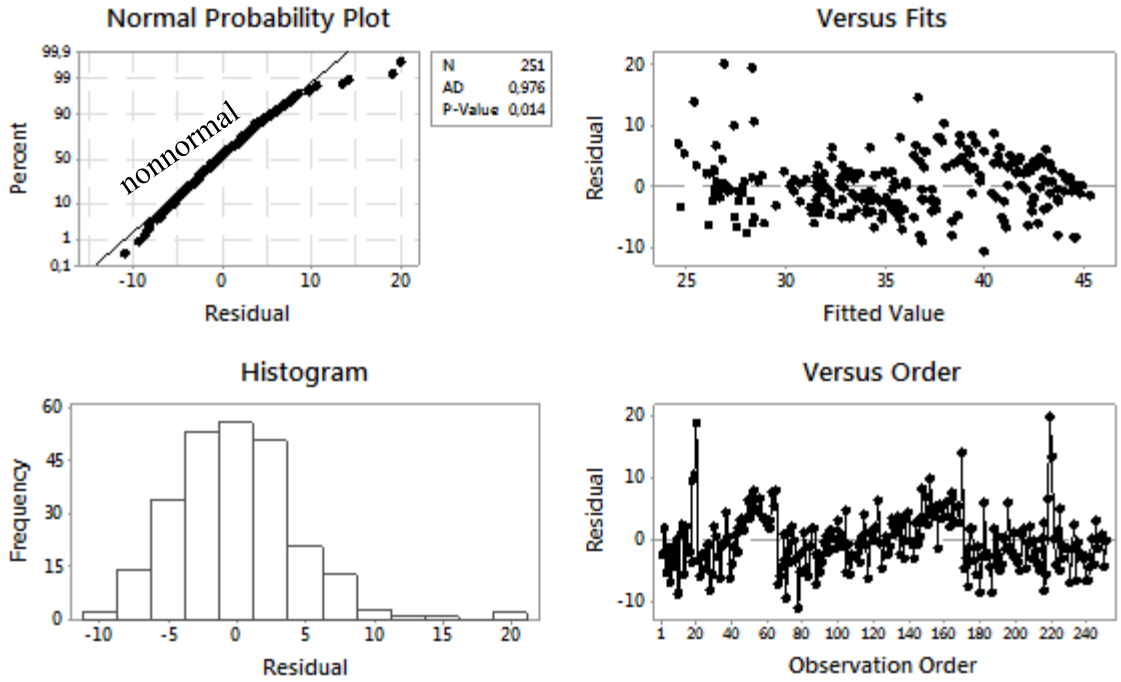


Figure C.10. Residual plots for Purdue Pegboard total result.

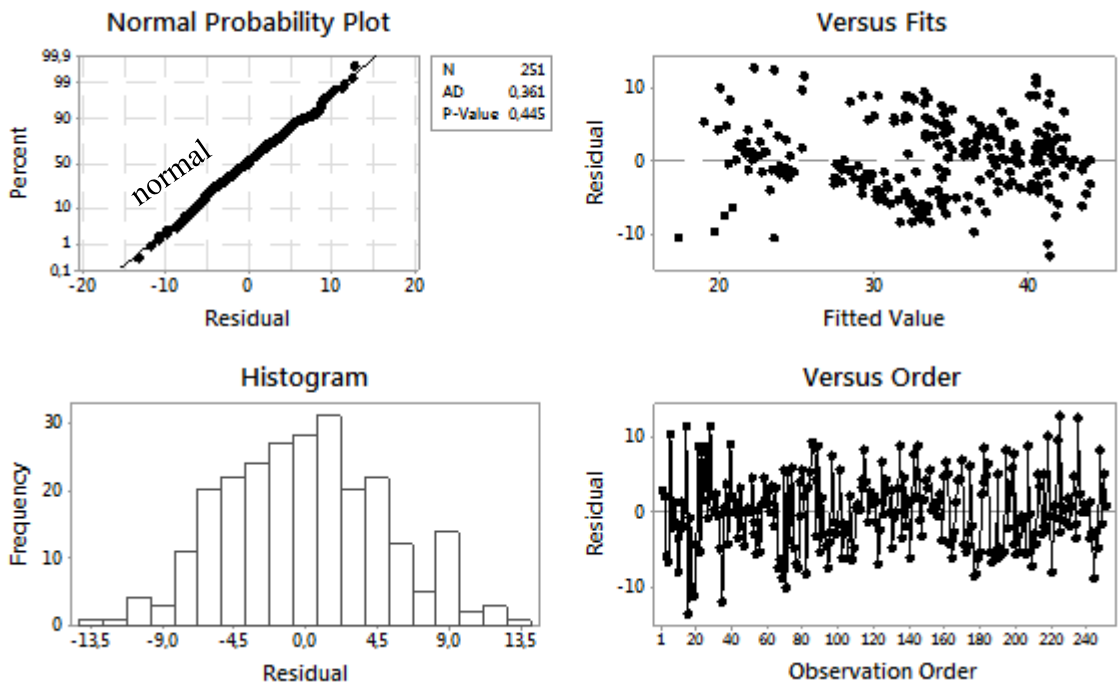


Figure C.11. Residual plots for Purdue Pegboard assembly result.

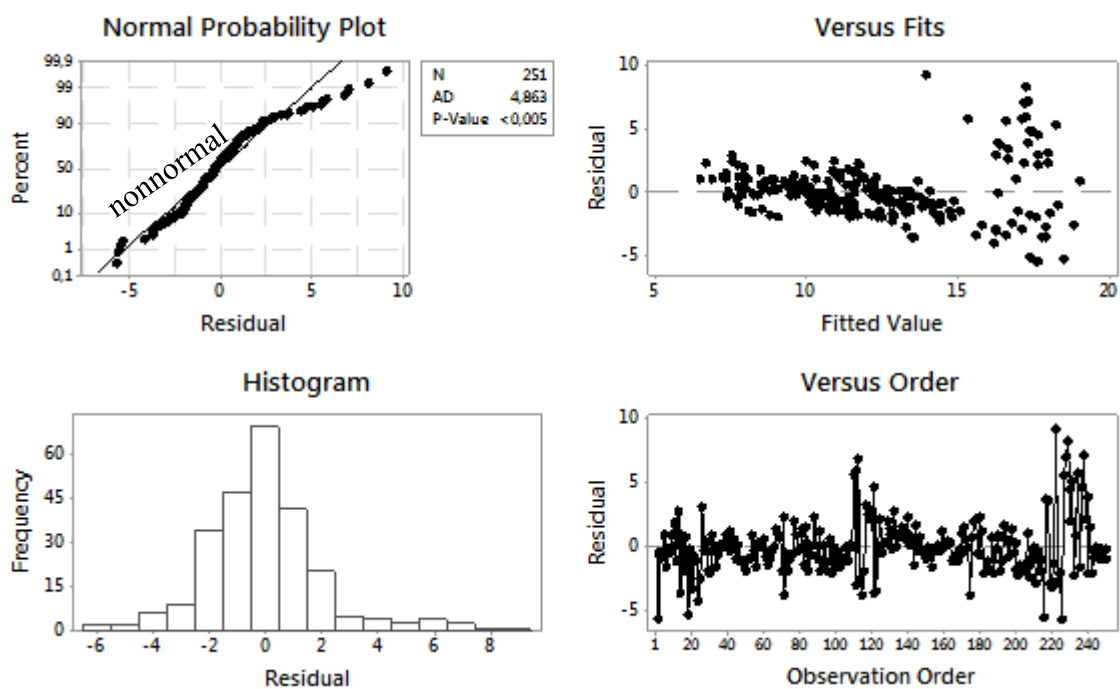


Figure C.12. Residual plots for Stroop Color part I result.

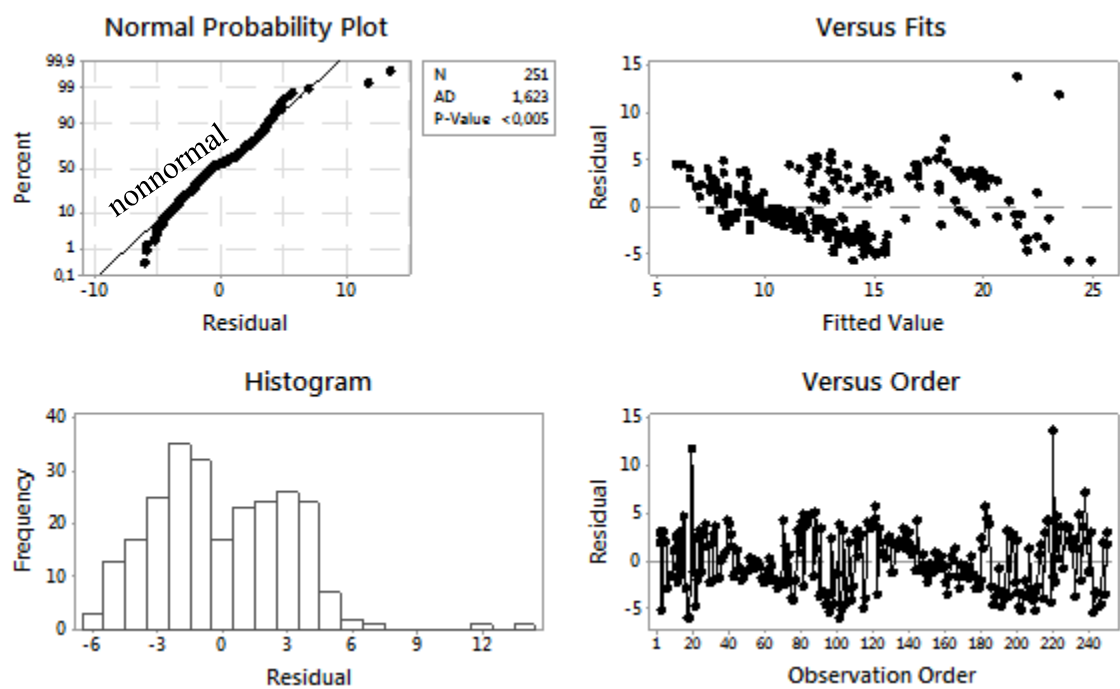


Figure C.13. Residual plots for Stroop Color part II result.

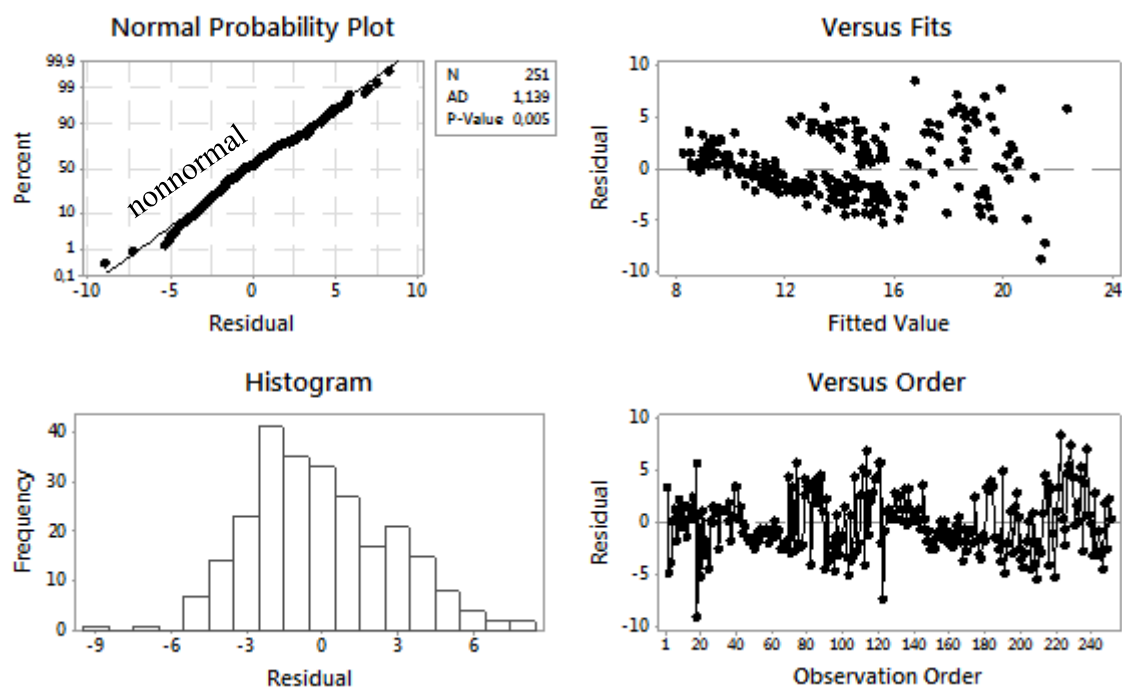


Figure C.14. Residual plots for Stroop Color part III result.

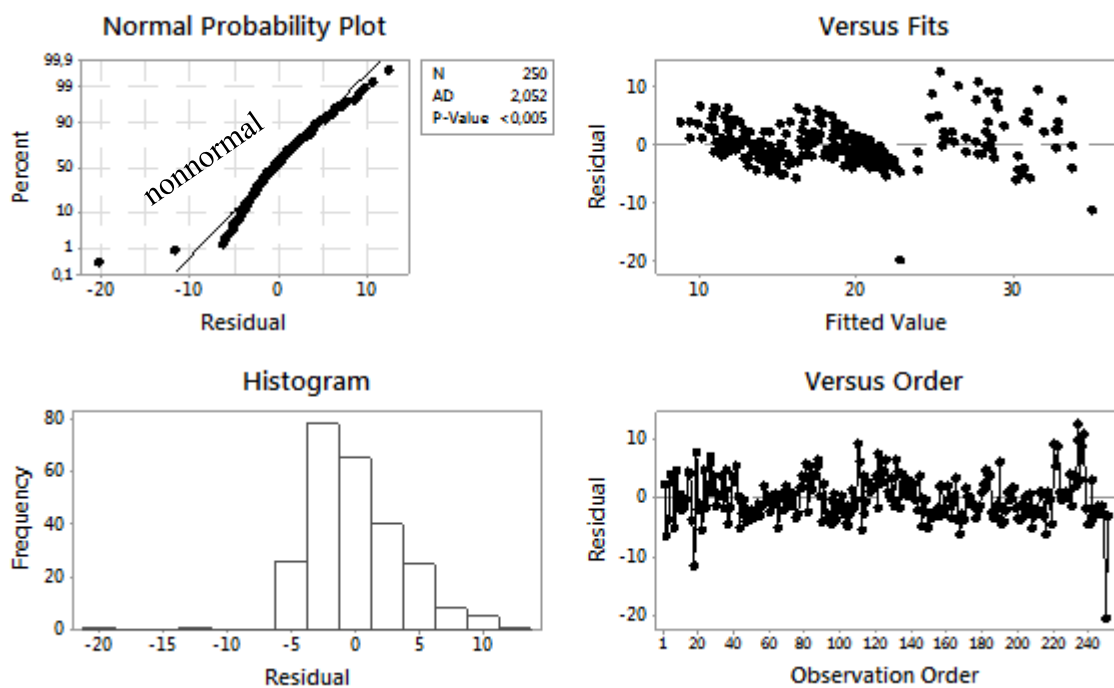


Figure C.15. Residual plots for Stroop Color part IV result.

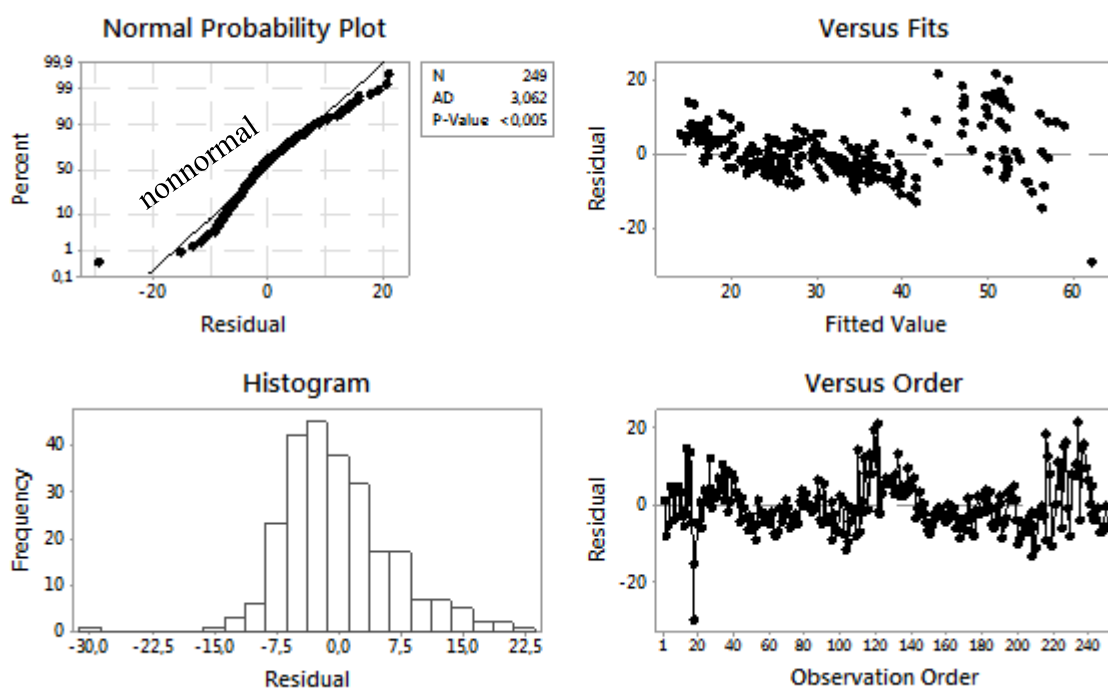


Figure C.16. Residual plots for Stroop Color part V result.

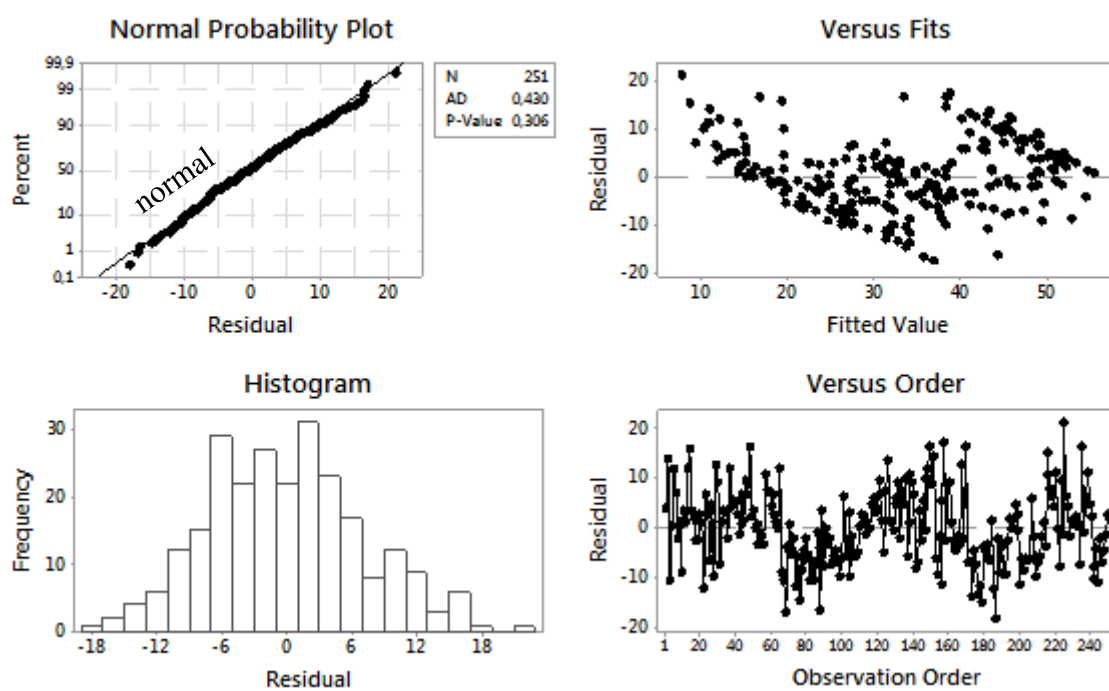


Figure C.17. Residual plots for Raven test result.

C.2. Scatter Plots of Response Variables

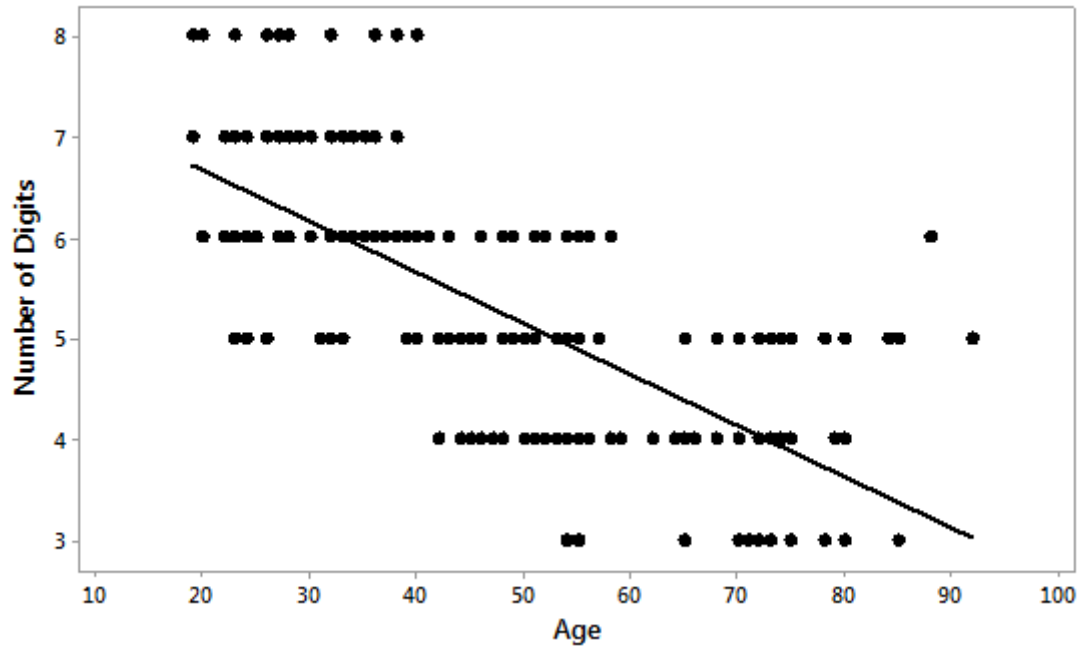


Figure C.18. Scatter plot of Digit Span forward test vs age factor.

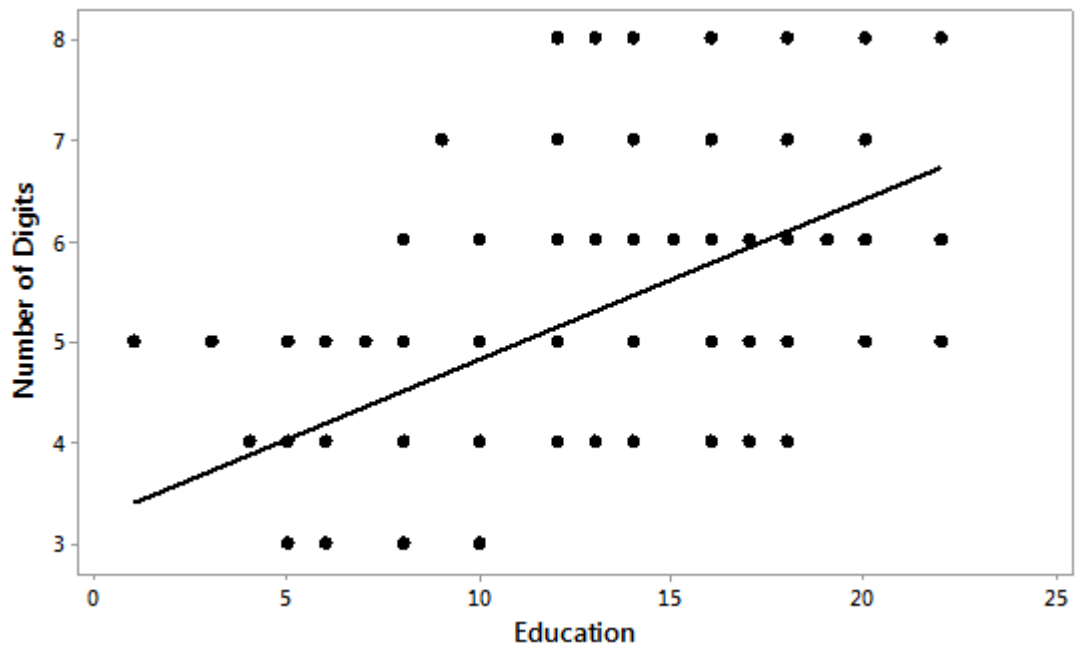


Figure C.19. Scatter plot of Digit Span forward test vs education factor.

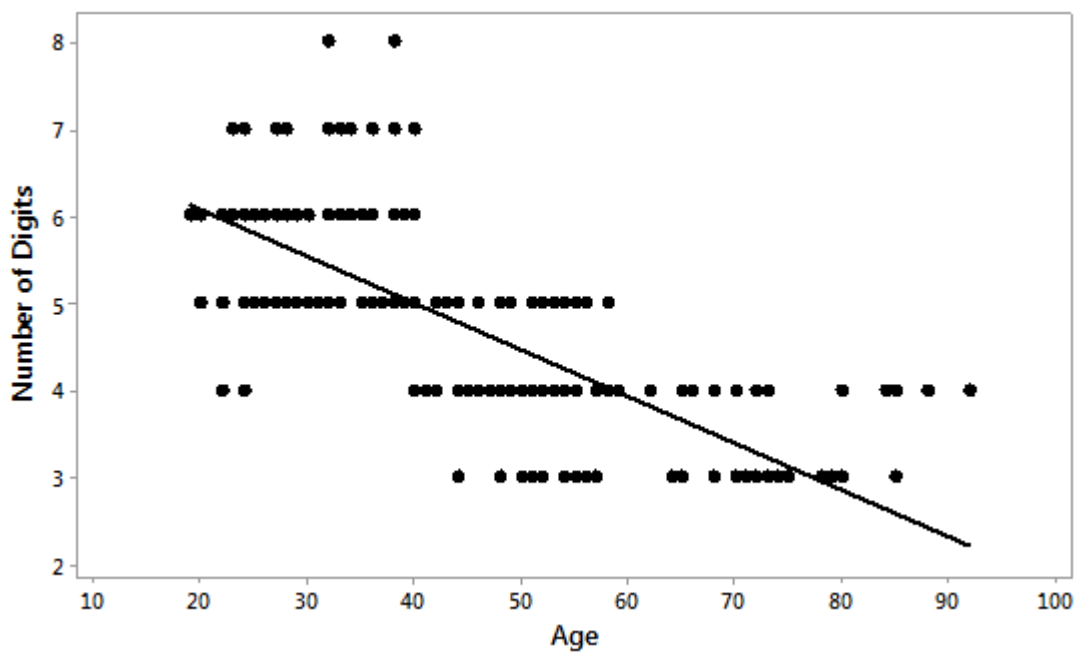


Figure C.20. Scatter plot of Digit Span backward test vs age factor.

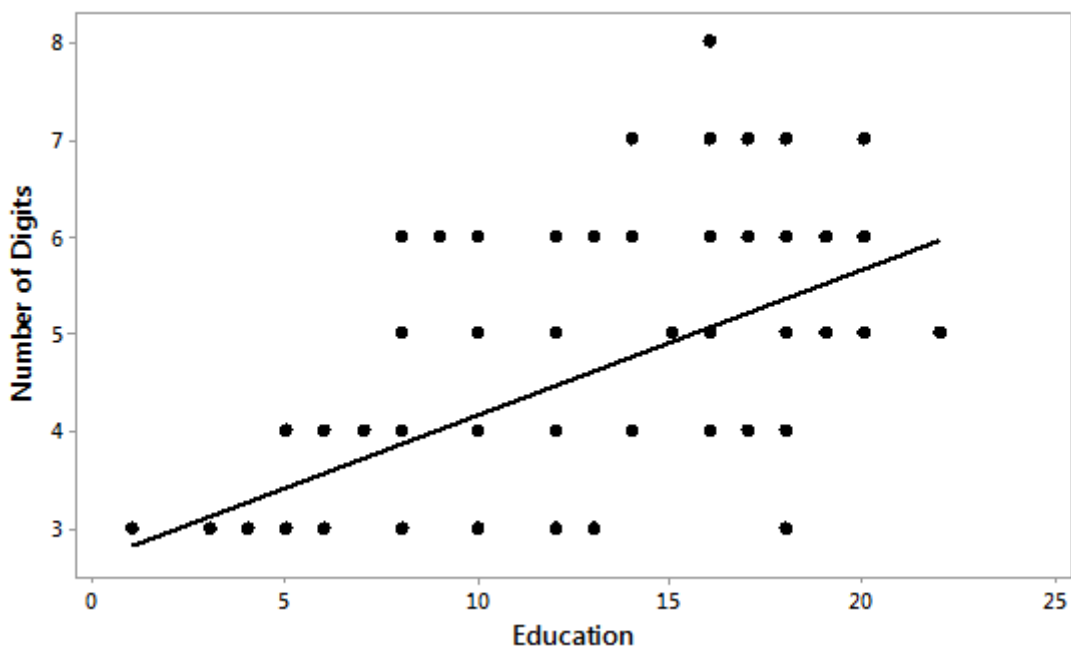


Figure C.21. Scatter plot of Digit Span backward test vs education factor.

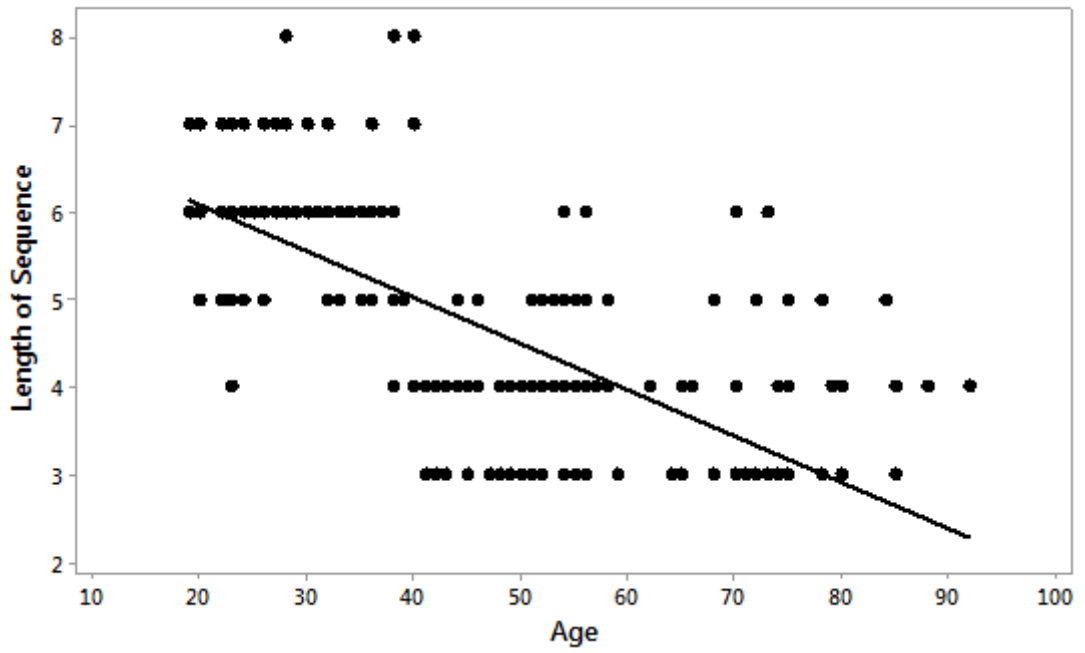


Figure C.22. Scatter plot of Corsi Span forward test vs age factor.

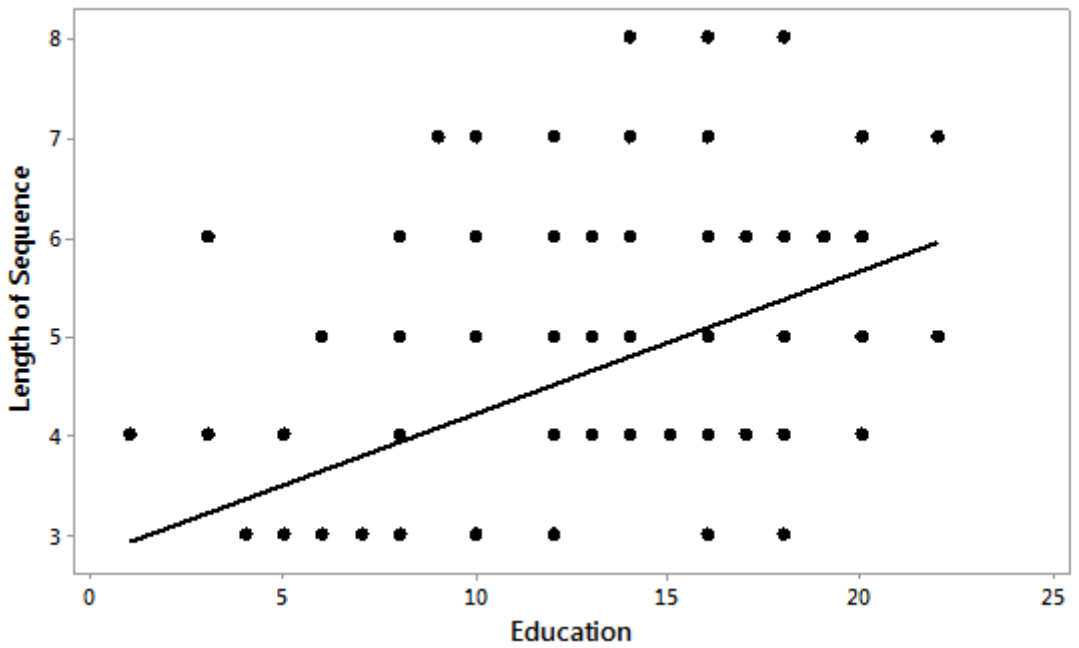


Figure C.23. Scatter plot of Corsi Span forward test vs education factor.

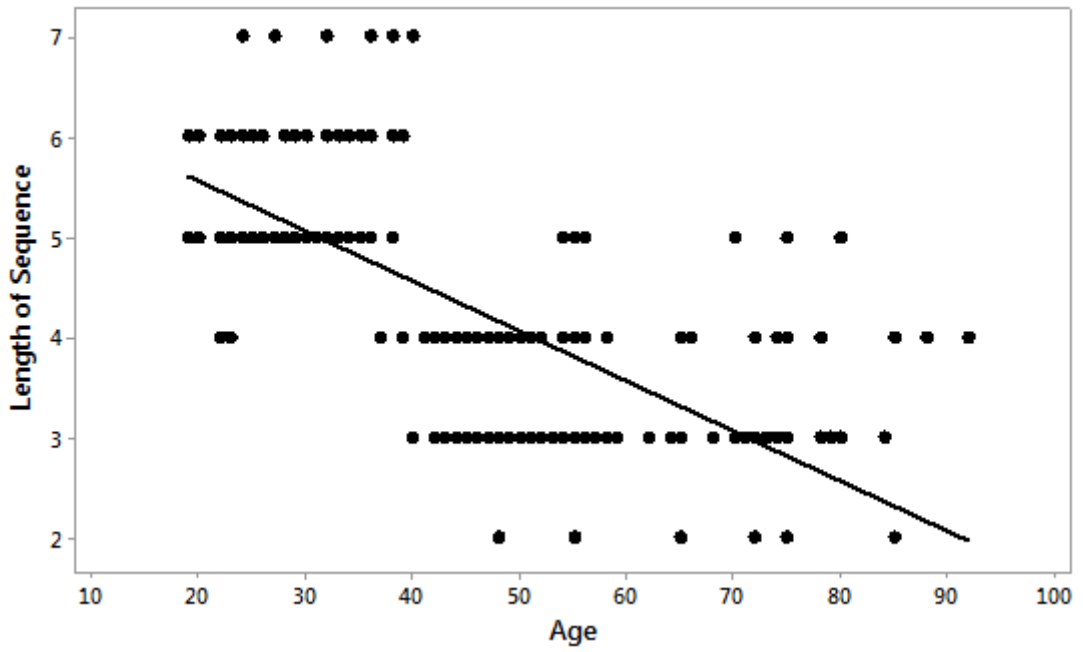


Figure C.24. Scatter plot of Corsi Span backward test vs age factor.

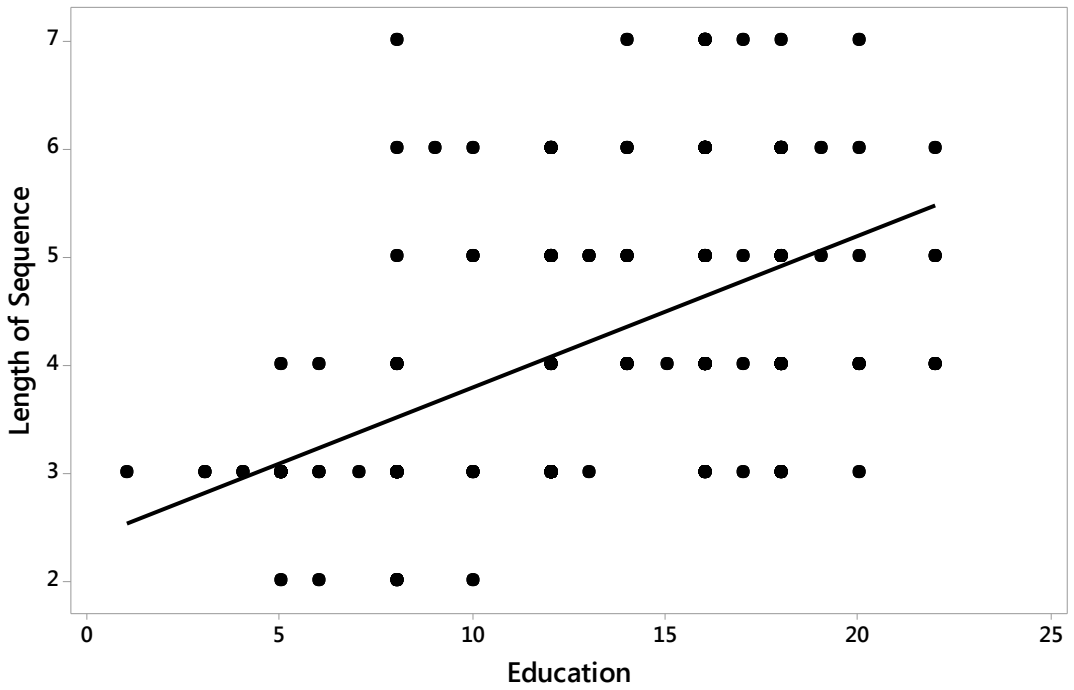


Figure C.25. Scatter plot of Corsi Span backward test vs education factor.

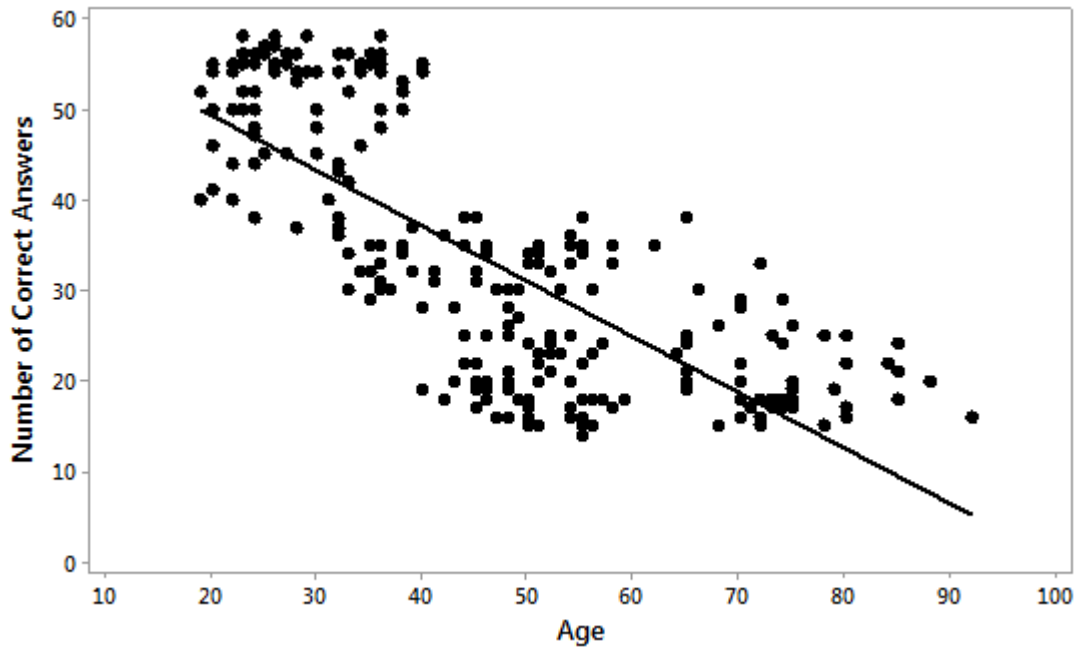


Figure C.26. Scatter plot of Raven test vs age factor.

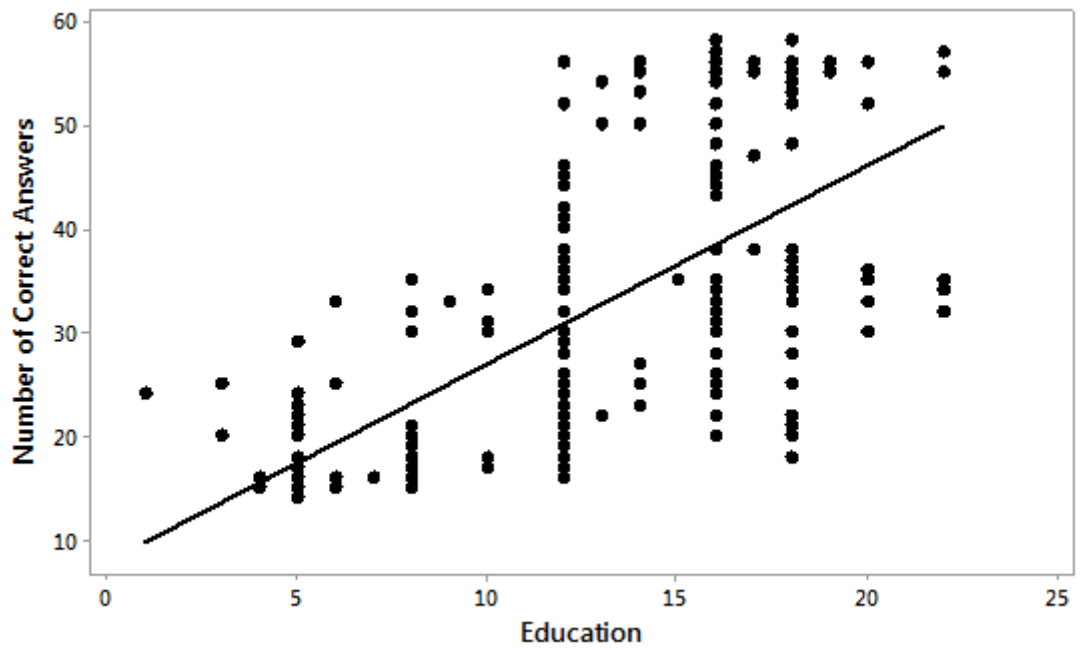


Figure C.27. Scatter plot of Raven test vs education factor

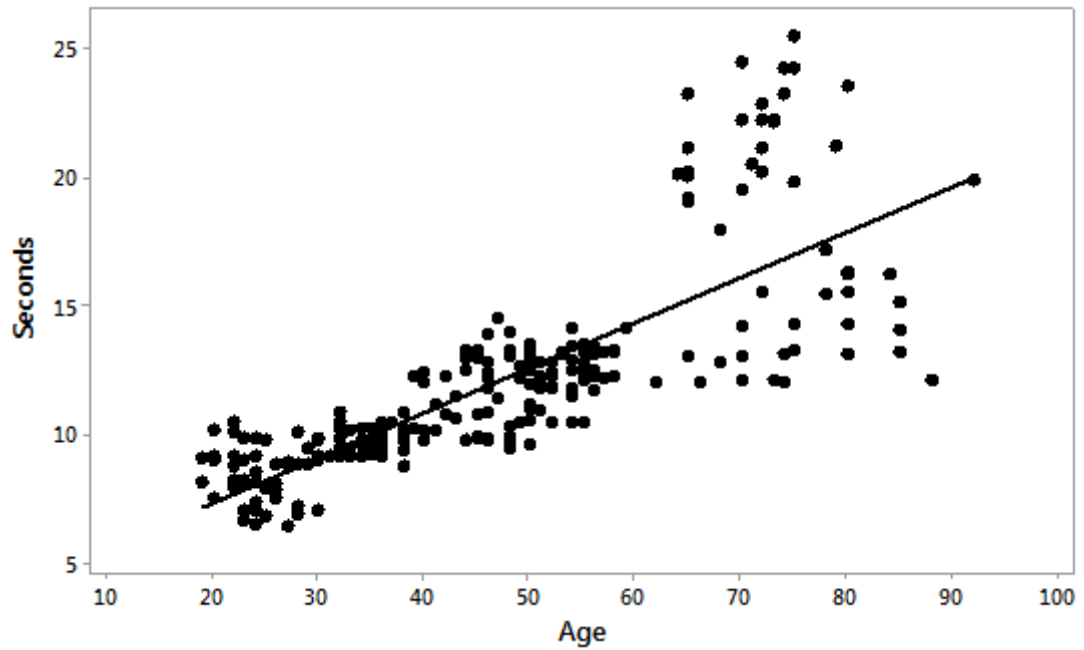


Figure C.28. Scatter plot of Stroop Color Word test part I vs age factor.

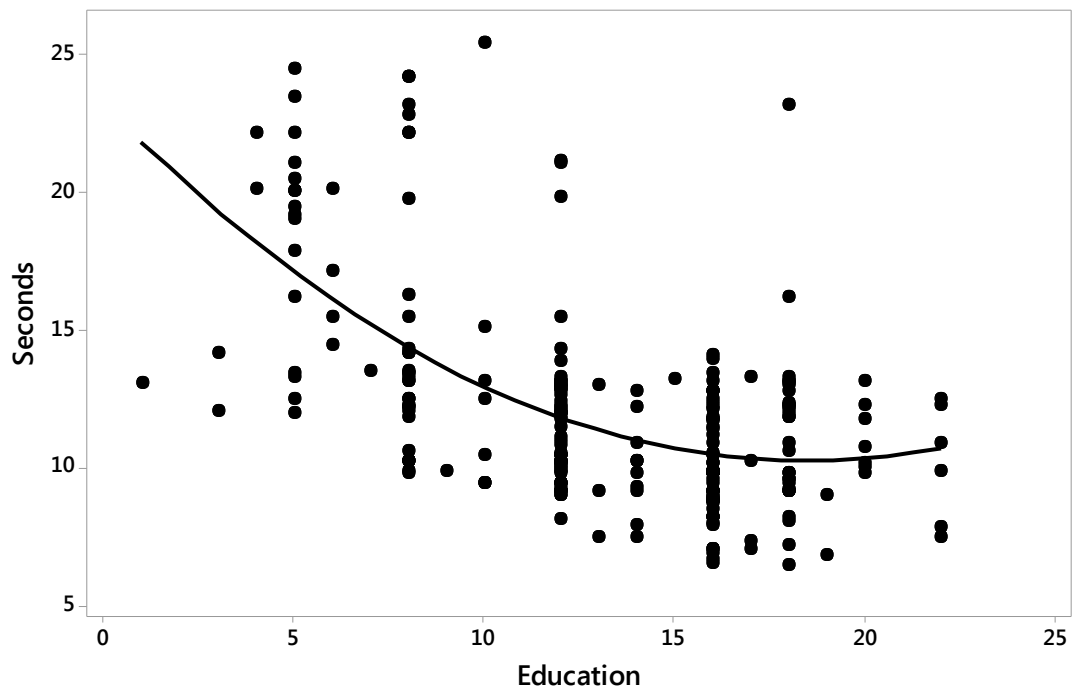


Figure C.29. Scatter plot of Stroop Color Word test part I vs education factor.

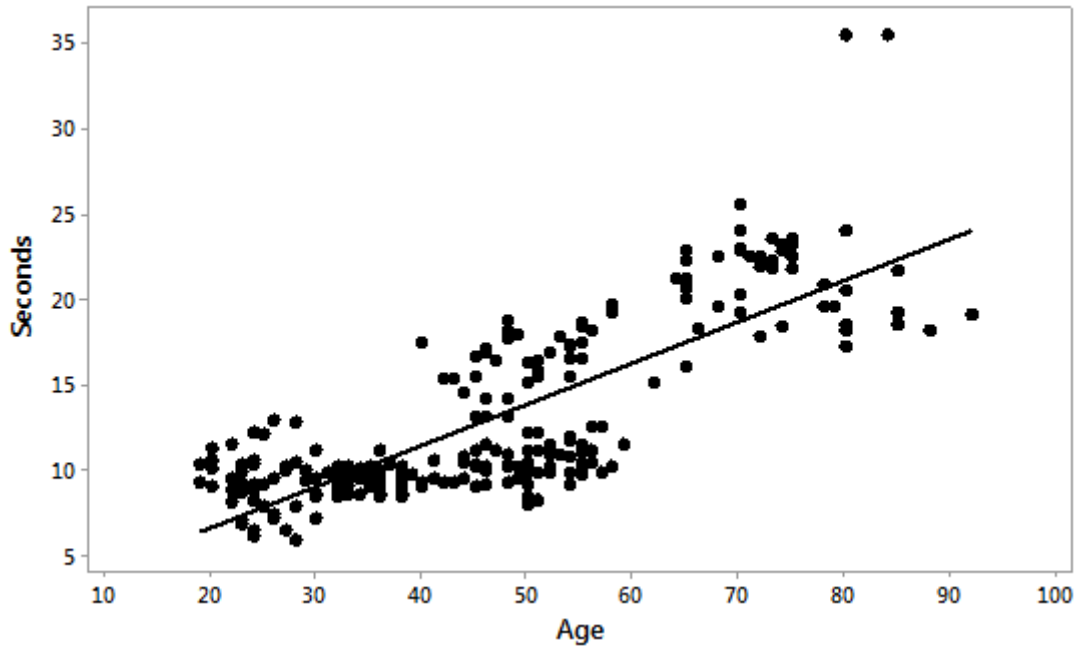


Figure C.30. Scatter plot of Stroop Color Word test part II vs age factor

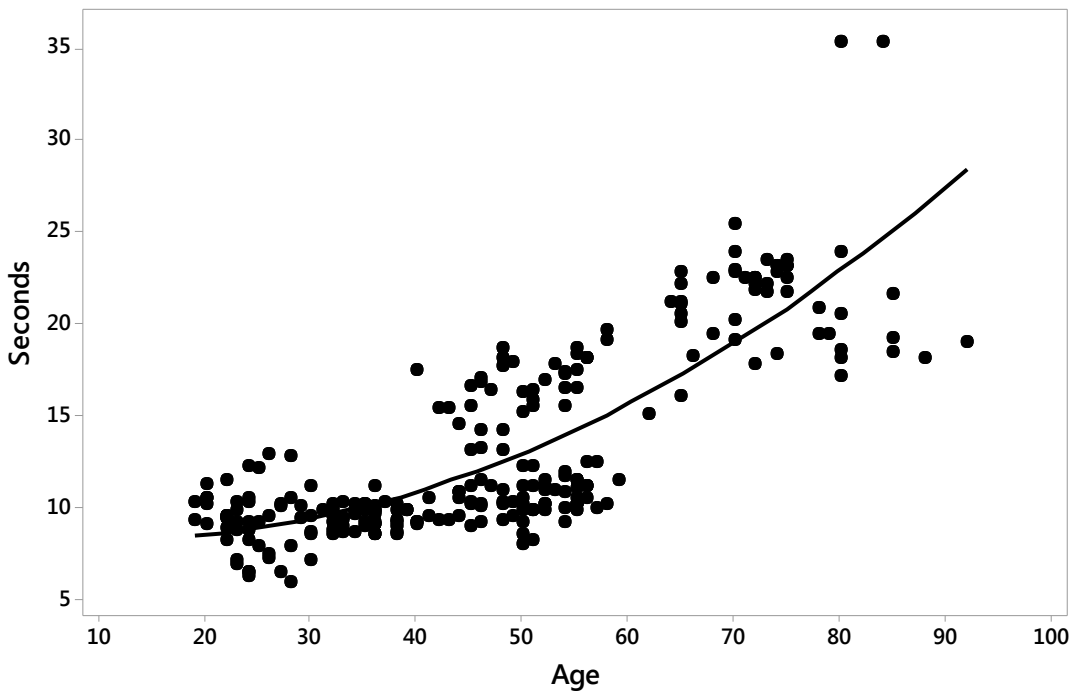


Figure C.31. Scatter plot of Stroop Color Word test part II vs education factor

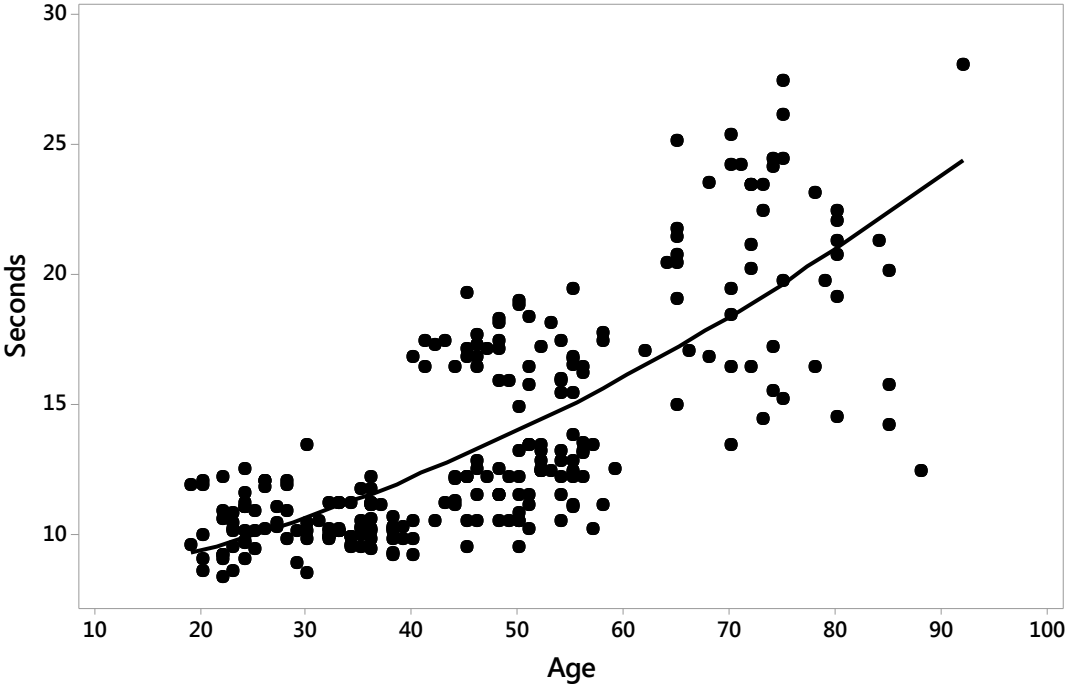


Figure C.32. Scatter plot of Stroop Color Word test part III vs age factor.

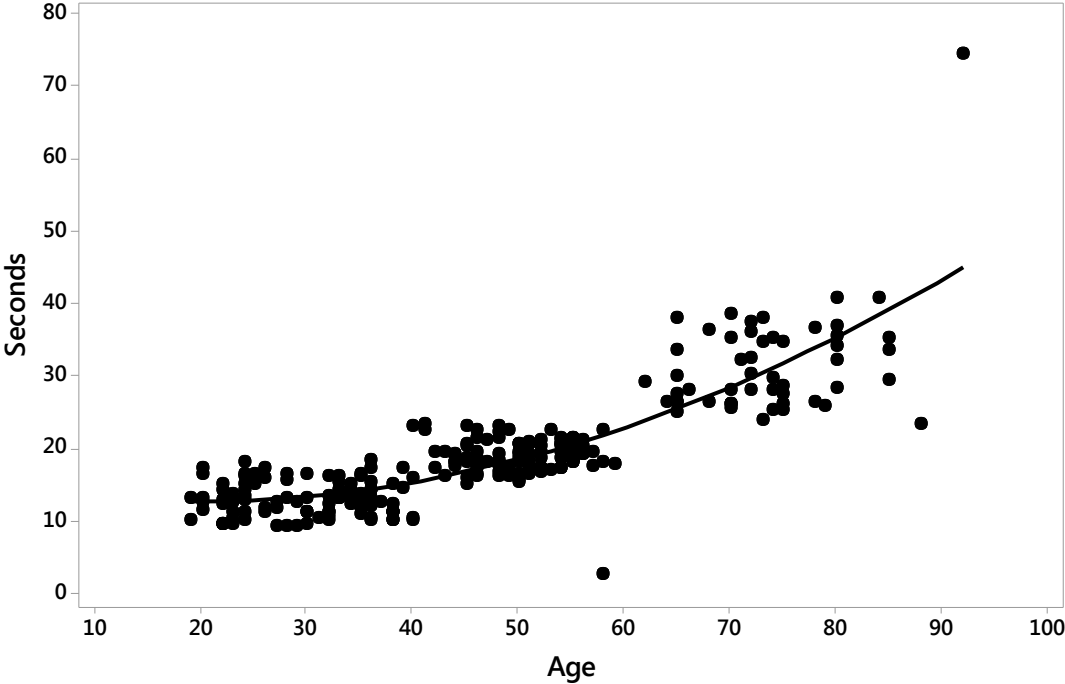


Figure C.33. Scatter plot of Stroop Color Word test part IV vs age factor.

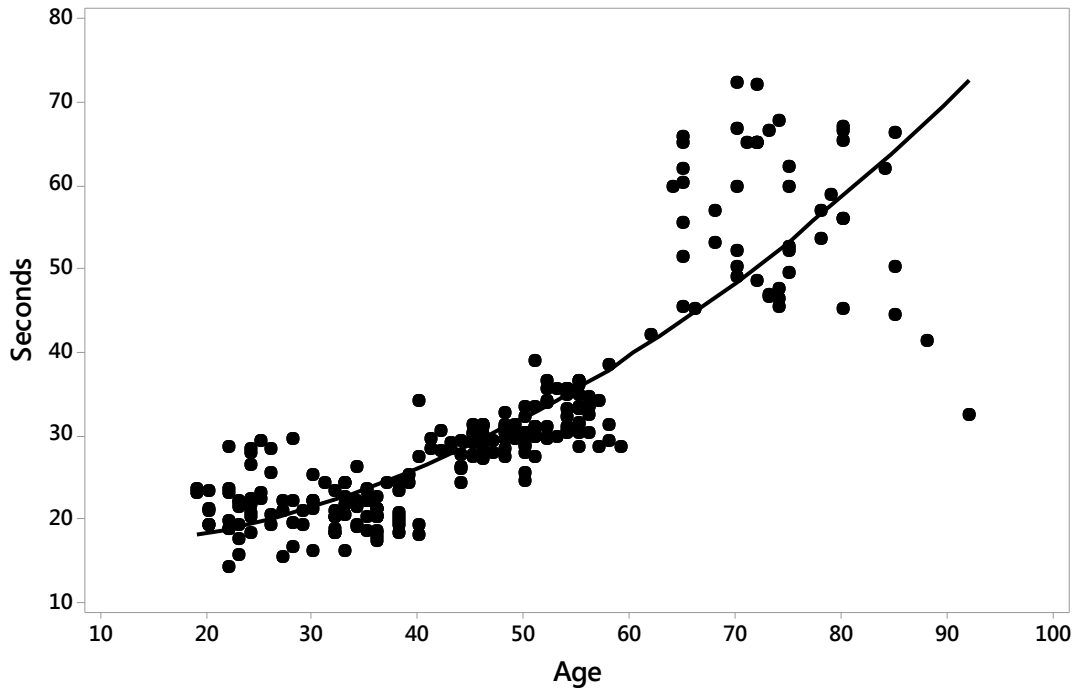


Figure C.34. Scatter plot of Stroop Color Word test part V vs age factor.

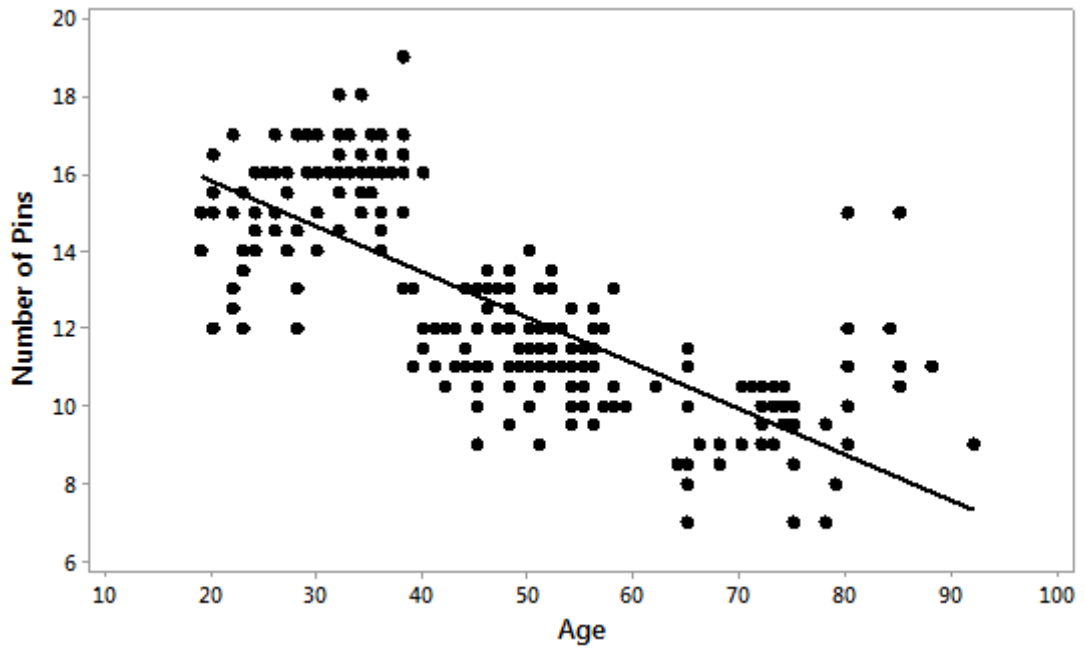


Figure C.35. Scatter plot of Purdue Pegboard dominant hand test vs age factor.

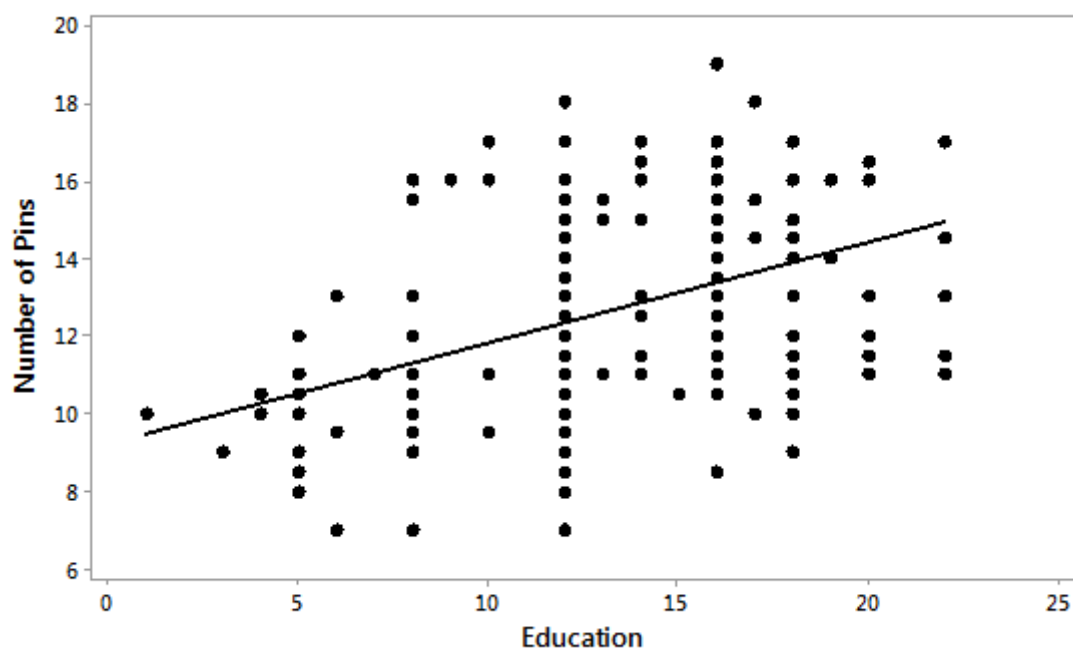


Figure C.36. Scatter plot of Purdue Pegboard dominant hand test vs education factor.

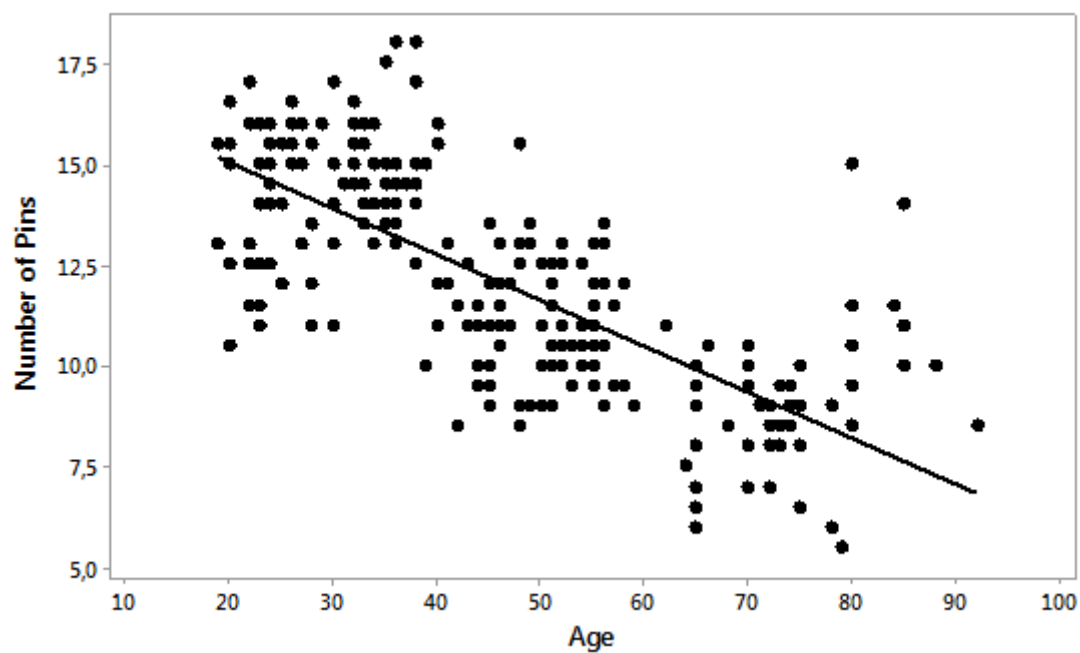


Figure C.37. Scatter plot of Purdue Pegboard nondominant hand test vs age factor.

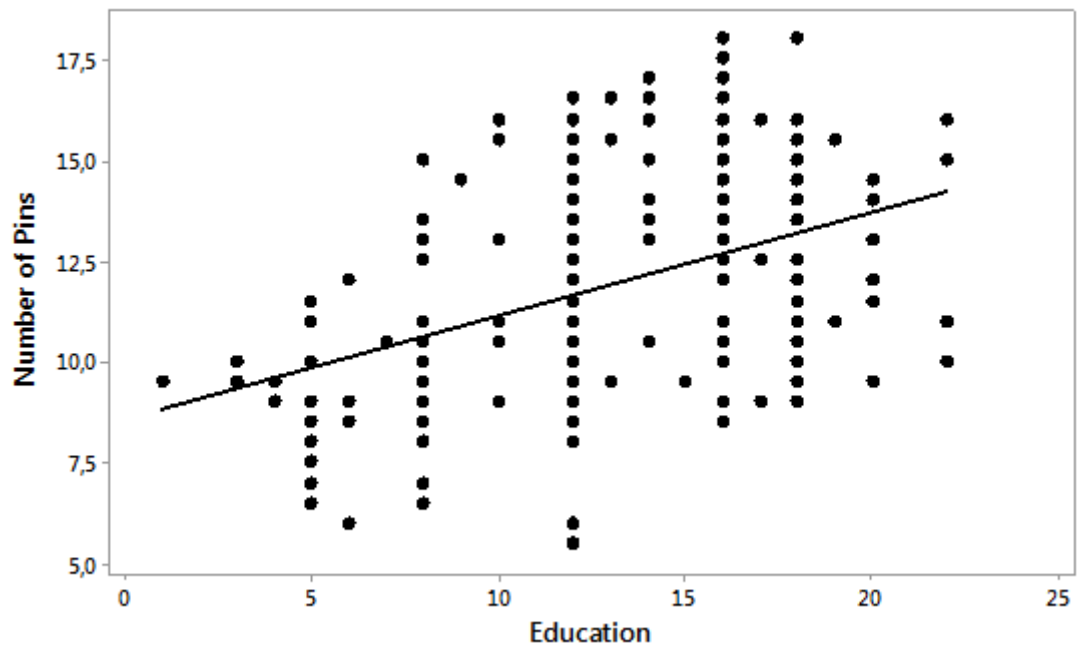


Figure C.38. Scatter plot of Purdue Pegboard nondominant hand test vs education factor.

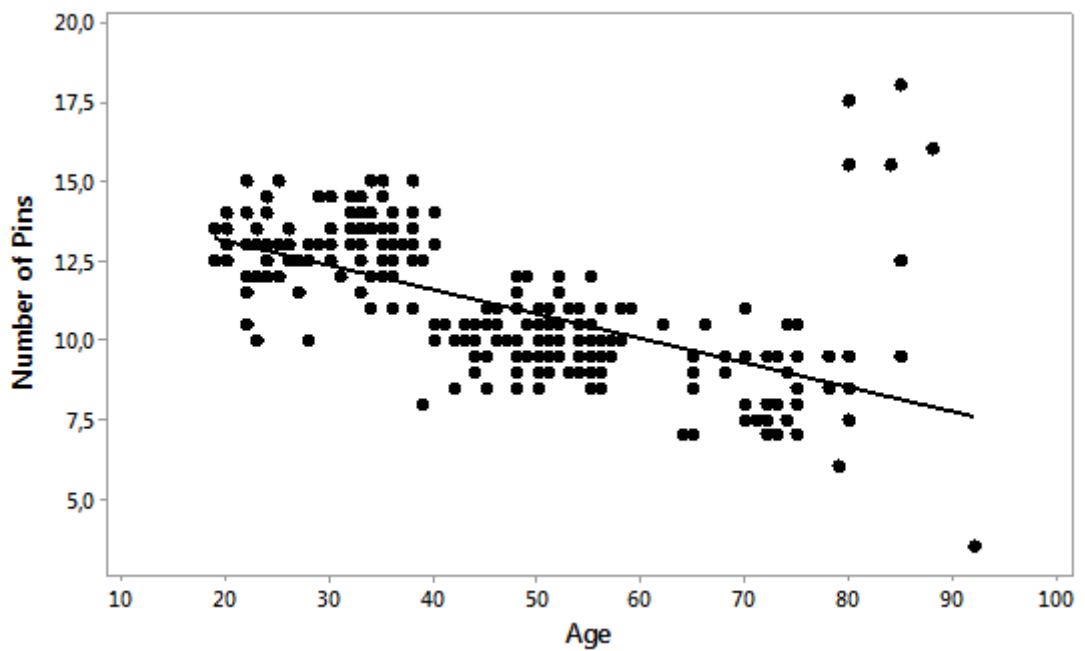


Figure C.39. Scatter plot of Purdue Pegboard both hand test vs age factor.

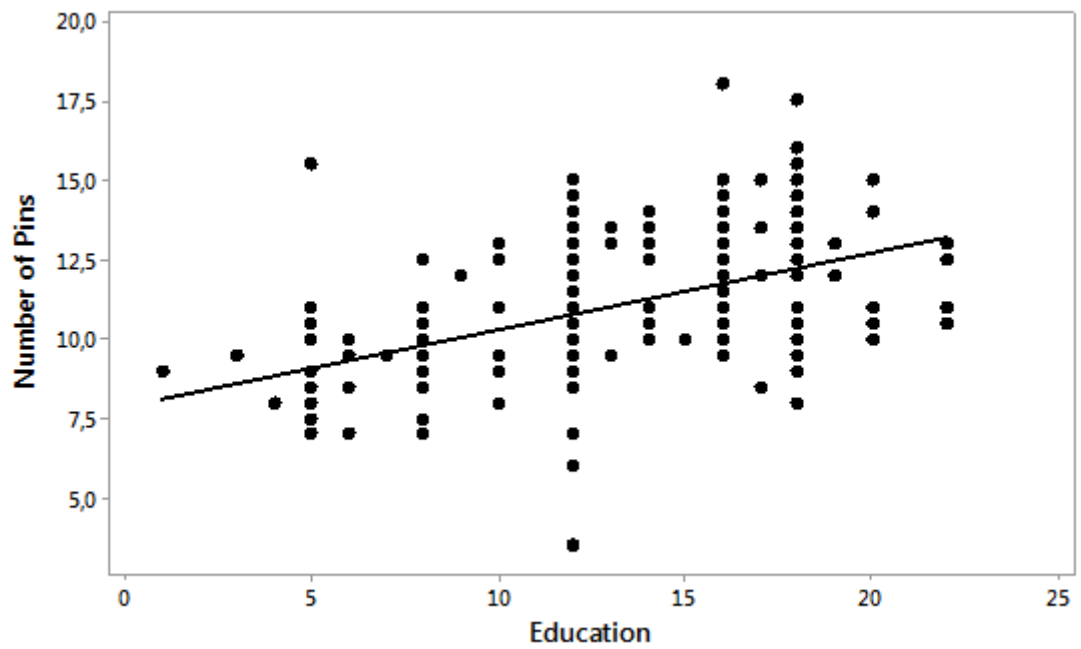


Figure C.40. Scatter plot of Purdue Pegboard both hand test vs education factor.

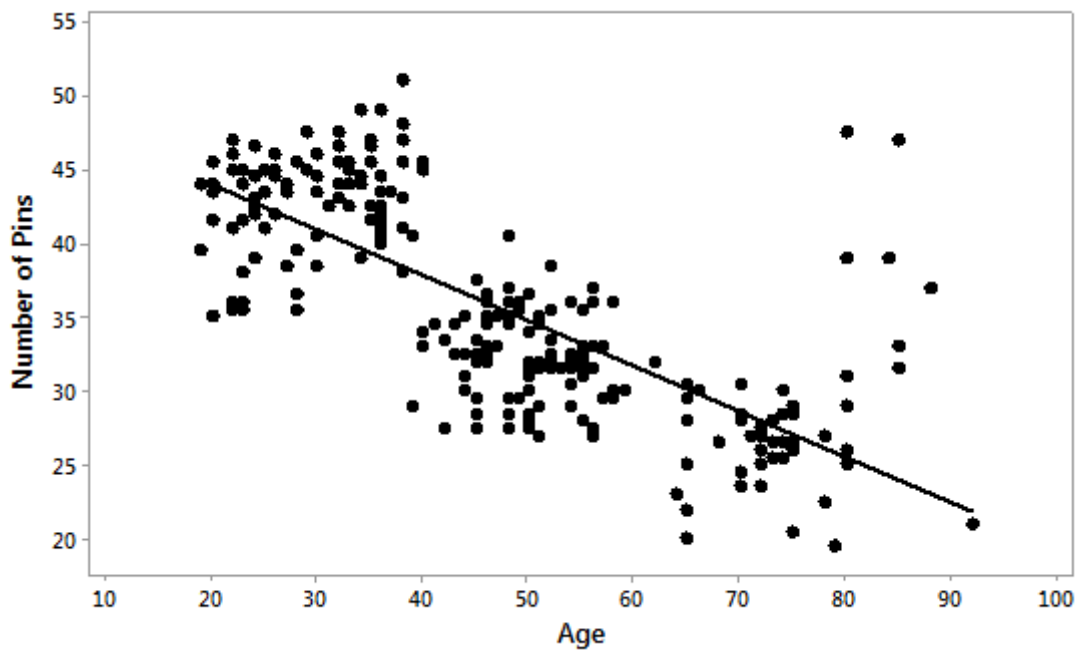


Figure C.41. Scatter plot of Purdue Pegboard total test vs age factor.

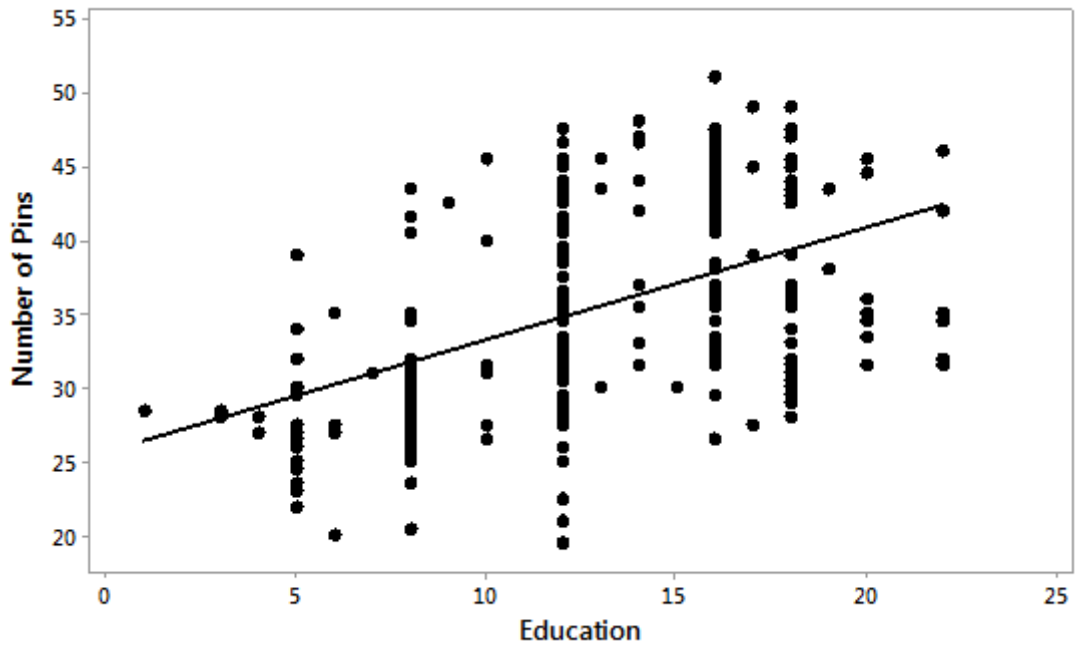


Figure C.42. Scatter plot of Purdue Pegboard total test vs education factor.

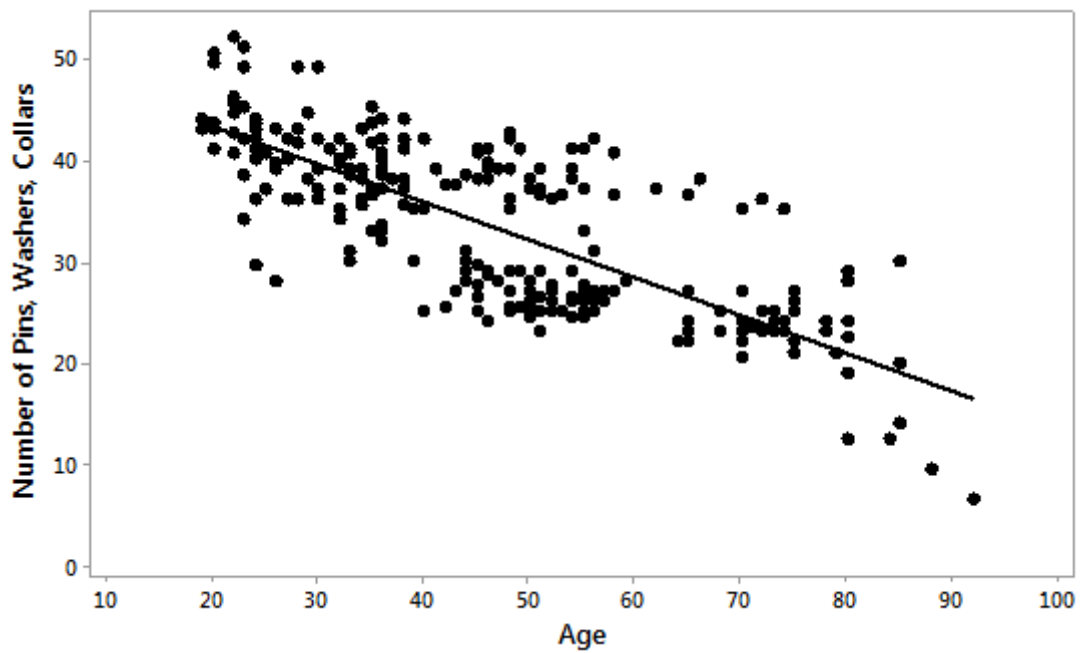


Figure C.43. Scatter plot of Purdue Pegboard assembly test vs age factor.

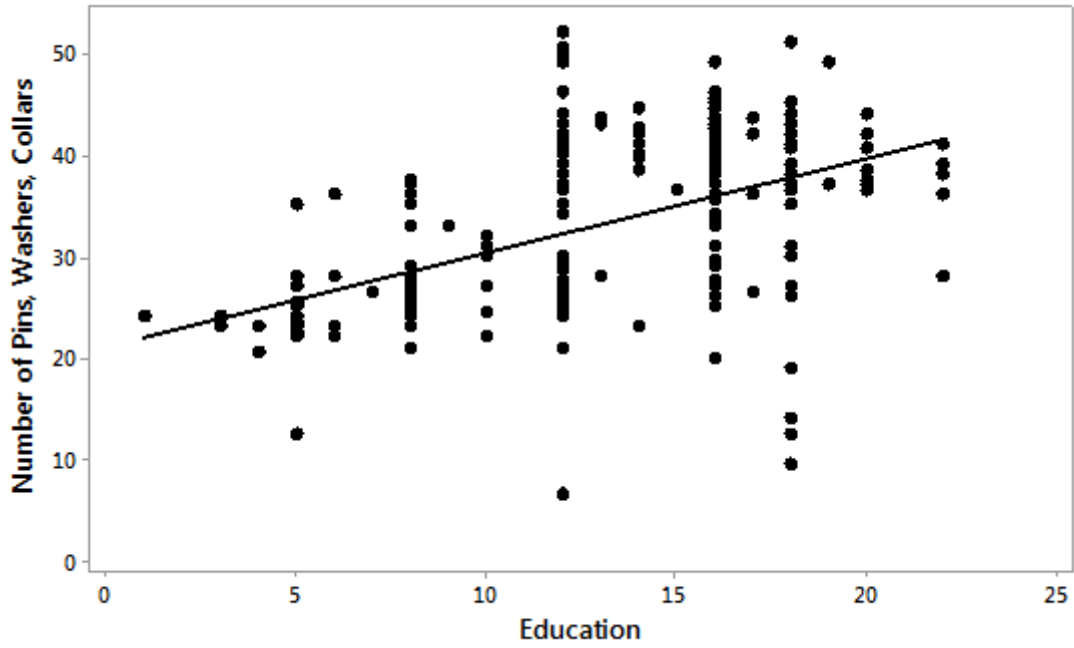


Figure C.44. Scatter plot of Purdue Pegboard assembly test vs education factor.

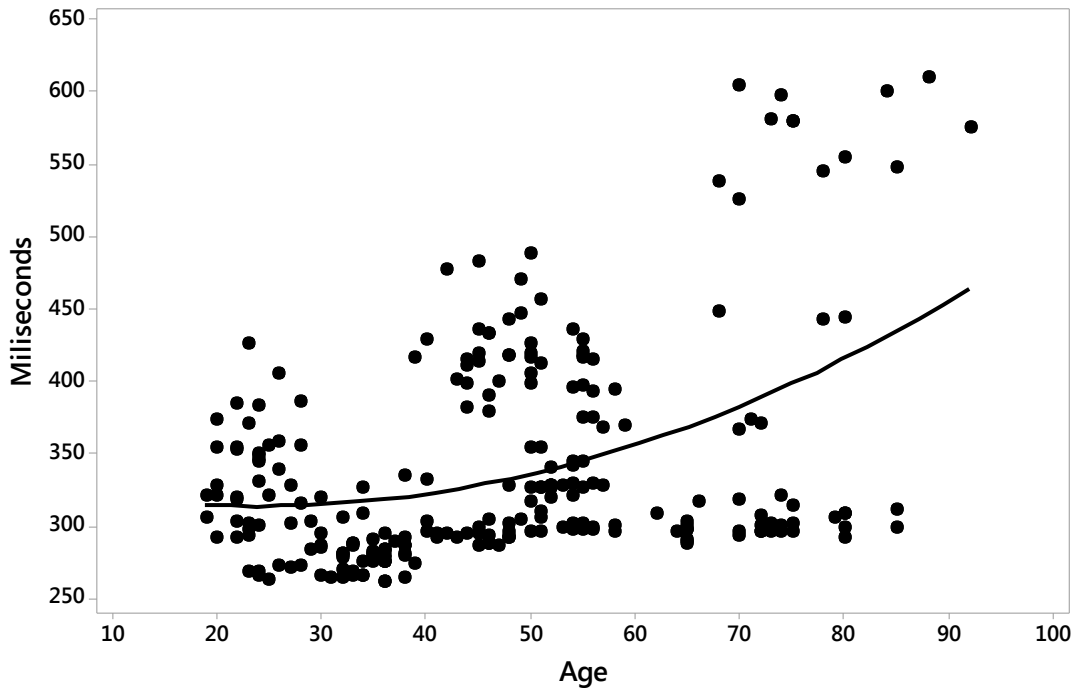


Figure C.45. Scatter plot of Reaction Time dominant hand test vs age factor

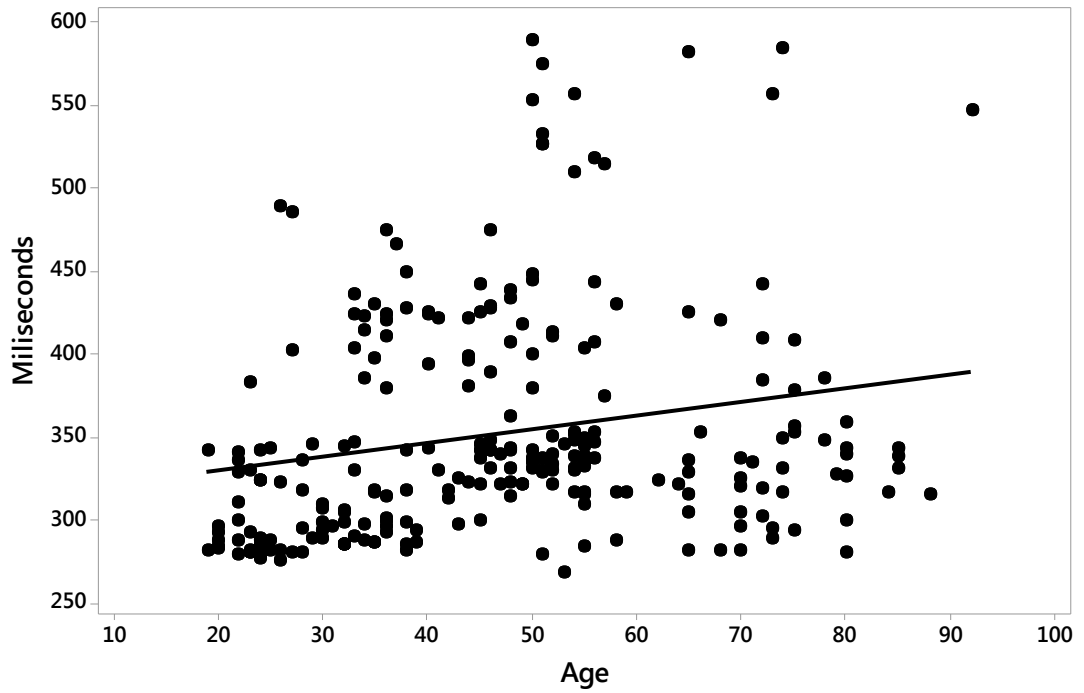


Figure C.46. Scatter plot of Reaction Time nondominant hand test vs age factor.

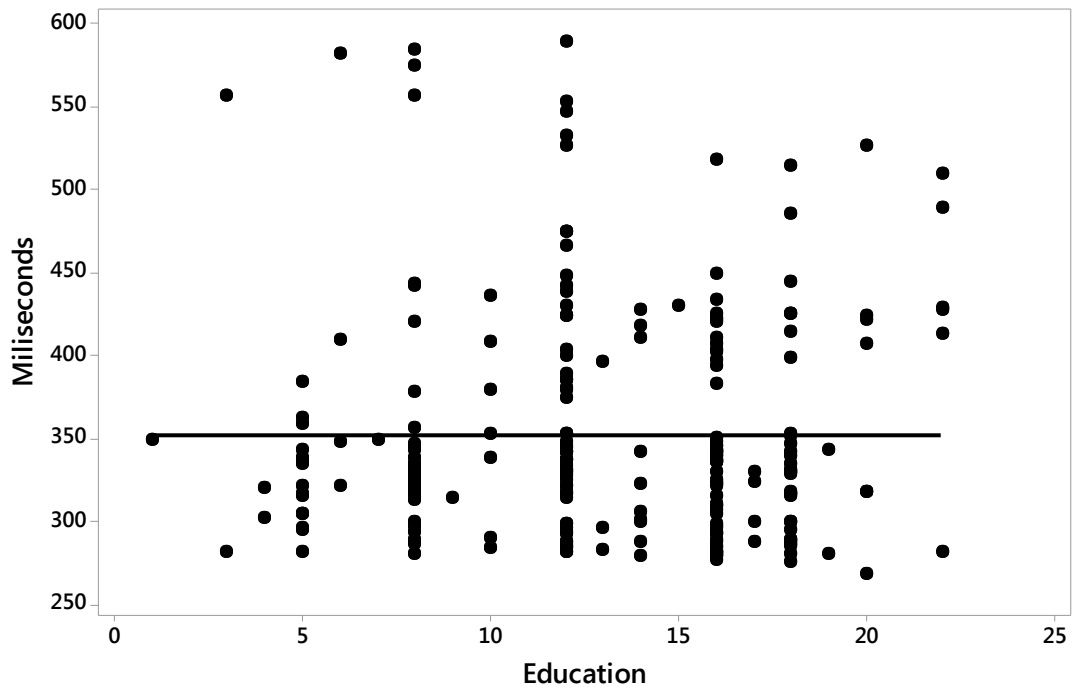


Figure C.47. Scatter plot of Reaction Time nondominant hand test vs Education factor.