Chapter 4

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Figure 9. Overview of Chapter 4

4.1 Introduction

This chapter presents the data collected during the experimental research phase. Firstly, an overview of the effect of the independent variables on the dependent variables will be presented, which will enable the researcher to determine the areas of significance that require further probing. Following the introduction, the data relevant to answering the

research questions and subquestion are presented. Figure 9 provides an overview of the chapter.

4.2 Overview of variables

In this study there were four independent variables: (1) *Test:* ALP (Alphabetical order test) or SUB (Subcategorisation test); (2) *Group:* A (ALP first) or B (SUB first); (3) *Grade:* 1 (Grade 1), 2 (Grade 2), 3 (Grade 3); and (4) *Gender:* M (Male), F (Female). There were two dependent variables: (1) *Time* (time measured in seconds); and (2) *Score* (number of correctly selected items).

An analysis of variance (ANOVA) was done to determine if the independent variables had a significant effect on the dependent variables. The ANOVA is frequently used when an independent variable is between-subjects in nature and has three or more levels (Tabachnick & Fidell, 2007). The ANOVA results are reflected in Table 11 where it can be seen that at the p<.05 significance level: (1) *Test* differs significantly for both dependent variables - *Time* F(1,212)=166.32, p=<01) and *Score* F(1,212)=33.67, p=<.01; (2) *Group* (order of presentation) is not significant, neither with respect to *Time* F(1,212)=.13, p=.72 nor *Score* F(1,212)=.00, p=.97; (3) *Grade* differs significantly for both dependent variables - *Time* F(2,212)=43.60, p<.01 and *Score* F(2,212)=28.29, p=<.01); and (4) *Gender* differs significantly with respect to *Time* F(1,212)=4.42, p=.04 but not with respect to *Score* F(1,212)=.38, p=.54.

Table 11

Overall Analysis of Variance on Time *and* Score

Independent variables	*df*	Dependent variables					
		Time			Score		
		F	*p*	ηp²	*F*	*p*	ηp²
Test	1	166.32	<.01*	.44	33.67	<.01*	.14
Group	1	.13	.72	.01	.00	.97	.00
Grade	2	43.60	<.01*	.29	28.29	<.01*	.21
Gender	1	4.42	.04*	.02	.38	.54	.00
Error	212						

Note. An * indicates significance at *p*<.05.

The partial eta squared was used to calculate the effect size of the ANOVA. The effect size indicates the strength of the relationship between the independent variable and the dependent variable (Tabachnick & Fidell, 2007). An effect size in the range .01 - .05 is considered small, .06 - .14 medium and >.15 large. The effect size for *Test* was therefore large for *Time* and medium for *Score*, for *Grade* it was large for *Time* as well as *Score*, and for *Gender* it was small for *Time*.

On the basis of the areas of significance determined by the ANOVA, the influence of *Test, Grade* and *Gender* is presented in this chapter. *Group* did not receive any further consideration in the data presentation or analysis because there were no significant differences between the means of the tests with respect to the order of presentation. Differences regarding *Test* are discussed in reference to Research Question 1, and the effect of *Grade* and *Gender* differences in reference to the subquestion. Research Question 2 addresses the impact of bottom-up factors on the results.

The means, standard deviations and ranges of all the independent variables for *Time* and *Score* have been tabulated in Table 12 for reference purposes.

Table 12

Means and Standard Deviations of all Variables

Variable		Number of participants	Time		Score	
			Mean	SD	Mean	SD
Test	ALP	109	337.55	142.17	31.38	4.06
	SUB	109	180.50	51.80	33.64	2.06
Group	A	110	261.13	125.82	32.50	3.24
	B	108	256.89	139.77	32.52	3.58
Grade	1	86	324.42	159.24	30.83	4.23
	2	66	245.98	103.22	32.86	2.40
	3	66	186.86	61.56	34.35	1.50
Gender	M	116	273.71	146.58	32.33	3.62
	F	102	242.33	113.13	32.72	3.15

For a summary of all data by grade and gender, inclusive of all pre-test and test data, as well as mean time and score, see Appendix W. For a record of the mean time and mean score data for each item across the 109 participants, see Appendix X.

4.3 Research question 1: Is there a significant difference between the performance of the participants, with respect to rate (time) and accuracy (score), in locating symbols in a large colour-coded visual display using either an alphabetical or a categorisation arrangement?

The ANOVA indicated that for *Test*, the means for *Time* and *Score* in ALP and SUB were significantly different (Table 11).

The mean for *Time* for ALP across all the participants was 337.55 sec., whereas the mean time for SUB was 180.50 sec. (Table 12), indicating that the participants completed SUB faster than ALP.

The mean for *Score* in ALP across all participants was 31.38 correct scores whereas for SUB it was 33.64 correct scores (Table 12), indicating that the participants were more accurate in their selections in SUB than in ALP.

4.4 Subquestion: Are there significant differences between the performance of the participants, with respect to grade and gender, in their use of alphabetical and categorisation arrangements to locate symbols in a large colour-coded visual display?

The means, standard deviations and ranges for *Time* and *Score* within *Grade* and *Gender* are shown in Table 13 as a summary reference of all the data pertaining to *Grade* and *Gender*. This table will be referred to in further presentation of the results.

Table 13

Means and Standard Deviations for Time *and* Score *Within* Grade *and* Gender

Variable		Test	Number of participants	Time			Score		
				Mean	SD	Range	Mean	SD	Range
Grade	1	ALP	43	434.07	155.10	204-1140	28.91	4.83	10-36
	2		33	324.15	89.57	224-708	31.91	2.63	26-36
	3		33	225.18	53.78	146-393	34.06	1.48	31-36
	1	SUB	43	214.77	51.37	122-320	32.74	2.32	26-36
	2		33	167.82	31.87	103-242	33.82	1.70	29-36
	3		33	148.55	42.17	105-284	34.64	1.50	31-36
Gender	M	ALP	58	361.52	157.28	159-1140	31.09	4.38	10-36
	F		51	310.29	118.47	146-667	31.71	3.68	20-36
	M	SUB	58	185.90	54.03	103-320	33.57	2.04	26-36
	F		51	174.37	48.94	105-319	33.73	2.11	27-36

Grade and *Gender* differences were analysed firstly with respect to the differences within the tests and secondly with respect to the differences between the tests.

4.4.1 Grade and Gender differences within the tests

An ANOVA was done per *Test* on both *Time* and *Score*, with *Grade*, *Gender* and the interaction between *Grade* and *Gender* as independent variables (Table 14).

Table 14

Analysis of Variance on Grade *and* Gender

Variable	Test	*Df*	Time			Score		
			F	*p*	ηp²	F	*p*	ηp²
Grade	ALP	2	31.72	<.01*	.37	20.71	.01*	.29
Gender		1	3.71	.06**	.02	.40	.53	.00
Grade*Gender		2	.24	.78	.00	.19	.82	.00
Error		103						
Grade	SUB	2	22.54	<.01*	.29	9.09	<.01*	.15
Gender		1	1.19	.28	.00	.08	.78	.00
Grade*Gender		2	.26	.77	.00	.22	.80	.00
Error		103						

Note. An * indicates significance at p<.05

Note. An ** indicates significance at p<.10

According to the ANOVA on *Grade* and *Gender*, there were significant differences on both tests on a 5% significance level between the grades, for both *Time* (ALP F(2,103)=31.72, p=<.01 and SUB F(2,103)=20.71, p=.01) and *Score* (ALP F(2,103)=22.54, p<.01 and SUB F(2,103)=9.09, p=<.01). All the grade differences had a large effect size. Between the genders, there were only significant differences at a 10% significance level for *Time* in ALP F(1,103)=3.71, p=.06, with a small effect size. There were no significant differences in *Gender* in ALP for *Score* F(1,103)=.40, p=.53, nor in SUB for *Time* F(1,103)=1.19, p=.28 or *Score* F(1,103)=.08, p=.78.

There were no statistically significant interactions between *Grade* and *Gender*, in either ALP or SUB, for both dependent variables – *Time* F(2,212)=.26, p=.77 and *Score* F(2,212)=.22, p=.80.

4.4.1.1 Grade differences within the tests

Because significant differences were found between the grades within test in the ANOVA for both *Time* and *Score* (Table 11), the Duncan Multiple Range Test (Duncan's new multiple range test, 2009) was applied to the tests within the grades. The results indicated that for ALP all three grades differed significantly for *Time* and *Score*. In SUB, only Grade 1 differed significantly from Grades 2 and 3 for *Time* and *Score* (Table 15).

In terms of *Time,* the mean time taken to complete ALP decreased as *Grade* increased. The mean for *Score* increased in ALP as *Grade* increased. The same pattern of results was noted in SUB, except that the differences between the Grade 2 and Grade 3 groups were not statistically significant. These results indicate that as *Grade* increased, participants made faster and more accurate selections.

Table 15

Post-Hoc Duncan Test Applied to Grade *Within the Tests*

Test	Grade	Number of participants	Time		Score	
			Mean	SD	Mean	SD
ALP	1	43	434.07[a]	155.10	28.91[a]	4.83
	2	33	324.15[b]	89.57	31.91[b]	2.63
	3	33	225.18[c]	53.78	34.06[c]	1.48
SUB	1	43	214.77[a]	51.37	32.74[a]	2.32
	2	33	167.82[b]	31.87	33.82[b]	1.70
	3	33	148.55[b]	42.17	34.64[b]	1.50

Note. The means of the variables with different superscripts ([a, b, c]) differ significantly.

4.4.1.2 Gender differences within the tests

As indicated in Table 14, mean time differences between the genders were significant in ALP (p=.06) at a 10% significance level. The female participants completed the ALP test faster (310.29 sec.) than the male participants did (361.52 sec.) (Table 13).

4.4.2 Grade and Gender differences between the tests

The means and standard deviations of the independent variables for the differences between ALP and SUB are reflected in Table 16. The paired T-Test was used to determine if ALP and SUB differed significantly with regard to *Time* and *Score* within *Grade* and *Gender* and the results are also presented in Table 16. The paired T-Test was used because the two variables that were compared were not independent.

Table 16

Comparison of ALP and SUB per Grade *and* Gender

Variable		Number of participants	Time				Score			
			Mean ALP-SUB diff	SD	*T*	*p*	Mean ALP-SUB diff	SD	*T*	*p*
Grade	1	43	219.30	144.41	9.96	<.01*	-3.84	3.76	9.96	<.01*
	2	33	156.33	86.98	10.33	<.01*	-1.91	2.67	10.33	.01*
	3	33	76.64	42.92	10.26	<.01*	-0.58	1.62	10.26	.05*
Gender	M	58	175.62	136.50	9.80	<.01*	-2.48	3.54	-5.35	<.01*
	F	51	135.92	95.12	10.20	<.01*	-2.02	2.80	-5.14	<.01*

Note. An * indicates significance at p<.05

4.4.2.1 Grade differences between the tests

In terms of *Time,* the mean time difference between ALP and SUB differed significantly for all three grades (Table 16). The mean time difference between ALP and SUB decreased as *Grade* increased. For Grade 1, the mean time difference was 219.30 sec., for Grade 2 it was 156.33 sec. and for Grade 3 it was 76.64 sec. The mean time in ALP was higher than the mean time in SUB (except for one participant in Grade 3). This indicated that for most participants (across all grades) SUB was faster to complete than ALP.

In terms of *Score,* the mean score difference between ALP and SUB differed significantly for all three grades (Table 16). The mean score difference between ALP and SUB decreased as *Grade* increased. For Grade 1, the mean score difference was -3.84 correct scores, for Grade 2 it was -1.91 correct scores and for Grade 3 it was -0.58 correct scores. The mean score for SUB was higher than the mean score for ALP (except for four Grade 1, four Grade 2 and seven Grade 3 participants who had small ALP-SUB score differences where there were higher mean scores in ALP compared to SUB). This indicated that most participants (across all grades) scored more accurately in SUB than ALP.

4.4.2.2 Gender differences between the tests

For *Time,* the mean difference between ALP and SUB was significant for both *Male* and *Female* (Table 16). The mean time difference between ALP and SUB was greater for

Male (175.62 sec.) than *Female* (135.92 sec.). The mean time for ALP was greater than the mean time for SUB, for both *Male* and *Female* (except for one female participant), indicating that for most participants (across both genders) SUB was faster to complete than ALP.

The mean differences for *Score* between ALP and SUB were significant for both *Male* and *Female* (Table 16). The mean score difference for *Male* was -2.48 correct scores, and for *Female* it was -2.02 correct scores. The mean score for SUB was higher than the mean score for ALP (except for seven male and eight female participants who had small score differences where there were higher mean scores in ALP compared to SUB), indicating that most participants (across both genders) scored more accurately in SUB than ALP.

4.4.3 Errors

4.4.3.1 Grade

The number of correct and incorrect selections was calculated across *Test* and *Grade*. Incorrect selections were further separated into *Escape* selections and *Error* selections. (Escape selections were primarily made when the participants could not find the target, and gave up on the search. Error selections were target identification errors). Frequencies of selection were calculated as percentages and are reflected in Table 17.

Table 17
Percentage of Correct, Escape *and* Error *Selections Across* Grade

	ALP				SUB			
		Incorrect				Incorrect		
Grade	Correct	Escape	Error	Total	Correct	Escape	Error	Total
1	80.30	13.05	6.65	19.70	90.96	4.26	4.78	9.04
2	88.55	5.72	5.72	11.45	93.94	2.36	3.70	6.06
3	94.53	2.69	2.78	5.47	96.21	1.26	2.53	3.79

From Table 17 it can be seen that with an increase in *Grade*, the percentage of *Escape* and *Error* selections decreased in both ALP and SUB. For all the grades, both the *Escape* and *Error* percentages were higher for ALP than for SUB. The *Escape* option was frequently used by participants in Grade 1, particularly in ALP where 13.05% of all selections were *Escape* selections (compared to 4.26% in SUB). By Grade 3, 94.53% of the participants' ALP selections and 96.21% of their SUB selections were accurate.

Table 18 records the mean time taken for all the items, as well as the mean time taken for the *Escape* and *Error* selections. It can be seen that the mean time for *Escape* selections (24.08 sec. in ALP and 17.83 sec. in SUB) was greater than for *Error* selections (10.74 sec. in ALP and 6.70 sec. in SUB). This indicates that in both tests the participants took longer making escape selections than error selections. It can also be seen in Table 18 that *Escape* selections had a much larger mean time (24.08 sec. in ALP and 17.83 sec. in SUB) than the mean time across all the test items (9.11 in ALP and 4.92 in SUB). *Error* selections, however, only had a marginally greater mean time (10.74 sec. in ALP and 6.70 sec. in SUB) than the mean time over all the items (9.11 in ALP and 4.92 in SUB). This, together with the greater percentage of *Escape* selections than *Error* selections noted in Table 17, suggests that E*scape* selections had a more important impact on overall mean times than *Error* selections, especially for the Grade 1 participants.

Table 18

Mean Time *for* Escape *and* Error *Selections*

	All items	Escape selections			Error selections		
Test	Mean time (sec.)	Mean time (sec.)	Min. time (sec.)	Max time (sec.)	Mean time (sec.)	Min. time (sec.)	Max time (sec.)
ALP	9.11	24.08	3	145	10.74	1	51
SUB	4.92	17.83	3	75	6.70	1	45

4.4.3.2 Gender

The number of correct and incorrect selections was calculated across *Test* and *Gender*. As for *Grade*, incorrect selections were further separated into *Escape* selections and *Error* selections. Frequencies of selection were calculated as percentages and are presented in Table 19.

Table 19
Percentage of Correct, Escape *and* Error *Selections Across* Gender

	ALP			SUB		
		Incorrect			Incorrect	
Gender	Correct	Escape	Error	Correct	Escape	Error
Male	86.25	8.14	5.60	93.25	2.39	4.36
Female	88.07	7.19	4.74	93.68	3.21	3.10

From Table 19 it is noted that in terms of incorrect selections, the differences in performance between *Male* and *Female* were minimal, for both ALP and SUB. For both *Male* and *Female* there were greater percentages of *Escape* and *Error* selections in ALP than in SUB.

4.4.4 Variability of performance within Grade and Gender

The SD-values across the results indicate variability in the performance of the participants, both within the tests (Table 13) and between them (Table 16), with a tendency to decreasing variability between the tests as *Grade* increased and greater variability in the performance of *Male* between the two tests compared to *Female*.

The variability within tests tended to decrease as *Grade* increased (Table 13). In ALP *Time*, the SD-values decreased from 155.10 in Grade 1, to 89.57 in Grade 2 and 53.78 in Grade 3. In ALP *Score*, the SD-values decreased from 4.83 in Grade 1, to 2.63 in Grade 2 and 1.48 in Grade 3. Variability within SUB was not as marked as in ALP.

The variability between the tests also tended to decrease as *Grade* increased (Table 16). With respect to the time difference between the tests, the SD-value was 144.41 sec. in Grade 1, 86.98 sec. in Grade 2 and 42.92 sec. in Grade 3. With respect to the score difference between the tests, the SD-value was 3.76 sec. in Grade 1, 2.67 sec. in Grade 2 and 1.62 sec. in Grade 3.

Variability of performance was also noted in *Gender* (Table 13). Greater variability in performance was seen within *Male* than *Female*. In ALP *Time*, SD-values were 157.28 sec. in *Male* compared to 118.47 sec. in *Female*. Variability within tests was not marked for SUB *Time*, nor ALP and SUB *Score*.

There was variability in performance in *Gender* between the tests (Table 16). With respect to the time difference between the tests, for *Male* the SD-value was 136.50 sec. but

for *Female* it was 95.12 sec. With respect to the score difference between the tests, for *Male* the SD-value was 3.54 but for *Female* it was 2.80.

4.5 Research question 2: Did the bottom-up factors of vigilance, position in display, size, colour and visual complexity impact the results?

There was, within both of the tests of this study, a wide variability across the items with respect to both the speed with which items were located, and the accuracy with which they were located. The means, standard deviations and ranges in terms of *Time* and *Score* over the 36 items are recorded in Table 20. A more detailed record of the data pertaining to the items can be found in Appendix Y and Appendix Z.

Table 20

Means and Standard Deviations for Time *and* Score *Across all Test Items*

Variable	Number of items	Time			Score		
		Mean	SD	Range	Mean	SD	Range
ALP	36	9.11	3.95	2.52 - 21.05	.88	0.10	0.53 - 1.00
SUB		4.92	2.34	2.21 - 13.58	.94	0.06	0.72 - 1.00

From Table 20 it is clear that the participants responded variably to the individual symbols, both *within* and *between* the two tests. The mean time for ALP was 9.11 sec., whereas for SUB it was 4.92 sec. The mean time across the 36 test items ranged from 2.52 to 21.05 sec. in ALP compared to 2.21 to 13.58 sec. in SUB. The mean score across the 36 test items was 88% correct scores in ALP compared to 94% correct scores in SUB. The mean score ranged from 53% to 100% in ALP compared to a range of 72% to 100% in SUB.

The factors (other than the two strategies that were used for target location) that were investigated for relationships between the visual symbols and the speed and accuracy with which they were located in the visual display were vigilance, position in field and three symbol characteristics (size of picture, colour of picture and visual complexity).

Pearson correlation was applied to size and visual complexity. Friedman's 2-way analysis of variance was applied to the data for factors that were analysed in groups – position in visual field and colour. Spearman correlation was applied to the data for features where the scores of both variables were in the form of ranks, the variables were both

measured for the same individual, and the observations on each variable were between-subjects in nature (Tabachnick & Fidell, 2007) – vigilance.

Pearson correlation coefficients were also found for *Time* and *Score* (Table 21) and indicated a significant negative relationship between them - as *Time* increased, *Score* tended to decrease. The coefficients were -.84 (p=<.01) for ALP and -.67 (p=<.01) for SUB, representing a large effect (Field, 2009). That is, the longer it took to find an item in the tests, the less likely it was that the item would be found accurately. This relationship was stronger for ALP than for SUB.

Table 21

The Relationship Between Time *and* Score *Across all Test Items*

Variable	Number of items	Time			
		ALP		SUB	
		Correlation coefficient	*P*	Correlation coefficient	*P*
Score	36	-.84	<.01*	-.67	<.01*

Note. An * indicates significance at p<.05

Analyses on the items were done for ALP and SUB, but without further analysis of *Grade* or *Gender* within *Test*. The purpose of these analyses was exploratory only, to investigate if there were any tendencies towards interactions between the results of the research task and the features mentioned above. It is important to note that the features explored were not controlled for in the design of this research study, but may still have had an impact on the results.

From this point on, only relationships of *Time* with the independent variables are presented in the analysis of the results. Due to: (1) the overview nature of this analysis; (2) the close relationship between *Time* and *Score* in this study (see the high correlations noted in Table 21 above); and (3) the close relationship between the various variables and *Time* in visual search literature, it was considered an unnecessary distraction for the purposes of this section of the study to analyse the impact of the variables on *Score* as well.

4.5.1 Vigilance

In terms of *Time,* the impact of the sequence of items on the data was analysed to investigate whether there was an increase or decrease in the time taken to complete the tests as the test progressed. Spearman correlation coefficients were used to investigate the relationship between *Time* (the mean time per item) and the *Item Number* (order of presentation of items) (Table 22).

Table 22
Spearman Correlation Between Time *and* Item Number

Variable	Item No. (Order of items)			
	ALP		SUB	
	Correlation coefficient	*P*	Correlation coefficient	*p*
Time	.12	.21	-.17	.07

Note. p<.05

All the correlations were very low and not significant. This suggests that vigilance (the ability of an observer to maintain a high level of detection performance in visual search tasks over long periods (Uttal, 1998)) did not significantly influence the time taken to complete the test items as the tests progressed, neither for ALP nor for SUB.

4.5.2 Position in Display

The impact of the position of the symbols in the visual field was analysed. The visual field was divided into three areas for both columns and rows (Figure 6). The mean times for *Position in display* were compared (Table 23).

Table 23

Friedman Analysis of Variance for Time *with Respect to* Position in Display

Variable		Column + Row Groups	ALP			SUB		
			Mean	SD	*p*	Mean	SD	*p*
Time	Column	Left	9.37[a]	3.88		5.22[a]	1.91	
		Centre	8.69[b]	4.83	.01*	4.77[a]	1.64	.11
		Right	10.20[a]	4.96		5.07[a]	2.05	
	Row	Top	8.83[a]	5.10		5.83[a]	2.24	
		Middle	9.90[b]	4.25	.06*	5.10[b]	2.01	<.01*
		Bottom	9.36[cb]	4.28		4.11[c]	1.32	

Note. An * indicates significance at p<.05.

Note. The means of the variables with different superscripts ([a, b, c]) differ significantly.

There are significant differences in the mean times for *Column* in ALP, but not in SUB, and for *Row* in both ALP and SUB (Table 23).

With respect to *Column*, in ALP the centre column or area of the visual display was the area in which target symbols were located fastest (8.69 sec., compared to 9.37 sec. in the left area and 10.30 sec. in the right area).

With respect to *Row*, in ALP the symbols were located fastest in the top area of the visual display but slowest in the middle area (9.90 sec.). In SUB, the mean times for target location decreased from top to bottom (5.83 sec. in the top area, 5.10 sec. in the middle area and 4.11 sec. in the bottom area).

4.5.3 Symbol features

4.5.3.1 Size

Pearson correlation coefficients were determined for *Size* by correlating the mean times of the 36 test items with *Size* (calculated as the percentage area covered by the symbol in the grid cell for each item and ranked from smallest to largest). (Table 24)

Table 24

Pearson Correlation Between Time *and* Size

Variable	Size			
	ALP		SUB	
	Correlation coefficient	*P*	Correlation coefficient	*p*
Time	-.01	.95	-.31	.01*

Note. An * indicates significance at p<.05

The mean time for *Size* was 41.62 sec. with a range of 22.25 to 95.37 sec. (SD=13.26).

The Pearson correlation coefficients for *Time* were significant for SUB. The correlation coefficient for *Time* in SUB was negative (-.31, p=.01). This represented a medium effect (Field, 2009) and indicated that as the size of the symbol increased, the time to locate the symbol decreased (locating the symbols became faster).

4.5.3.2 Colour

The mean times for each of the colour groups were compared (Table 25).

Table 25

Friedman Analysis of Variance for Time *with Respect to* Colour

Variable	Colour groups	ALP			SUB		
		Mean	SD	*p*	Mean	SD	*p*
Time	Black + white	7.24[c]	4.91	<.01*	5.01[b]	2.46	<.01*
	Grey	9.81[ab]	4.72		5.62[ab]	2.27	
	Brown	10.79[a]	4.92		6.05[ab]	2.12	
	Blue / green	9.77[b]	5.91		3.76[c]	1.62	
	Red / orange	7.14[c]	5.02		3.17[c]	1.10	

Note. An * indicates significance at p<.05.

Note. The means of the variables with different superscripts ([a, b, c. d, e]) differ significantly.

There were significant differences between the mean times for the colour groups in both ALP and SUB.

The mean time was highest for the brown group of items in both ALP (10.79 sec.) and SUB (6.05 sec.), indicating that the brown group of symbols was the slowest to locate. There were significant differences between the brown group and all the other groups (except the grey group), in both ALP and SUB.

The mean time was lowest for the red/orange group of items in both ALP (7.14 sec.) and SUB (3.17 sec.), indicating that the red/orange group was the fastest to locate. The differences between the red/orange group and all the other groups were significant (except for the blue/green group in SUB).

4.5.3.3 Visual complexity

Pearson correlation coefficients were determined for *Visual Complexity* by correlating the mean times for each item with the JPEG value of each item (Table 26).

Table 26

Pearson Correlation between Time *and* Visual Complexity

Variable	Visual Complexity			
	ALP		SUB	
	Correlation coefficient	*P*	Correlation coefficient	*p*
Time	-.11	.24	-.26	.01*

Note. An * indicates significance at p<.05

The mean time for *Visual Complexity* was 6.33 sec. with a range of 4.13 to 9.28 sec. (SD=1.26).

Pearson correlation coefficients were only significant for *Time* in SUB, but weak (-.26, p=01), representing a small effect of size on *Time* in SUB. The correlation coefficient was negative, indicating that as the visual complexity of the items increased, so the time to locate the items tended to decrease (locating the symbols became faster). This must, however, be treated with caution as the correlation coefficients were low.

4.6 Summary

Research Question 1: Test differences

The participants were faster and also more accurate in SUB than in ALP.

Subquestion: Differences regarding Grade and Gender

Differences within the tests: An increase in *Grade* resulted in both higher rate and higher accuracy in both the tests. Females were faster in ALP than males, but not more accurate.

Differences between the tests: Concerning *Time* and *Score* the mean difference between ALP and SUB was significant for all the grades and also for both the male and female participants. The mean differences between ALP and SUB decreased as *Grade* increased, for both *Time* and *Score*. Most of the participants, with respect to *Grade* and *Gender*, were faster as well as more accurate in SUB than they were in ALP.

Error selections for Grade and Gender: For all the grades, both the escape and error selection percentages were higher for ALP than for SUB. The escape option was frequently used in Grade 1, particularly in ALP. The differences in performance between males and females in terms of incorrect selections were minimal.

Variability: There was a variability of performance in both *Time* and *Score* within and between the tests in *Grade*, which decreased as grade increased. The variability was greater in ALP than SUB. There was also a variability of performance in *Gender*, which was more evident in *Male* than *Female*.

Research question 2: Impact of bottom-up factors

There was a wide variability in the rate and accuracy with which individual items were located in the study, in both ALP and SUB. There was also a strong relationship between the time taken to select an item and the accuracy of selection.

There was no indication of fatigue or practice having influenced this study. Items were located with variable speed with respect to their position in the visual field.

Size and visual complexity impacted on speed of target location in SUB only, and colour in both ALP and SUB.