

Chapter 3

Research Methodology

3.1 Introduction

In this chapter, the methodology of the research project is explained. The study required a pre-experimental phase (Phase 1) for the development of the material, a pilot study to test the suitability of the material and procedures on the targeted participants and to inform adjustments to the material (Phase 2), and an experimental phase (Phase 3). Figure 3 presents these three phases of the study in the form of a flow chart diagram.

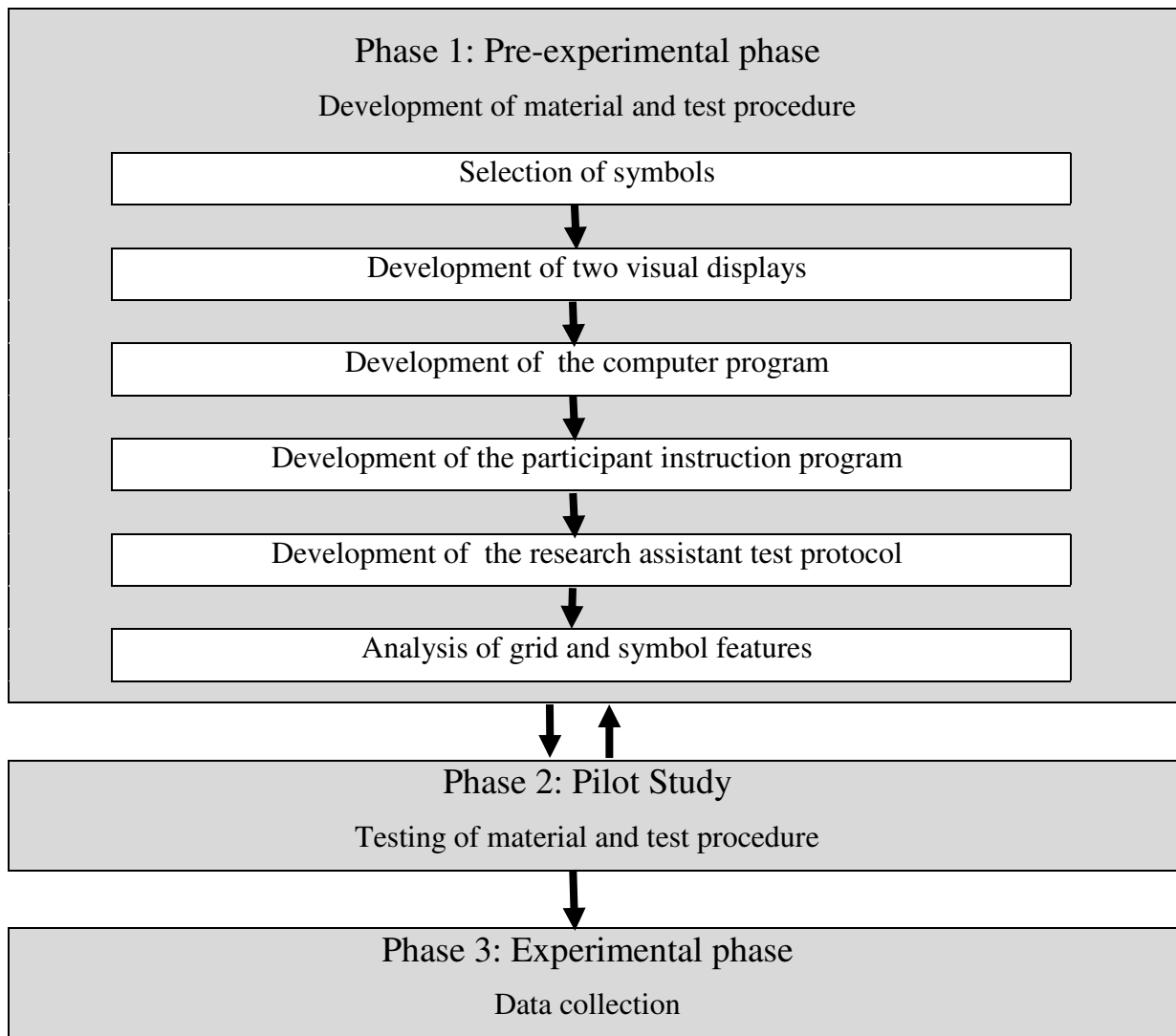


Figure 3. The phases of the study

3.2 Research question

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?

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

Research question 2

Did the bottom-up factors of vigilance, position in display, size, colour and visual complexity impact on the results?

3.3 Research design

The study used a cross-over group design (DePoy & Gitlin, 1994) in which both groups were exposed to the same tasks in alternating order to control for order effect. A stratified sample was used to ensure both groups were the same with regard to grade level and gender.

3.4 Phase 1: Pre-experimental phase

The pre-experimental phase was for the development of the material for the study. The steps of the pre-experimental phase identified in Figure 3 will be expanded on briefly:

Phase 1 included: (1) selection of symbols to include in the study; (2) development of the alphabetically ordered and categorically ordered displays; (3) development of the computer program that presents the tests and the data management system to record the testing procedures; (4) development of the instruction necessary for participants to complete the tasks; (5) development of the research assistant instruction protocol; and (6) analysis of the grid and symbol features.

3.4.1 Selection of graphic symbols

The important issues to consider in the selection of the graphic symbols were that the symbols had to be familiar to all the participants – (easy to recognize (iconic) and given the

same name when labelled), available in a large set, suitable for subcategorisation into a number of groups, coloured and of high interest to the participants.

Coloured PCS symbols (Mayer-Johnson, 1992) were chosen as the symbol set to represent the animals in the study because of their availability, the extensiveness of the PCS set relative to other picture sets and because of their widespread use in the AAC field (Thistle & Wilkinson, 2009).

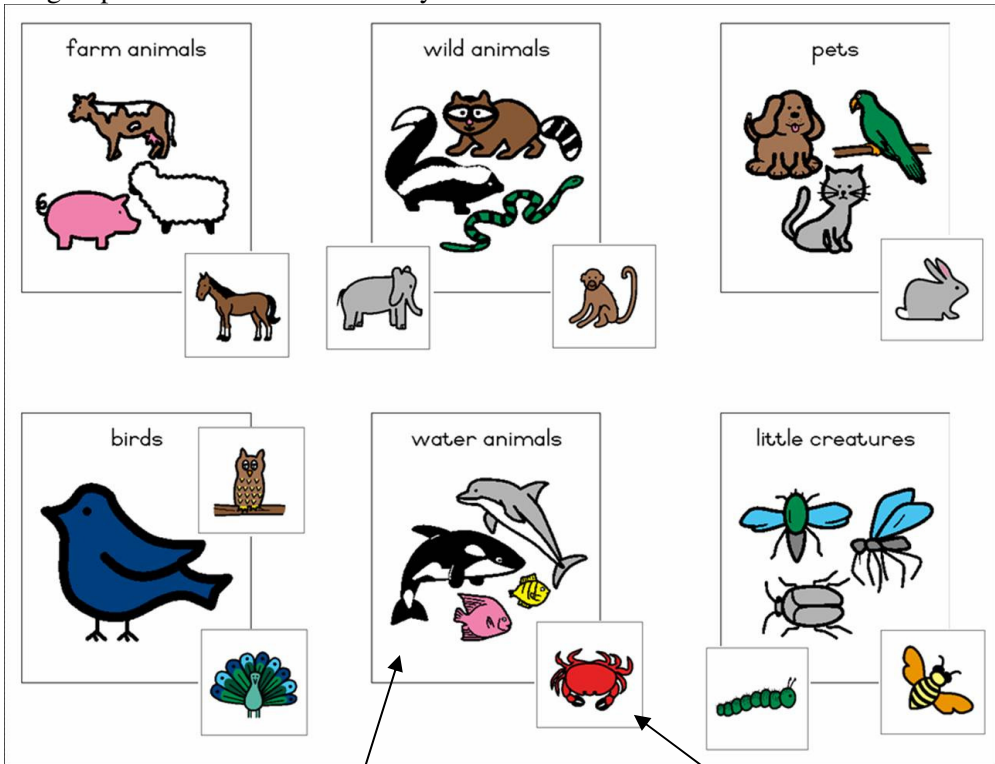
The superordinate category of Animals, with the subcategories wild animals, water animals, farm animals, birds, pets and little creatures was chosen.

The full range of 194 animal symbols available in a basic PCS set was analysed with the purpose of reducing the list to a more manageable size of 120 animal symbols which would most likely represent familiar animals to participants in Grades 1 to 3 in the South African context. Appendix A provides a record of all the animal symbols that were originally available for selection, the animal symbols which were discarded in this initial reduction process and the reasons for their removal.

The potential list of 120 symbols was refined to 81 symbols through testing 12 participants to identify the most familiar and consistently named animals symbols and the animal symbols most consistently assigned to the six pre-determined subcategories. The purpose was to find the most suitable symbols for the development of the two visual displays required for the two tests. Table 2 describes the process of selecting the symbols and describes the procedures followed in refining the potential list of 120 animal symbols to 81 animal symbols.

Table 2

Refining the Symbol List

Elements of the refining process	Brief description of the procedures
Participants	<p>Twelve typically developing Grade 0 to Grade 3 learners, drawn from personal contacts, a local school after care facility and a local nursery school participated in this step.</p> <p>Verbal permission was obtained from the relevant parents, supervisor and headmistress.</p>
Material	<p>Six group identifier cards and 120 symbol cards.</p>  <p>The diagram illustrates the materials used. It shows six group identifier cards, each containing a set of animal illustrations. The categories are: farm animals (cow, pig, sheep, horse), wild animals (raccoon, skunk, snake, elephant, monkey), pets (dog, cat, rabbit, parrot), birds (blue bird, owl, peacock), water animals (dolphin, orca, fish, crab), and little creatures (beetle, fly, caterpillar, bee). Arrows indicate that the larger boxes are 'Group identifier cards' and the smaller boxes are 'Symbol cards'.</p>
Method	<p>The six group identifier symbols were laid out in front of the child as shown above and were defined by the researcher by their most identifying criteria. The small symbol cards were handed to the child one by one, who had to name the animal symbol and then place the symbol card on the group identifier card where he thought the symbol card belonged. As PCS did not have a group identifier symbol for birds, the single symbol for bird was used. The name or names given by the child (exactly as the child said it) and the category the child assigned the animal symbol to, was recorded. Appendix B provides the scoring sheet that was used.</p>
Results	<p>Scores for naming the animal symbols the same name correctly covered a wide range of 42–93 correct names out of 120 symbols (Appendix C). It is important to note that the scores were subject to strict scoring criteria. If the child said <i>little bird</i> rather than <i>bird</i>, the response was marked as incorrect. If the child provided two names, even if the one was correct, the response was marked as incorrect. Category placement was shown to be much more constant across the participants than labelling. Scores for assigning the animals to the same categories as the researcher assigned them ranged from 93-109 correct scores out of 120 symbols (Appendix C).</p>

Elements of the refining process	Brief description of the procedures
	<p>It was considered that some of the categorization of symbols into different categories than expected could be averted by changes to details within the graphics, since the original PCS group identifier symbols were not adequately suitable for defining the subcategories used in the study. It was important to the study that strong category concepts be established in the learners and that the group identifier symbols fulfil the criteria of representativeness (being prototypical) of the animal category group and familiarity to South African children.</p> <p>The written word labels for the animals represented on the test symbols did not appear above the animal symbols during the above screening procedure. The researcher considered that this omission may have influenced the labelling discrepancies among the learners and that labelling issues could be reduced by having the gloss present.</p>
<p>Decisions for implementation in pilot study</p>	<p>Ninety two symbols were chosen that fulfilled both the requirements of eliciting the same basic, simple name across the full range of the learners, as well as being the most frequently assigned to the same subcategories. Eighty one were then selected from this group to be included in the visual displays, fulfilling additional requirements of a balanced distribution of symbols across the six categories and letters of the alphabet.</p> <p>When explaining the categories to the participants during instruction, the definition of the categories would need to be thorough.</p> <p>A computer graphic artist adjusted some of the group identifier symbols. Appendix D indicates what the original PCS category symbols looked like, what difficulties they presented with and how they were reworked to be more suitable. Changes were also made to three of the original PCS animal graphics for the pilot study, either to add or remove detail that would facilitate the desired category placement or would prevent an incorrect category placement (Appendix E).</p> <p>It was decided that in the tests in the pilot study the written word label (gloss) would appear above the animal symbol.</p> <p>A table displaying the 81 animal symbols selected and the reasons for their inclusion or rejection on the basis of naming inconsistencies is presented in Appendix A.</p>

3.4.2 Development of the visual displays

After the selection of the 81 animal symbols two visual displays were developed. The first was an Alphabetical Order (ALP) visual display (Figure 4) and the other a Subcategory (SUB) visual display (Figure 5).



Figure 4. Screen view of ALP visual display



Figure 5. Screen view of SUB visual display

The symbols in the ALP visual display were arranged in alphabetical order, starting from the upper left corner of the top row through to the bottom right corner of the bottom row. The symbols in the SUB visual display were placed in their category groupings. Symbols were chosen and shuffled so that in each display each third of the display (left-centre-right, top-middle-bottom) had as equal a number of test symbols as possible. The final number of symbols in each third of the display varied from 10 to 14. This is important for later statistical analysis of the influence of the position of the symbols in the display. Appendix F presents the layouts of the symbols across the two visual displays.

Six colours were chosen for the SUB display that represented colours that were distinct from each other, but were not bright or dominating, so as not to distract visually from the symbols. The same six colours were used in the ALP display.

It is important to note that the colours in the visual displays appear a little stronger in the printed form of the visual displays than they appeared on the computer screens. The function of the background colours was to serve as area markers only – muted colours were sufficient for this demarcation. It was considered important to avoid the possibility that stronger colours may distract in the visual perception of the symbols themselves.

3.4.3 Development of the computer program

An independently operated program was created for the research study using The Grid™ software (The Grid, 2002). The purpose of this program was to present the pre-tests and tests, and to manage the data collection.

The tests required the presentation of 36 test items within a set of 72 linked grids that could be operated independently by the participants. Each test item was presented as a single symbol cell with a white background in the centre of a grey display and was followed by either the alphabetical order visual display or the subcategorisation display. Appendix G provides greater detail about these tests.

The Mouse Control Screening (Herold, 2004), a pre-test, served to screen the functional mouse ability of the participants as mouse control was a fundamental skill required for execution of the tests. Mouse control can be impacted by motor difficulties, visual difficulties and inexperience. Appendix H describes this pre-test in greater detail.

The ALP Pre-test was designed to test the ability to determine the starting letter of the animal name and then find that letter in an alphabetically ordered array. The SUB Pre-test was developed to test the ability to subcategorise animals into the given groups. The ALP

and SUB Pre-tests were both selection criteria pre-tests. There were five test items in each of the tests, within a set of 10 linked grids. Four out of five test items had to be selected correctly for the participant to pass the pre-test selection criteria.

An orientation program for the ALP and SUB pre-tests and tests followed the identical pattern of the pre-tests and tests. Six practice symbols were built into the program to be worked through before formal testing began. The six practice symbols were chosen to cover a range of initial letters and all six subcategory groups. Appendix A provides a list of the symbols used for this purpose.

A set of grids preceding the tests were designed to capture within the data log files the participant information comprising the participant (A or B), the participant number, session (1 or 2), grade (1,2 or 3), gender (M or F), research assistant (1-4) and computer number (1-4). This procedure ensured rigorous control of data. The session, research assistant and computer numbers were not used in data analysis, but for administrative control purposes only. The research assistant would be required to enter the administrative details associated with each participant at the beginning of each session. An overview of the administration process and grids is presented in Appendix I. The computer program began with the administrative section before guiding the participants through the pre-tests, and then the tests. The two testing sessions (to test ALP and SUB) were divided by a 10-minute break.

Internal logging on the computer was set to occur automatically throughout the pre-tests and tests.

After the operating program was developed, it was tested on various children and fellow research students to ensure that there were no errors in it and that it was sufficiently simple to operate independently.

3.4.4. Development of the participant instruction program

An instruction program was required to prepare the participants for the pre-tests and tests. This included orientating the participants to; (1) the principle of searching a visual field in terms of categories; (2) the principle of searching a visual field in terms of alphabetic order; and (3) the structure of the computerised test program and the pre-tests.

The instruction was designed as a group session. It had two components – a pen and paper instruction workbook and watching a demonstration of the computer test program. It also included A3 visuals of the computer screens so that the researcher could point directly to the specific aspects of the procedure during instruction.

A structured script for the instruction program was drawn up and modified on the basis of input and recommendations by fellow research students. Appendix J provides the complete instruction script used by the researcher in instructing the learners while Appendix K provides the complete instruction workbook used by the participants during instruction.

The principle aspects of the instruction included: (1) equivalent instruction of all of the participants through structured scripts; (2) presenting the instruction and task requirements in sufficiently simple language for all the participants to understand and execute; (3) equipping the participants with sufficient knowledge to enter the research task confident that they know what to do and that they have the skill to do it; (4) stressing the need for the participants to work both quickly and accurately during the research task; (5) providing repetition to consolidate the concepts; (6) providing a booklet to structure in active participation, concretise concepts and maintain optimal attention; (7) providing feedback by having research assistants check that the participants execute instructions correctly, and correct the participants where errors are noted; (8) instructing the participants on what to do when they have difficulties during the research task; (9) providing opportunities to ask questions; and (10) group watching of a visual demonstration of what the participants could expect in the computer test program in order to make them feel comfortable with the process.

3.4.5 Development of the research assistant test protocol

A structured script was provided for the research assistants to guide them through the test administration (Appendix L). It took the form of an A4 booklet with large font text, one page for every section of the test – administration, pre-test, test, break, administration, pre-test and test.

3.4.6 Analysis of grid and symbol features

To later investigate the relationship between the results and the position of the symbols in the grid and the size, colour and visual complexity of the symbols, these characteristics had to be determined and recorded.

For the position of the symbols in the display, the rows and columns of the 9 x 9 grids in the two visual displays were divided into thirds, both horizontally and vertically, as can be seen in Figure 6. The horizontal thirds were termed top, middle and bottom and recorded as Group 1, 2 or 3. The vertical thirds were termed left, centre and right, and recorded as Group 1, 2 or 3.

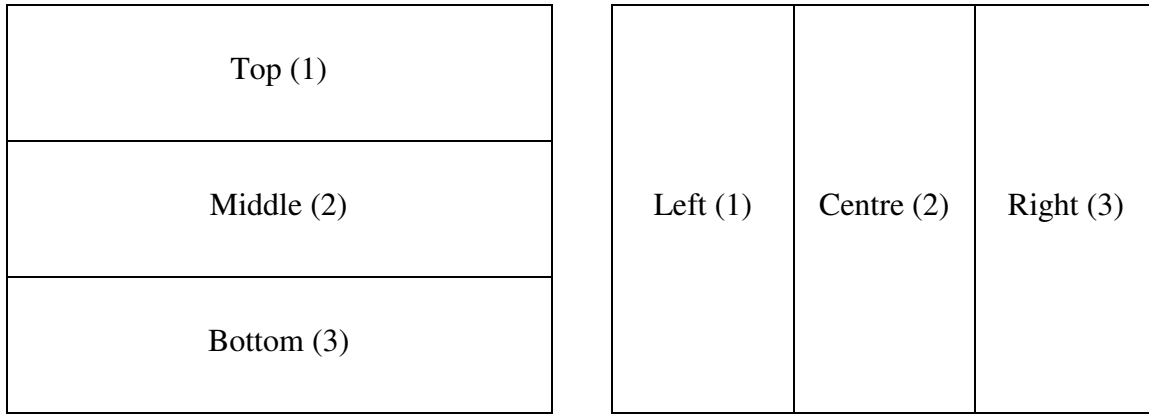


Figure 6. Position in display

The size of the symbols was determined through the use of a software program called Analysing Digital Images (a free Internet download). The pixel value of each symbol was calculated and recorded as a percentage of the total area covered by the symbol. Figures 7 and 8 are screen views of the analysis for one of the symbols. The size of the symbols ranged from 22.25% to 95.37% of the area covered by the symbol. This size difference was a feature of the PCS symbols themselves, and not manipulated by the researcher.

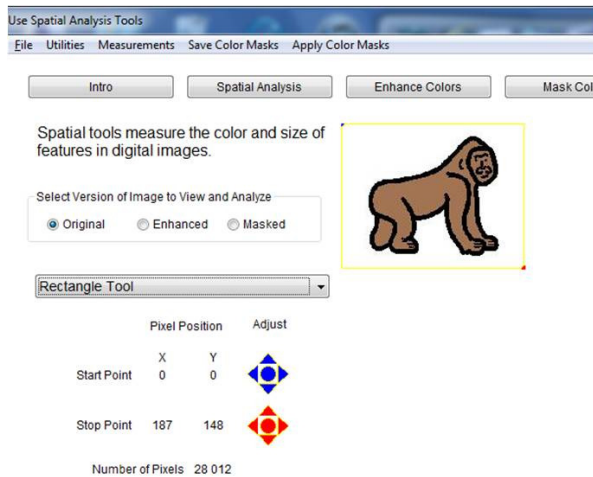


Figure 7. Pixel count of total area

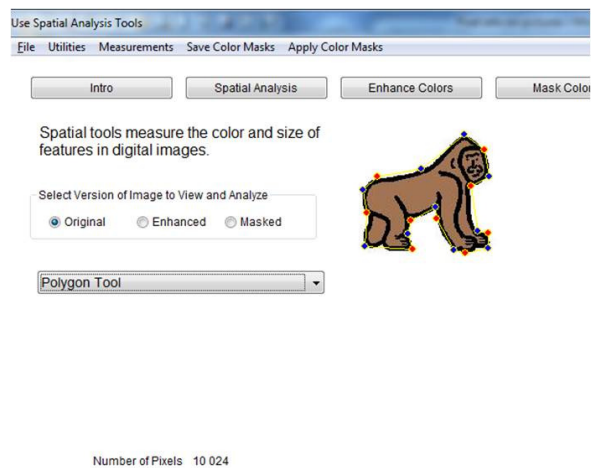






































Figure 8. Pixel count of symbol area

The 36 test items were allocated to one of five colour groups, depending on their dominant colour – *Black & White*, *Grey*, *Brown*, *Blue/Green* and *Red/Orange*. Table 3 shows the distribution of the symbols.

Table 3

Distribution of Symbols into Colour Groups

Colour	Animal symbols							
Black and white								
Grey								
Brown								
								
Blue/Green								
Red/Orange								

For a measure of visual complexity, the Joint Photographic Experts Group (JPEG) value of the symbol was recorded for each of the 36 test items. JPEG values have been used in previous research as an objective measure of visual complexity (Szekely & Bates, 2000). The JPEG values across the test items of this study ranged between 4.13KB and 9.28KB.

Appendix M provides a record of the information pertaining to *Position in the Display*, *Size*, *Colour* and *Visual Complexity*. The size, colour and visual complexity of the symbols were identical in the two displays, as the same PCS symbols were used in both displays.

3.5 Phase 2: Pilot study

3.5.1 Participants

The 12 participants for the pilot study were drawn from the Sunday school children of a local church. The children's parents were informed of the nature of the study and their signed permission was obtained to conduct the pilot study with their children as participants.

Although the sample group for the main study would be drawn from Grade 1 to Grade 3 children, piloting included Grade 0 children because it was considered important to understand the performance of the youngest participants in the sample group with the aim to determine the lowest age-group that would cope with the main study.

3.5.2 Aim, problems and recommendations

The objectives of the pilot study were to determine the following: (1) the logistics and flow of the test procedure (administration); (2) the suitability of the instruction program; (3) the suitability of the test program for the target age-group with respect to task comprehension and fatigue; (4) the usability of the data captured in the log files; and (5) the suitability of the research assistant instruction.

Firstly, problems were found with the administration of the test. Participants finishing their tests before others were disruptive to them, so the logistics of participant arrival and departure had to be tightened.

Secondly, the instruction program appeared adequate and suitable, although it was found that some of the participants worked faster than others did. To streamline the time taken for test execution, adult support would be maximized by having all research assistants available to ensure all participants kept up with the instructions at the same pace. Also, class teachers would be present to facilitate control of the group.

Thirdly, a number of changes were made to the test program after piloting. It was found that the ALP test took significantly longer than the SUB test. Also, the three repeat trials of each test (to investigate the impact of practice) proved to be too long for some of the participants, especially in the ALP test. Reflection resulted in the decision to remove the repeat trials from the test and contain the study to an investigation of first exposure visual search only. This would reduce the number of test items from 72 (18 items + 3 repeats of those 18 items) to 18. This significant reduction in the number of test items (and therefore testing time) allowed for the addition of test items to the test. It was decided to present 36 items in each test in the main study. Further reduction of total test time was made by removing the second ALP pre-test, which had been designed for descriptive purposes only.

Participant instruction would need to pay greater attention to the use of the escape option and the need to work accurately and carefully, as participants were sometimes insecure in knowing what to do when they couldn't find the target symbol.

Fourthly, problems were identified when linking participant information to the log files created during testing. This was solved through adding into the program design the requirement that the necessary participant information such as grade, gender, group and sessions be entered prior to *both* sessions of the testing so that all the administration data would be integrated directly into a new log file for each testing event.

Also, on analysing the data in the log files, it became apparent that managing multiple errors would, statistically, be a problem. Participants sometimes made multiple selections to find the correct one. The program was originally designed so that only the correct selection activated the link to the next test item. This problem would be addressed by redesigning the program so that every selection, whether incorrect or correct, would now result in the next test item appearing.

Finally, the research assistant instruction would need to be addressed, as the assistants were sometimes insecure in their role and uncertain of what to do when problems arose. A detailed script would be provided with hands-on experience before testing.

Appendix N presents a more detailed report on the problems encountered in the pilot study and the solutions to those problems.

3.5.3 Discussion of results of the pilot study

A summary of the data from the pilot study is presented in Appendix O. Some insights that were gained from the pilot study data were:

In the pilot study, the ALP Test (first exposure) took on average 225 sec (almost 4 min.) and the SUB Test (first exposure) took on average 153 sec (about 2.5 min.) to complete.

The Grade 1 participant who scored the highest mouse screening time of 115 sec, which was much longer than the next highest score of 85 sec, was also the participant who struggled the most with the ALP test. His time for the first round of the test was 391 sec. Because he was clearly struggling with the test, he did not complete it. This reinforced the need to determine competency in mouse control as a selection criterion.

Although there was a marked average reduction in the time taken to complete the four phases of the tests (first exposure and three practice rounds), there were a number of participants whose times increased during the last two phases. This indicated a conflict between the effects of practice and fatigue. To reduce the effects of fatigue, the task in the main study was made less demanding with respect to the length of the test by reducing the

length of the test in the main study to one half of the length it was in the pilot study. This was done by removing the three repeat rounds and doubling the number of test items.

3.6 Phase 3: Main study

3.6.1 Introduction

The main study was conducted in a middle-class socio-economic suburb, all participants coming from the same school. There were 155 potential candidates in the Grade 1 to 3 classes distributed between three Grade 1 classes, two Grade 2 classes and two Grade 3 classes. The average class sizes ranged between 20 and 24 learners. Testing was executed in June, the middle of the academic year in South Africa.

Ethical clearance for the study was obtained from the University of Pretoria (Appendix P). Formal permission to conduct the study was obtained from the principal of the school as well as from the school's Governing Body, all the teachers from whose classes children were used for the study and the parents of the children. The consent documents included information concerning the purpose of the study, what the study at the school involved, what was required of them and what would be required of their children.

3.6.2 Participant selection criteria

Table 4 outlines the selection criteria for the participants for the study and indicates how the criteria were assessed. The table also includes some comments that explain the importance of the criteria to the study.

Table 4

Participant Selection Criteria

Selection Criteria	Method	Motivation
School Grade 1 to 3	Obtain the class lists for all the Grade 1, 2 and 3 children in the school from the school secretary.	The possible impact of the participants' academic level on test performance
Permission from parents.	Forms requesting informed consent sent home to parents two weeks before testing. Reply slips signed by parents were required.	Ethical obligation (Appendix P)

Selection Criteria	Method	Motivation
Child assent	Assent forms were required to be signed by each child. These were attached to the instruction manuals and signed before commencing with instruction.	Ethical obligation
No attention deficit	Teacher's questionnaire: Does the child show difficulty with independent completion of school tasks demanding concentration for less than 10 min.?	As the research task was timed, and required maintained concentration for about 20 min., it was important that the participants be able to maintain focus on the task for its duration. Children with uncontrolled attention difficulties and difficulties in maintaining attention were not eligible for selection.
Absence of specific sensory difficulties that may impact on test performance	Teacher's questionnaire: Does the child have any other specific difficulties, such as uncorrected hearing or uncorrected vision difficulties?	Appendix Q contains the teacher's questionnaire.
Motor and visual difficulties	Participants scoring speeds of more than 2 standard deviations longer than their peers on the mouse control screening were considered to have co-ordination skill difficulties and/or insufficient visual skills for the research task.	Motor and visual difficulties could impact on functional mouse control and speed of symbol identification on the screen. Because timing and visual discrimination was an issue in this study, it was considered important to control for it. Test symbols that had to be clicked on were significantly bigger than the symbols used in the mouse control screening. Therefore, if participants could complete the mouse control screening within 2 standard deviations of scores for the group, they were considered to have adequate motor skills and visual acuity for this test.
Passing of SUB Pre-test	Allocation of five animal symbols to one of six subcategory animal groups.	Participants had to demonstrate the ability to categorise. They had to allocate 4 out of 5 test items correctly to qualify for selection.
Passing of ALP Pre-test	Indicating the starting letter of five animal symbols.	Participants had to demonstrate the ability to identify the first sound of a word and to locate the written letter representing that sound on an ordered sequence of alphabet letters. They had to indicate four out of five test items correctly to qualify for selection.

Table 5 summarises the information relating to the number of participants who were available for selection, how many participants were disqualified on the basis of the selection

criteria and for what reason they were disqualified. Appendix R records the information in more detail.

Table 5

Summary of the Number of Participants Qualifying for the Study

Criterion	Grade 1			Grade 2			Grade 3			Total		
	F	M	Tot	F	M	Tot	F	M	Tot	F	M	Tot
Total number of children available initially	29	33	62	24	24	48	19	26	45	72	83	155
<i>Parental permission denied</i>	2	2	4	4	1	5	0	3	3	6	6	12
<i>Parental permission no reply</i>	3	4	7	2	1	3	0	2	2	5	7	12
Parental permission granted	24	27	51	18	22	40	19	21	40	61	70	131
<i>Selection criteria disqualifications</i>	2	4	6	3	2	5	1	5	6	6	11	17
<i>Child assent denial</i>	0	0	0	0	0	0	0	0	0	0	0	0
Total number of participants tested	22	23	45	15	20	35	18	16	34	55	59	114
<i>Mouse screening failure</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Subcategories Pre-test failure</i>	2	0	2	0	0	0	0	0	0	2	0	2
<i>Alphabetical order Pre-test failure</i>	0	0	0	0	0	0	0	0	0	0	0	0
<i>Spoiled data due to procedural errors</i>	0	0	0	2	0	2	0	1	1	2	1	3
Total number of participants whose data was used for analysis	20	23	43	13	20	33	18	15	33	51	58	109

3.6.3 Participant description criteria

In Table 6 a summary is presented of the participants according to age, gender and grade. For a more detailed record of the age range of the participants, see Appendix R. Only participants whose data was used for analysis are recorded in the table.

Table 6

Participant Description Criteria

Grade	Male			Female		
	Years	Range (years)	Number	Years	Range (years)	Number
Grade 1	6.07 - 8.08	2.01	23	6.05 – 7.05	1.00	20
Grade 2	7.07 – 9.03	1.08	20	7.05 – 9.00	1.07	13
Grade 3	8.02 – 9.05	1.03	15	8.06 – 9.05	0.11	18
All	6.07 – 9.05	2.10	58	6.05 – 9.05	3.00	51

The age range within the grades varied between 11 months and 2;1 (years;months). This age-range is acceptable within the South African context (where late school entrants, academic year repeats and absorption of children from other international school systems are common occurrences). As formal instruction was deemed an important factor in the acquisition of the alphabetical and categorisation skills required for the task, construction of the sample according to grade rather than age was preferred.

3.6.4 Distribution of sample into two groups

The sample was divided into two groups (A and B). The participants who passed all the permission and teacher-measured criteria were sorted and arranged firstly by grade, then by gender within grade and then by age within grade and gender. Once the 114 participants were arranged as explained, they were systematically divided off, one by one, into A and B groups. Appendix R explains the grouping procedure. The two groups executed the two tests in opposite order (ALP then SUB and SUB then ALP).

Five participants were lost before final compilation of the two groups, two due to pre-test failure and three due to procedural errors. There was also a gender allocation error, where a participant was marked male but was found to be female during testing. To determine if there were differences between the two groups in terms of grade and gender, a chi-square test was done which confirmed that there were no statistically significant differences between the groups on the 5% level on these variables ($p=0.96$ for Grade and $p=0.92$ for Gender). The groups remained equal after the loss of the five participants and the gender allocation error, as indicated in Tables 7 and 8.

Table 7

Analysis of Group by Grade

Group	Grade			Total
	1	2	3	
A	22	16	17	55
B	21	17	16	54
Total	43	33	33	109

Table 8

Analysis of Group by Gender

Group	Gender		Total
	Female	Male	
A	26	29	55
B	25	29	54
Total	51	58	109

3.6.5 Materials and equipment used in the study

Additional material and equipment required for this study included computers, mice, The Grid™ software and the venue facilities for the testing.

Four laptop computers with the following specifications were used for all sections of the research study: ACER Amd Athlon 2650, 2GB memory, 160GB, DVD writer, 14.1” crystal bright screen, SD card reader, Windows VISTA Home Basic.

The laptops were bought specifically for the purposes of this study. They had no programs other than The Grid™ (The Grid, 2002) installed on them and were never used for any other function than this study.

Four identical mouse pointers were linked to the four laptops. They were conventional laptop mouse pointers, smaller than the average PC mouse, which was well suited to the smaller hands of the participants. The model of the mouse was MS Compact 500.

The Grid™ (The Grid, 2002), a PC software program created by Sensory Software International, was used for all the tests and data collection during the tests. The program was well suited to the creation of linked grids that could hold the large number of graphic content cells required for the tests in this study. In addition, The Grid™ had the facility to internally log every mouse click during an activity within The Grid™ program, as well as to document

the contents of any cells that were selected, together with a time stamp of the mouse click event – all vital requirements for the execution and recording of the tests in this study.

Four computer stations were set up in one large room. Immediately outside the venue a registration point was set up from where the researcher could control the arrival of each participant, administer the registration process and manage the refreshment station.

3.6.6 Data collection procedures

The total amount of time required for each participant to complete the full test procedure was about 30 min. Table 9 outlines the steps and the time allocated to each step.

Table 9
Sequence of Events and Time Requirements

Group A	Group B	Time required	Time
	Administration	1.5 min.	
	Mouse Control Screening	1 min.	10.5 min.
Subcategories Pre-test	Alphabetic Order Test	1 min.	
Subcategories Test	Alphabetic Order Test	7 min.	
	Break	10 min.	10 min.
	Administration	1.5 min.	
Alphabetic Order Pre-test	Subcategories Pre-test	1 min.	9.5 min.
Alphabetic Order Test	Subcategories Test	7 min.	
	Total	30 min.	30 min.

Note. min.=minute

The participants were collected four at a time from their classes by a research assistant (after prior arrangement with their teachers). They waited outside the testing room until it was time for their turn. As they entered the room they were given a registration slip (Appendix S) and directed to a computer station. A research assistant then immediately began following through the procedural script (Appendix L), beginning with a welcoming of the participant by name, followed by the administration requirements, the testing sequence and closing thanks. The procedural script served to guide the research assistants in the exact testing procedure and handling of the participant (including putting them at ease and informing them of what was expected of them). After completion of the test, the participants were given a gift of a pack of playing cards and escorted back to class.

Data collection procedures included the creation of a log file for each participant, processing of the log files, a procedural integrity check for the instruction program and a procedural integrity check for the testing.

The dependent variables were coded in the following manner: Time was measured in seconds and was the time taken between the mouse click on the target symbol and the first mouse click on the visual display which followed the presentation of the target symbol. Score was recorded as a 1 if the symbol located in the visual display was the same symbol as the target symbol, and as a 0 if it was not the same symbol as the target symbol (whether it was an incorrectly selected symbol or an escape option).

To keep participant information and test data linked, all participant information was entered into the computer by the research assistants at the beginning of each session. The information was prepared in advance on individual registration slips (Appendix S).

Log files in coded digital information were created for every test session, which had to be collated and processed into a MS Office Excel spreadsheet for statistical analysis. A more detailed explanation of the steps required for the processing of the log files is provided in Appendix T.

Three instruction sessions were executed by the researcher (one for each grade). Each session was assessed for procedural integrity through direct observation by two raters who were equipped with a copy of the researcher's instruction manual and participant workbook. They assessed the extent to which the instruction was implemented as originally designed (Lane et al., 2004). Their task was to check that all units of the instruction procedure had been executed in the same manner for each instruction session, note any deviations or irregularities in the research protocol, any imbalances in instruction style between the three grade instruction sessions and any other observations deemed relevant. The raters scored the researcher with 100% for executing the required steps. Appendix U contains the form the raters had to fill in as well as their scores and comments. Comments included that the participants were sometimes not able to see the computer screen and that sometimes the participants were not asked if they had any questions. The researcher considered these problems to not have had a significant impact on the study, as the participants had further opportunities to observe and ask questions during the computer orientation practice session preceding the testing.

Procedural integrity for the testing procedure administration was verified through an assessment of the sound recordings made during testing. A percentage of 23.39 of the sound files were found to be either missing or damaged. A random sample of 16.97% of the

available sound files collected from the four research assistants was checked by an independent rater. The rater's task was to listen to the sound files of all verbal communication occurring between the research assistants and the participants to ensure that the testing procedure was executed as originally planned (Lane, et al., 2004). The rater was also required to note any deviations or irregularities in the testing protocol as well as any evidence of unauthorised verbal assistance. The rater scored the research assistants with an average of 93.92% in this check. Errors were mainly due to omission of enquiring of the participant which side he wanted the mouse on and absence of recording of a greeting or *thank you*. Appendix V contains the form the raters had to fill in as well as their scores and comments. Comments were primarily related to paraphrasing of instructions considered to be important ones. The mouse pointer positioning omission is considered by the researcher to not have presented the study with any difficulties, as the participants positioned the mouse pointers to their own comfort themselves (especially in the second testing session). The paraphrasing of instructions, such as "Think carefully" (during pre-tests) and "Work fast but be careful" (during tests) may have had methodological implications because different instructions in categorisation tasks can lead to different results (Blaye & Bonthoux, 2001; Osborne & Calhoun, 1998).

Further integrity checks were made during processing of the log files (where it could be determined if any sections had been omitted, repeated or incorrectly recorded) and through statistical analysis of the data in the extensive spreadsheet resulting from collation of all the participants' logged data, where missing or repeated data would manifest itself. There were three procedural errors made – two participants (No 47 and No 106) executed the SUB Test twice with the ALP Test not being executed, and one participant (No 46) did not complete the ALP Test. The data from these three participants had to be removed from the data bank.

Two data recording errors were found during the statistical procedures. Two time measures had been incorrectly recorded in the data (participants No 65 and No 109). The mean time over the 36 ALP items for those two participants was therefore underestimated by 4.96% and 1.78% respectively. The same items were recorded as correctly marked when they were in fact incorrect selections. Therefore, the mean correct score over the 36 ALP items for these two participants was overestimated by 3.00% and 2.98% respectively. These errors could not be corrected, having only been detected at the end of statistical analysis. However, considering that the mean time and score was mostly calculated over the 109 participants, the impact of the errors was probably minimal.

3.6.7 Data analysis

Table 10 outlines the statistical procedures (Tabachnick & Fidell, 2007) that will be applied to the data in order to interpret the results within the framework of the research questions. An analysis of variance (henceforth ANOVA) for Test, Group, Grade and Gender will determine which of the independent variables have significant rate and accuracy differences between them, Time and Score being the dependent variables. The outcome of the ANOVA will indicate how the main research question will be answered. If significant differences are found between the two organisational strategies, further investigation will determine if those differences extend through Grade and Gender, both with respect to within-group and between-group differences. Statistical analysis will then focus on an item analysis, investigating the influence of some bottom-up processes on the results.

Table 10

Data Analysis Procedures

Aim	Test
Determine which independent variables had significant differences in rate (Time) and accuracy (Score)	
Do an analysis of variance for Test, Group, Grade and Gender, to determine which variables had significant differences between them.	ANOVA
Research question 1: Is there - with respect to rate and accuracy of symbol location - a significant difference between the performances of the participants in locating symbols using either a colour-coded alphabetical or colour-coded categorisation organisational strategy for children in Grades 1 to 3?	
Compare ALP and SUB across the full sample	Means and SDs
Research sub-question: Are there differences in the performances of these children in their use of these strategies, with respect to grade and gender?	
Investigate within group differences with respect to grade and to gender.	ANOVA and Duncan
Investigate between group differences with respect to grade and gender.	T-Tests
Research question 2: Did the bottom-up factors of vigilance, position in display, size, colour and visual complexity impact the results?	
Compare the items with respect to rate and accuracy (across full sample)	Means and SDs of items
Investigate a relationship between rate and accuracy	Pearson
Investigate the impact of vigilance during the test procedure on location rate.	Spearman
Investigate the impact of the position of the symbols in the visual field (with respect to left, centre or right positioning, or, top, middle and bottom positioning) on location rate.	Friedman
Investigate the impact of the size of the symbol on location rate.	Pearson
Investigate the impact of colour groups on location rate.	Friedman
Investigate the impact of visual complexity of the symbols on location rate.	Pearson

Note. ANOVA=Analysis of variance

Note. SD=Standard deviation

3.7 Summary

A research plan was drawn up to compare the performance of the participants – with respect to rate and accuracy of symbol location – in locating symbols using either a colour-coded alphabetical or a colour-coded categorisation organisational strategy. The development of the research material was described.

The study was executed at a mainstream school. A sample of 114 Grade 1 to 3 participants was selected from the children passing the selection criteria. After a group instruction session, the participants were individually tested in a computerised research task.

A pilot study tested many aspects of the study, the results and recommendations of which were incorporated into the final design and procedures of the main study. Material used in the study was described, as well as data collection and analysis procedures.