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The Effect of Sequential Exposure of Colour Conditions on Rate and Accuracy of Graphic Symbol Location

by

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ABSTRACT

There has been limited research done to determine the impact of the use of colour on communication displays in the facilitation of graphic symbol location within an overlay. As many Augmentative and Alternative Communication systems are pictorial in nature, it is of importance that interventionists are aware of the potential impact that colour can have on the accuracy and rate of symbol location. The present study is based on a study by Wilkinson, Carlin and Jagaroo (2006) and used the same testing material (colour conditions) whilst modifying the type of exposure to these colour conditions.

This study investigated the effect of sequential exposure of colour conditions on the rate and accuracy of graphic symbol location. The study used a comparative, non-experimental group design using sixty participants who conformed to specific selection criteria. Each participant was exposed to three colour conditions that were placed in a specific sequential order. The participants were required to match a target, graphic symbol within an array of symbols in the differing colour conditions. Two different types of graphic symbols were used meaningful (Type A) and arbitrary (Type B). Two different colour sets were also used with the colour conditions varying in each set. Set 1 were the sequentially ordered colour conditions of same colour, mixed colour and unique colour symbols (difficult to easy) while Set 2 were the sequentially ordered colour conditions of unique colour, mixed colour and same colour symbols (easy to difficult).

The major findings of the study were as follows. In terms of rate, there was a significant interaction noted between the two symbol types and their sequential ordering. The time taken (rate) for the location of the non-referential forms was slower than that taken for the meaningful symbols. The reasoning behind this result could be that the non-referential forms were not as familiar to the participants as the meaningful symbols were. Thus, the rate recording of the meaningful symbols and the non-referential forms described in the three colour conditions was different and could be noted in the results.

In terms of accuracy, a significant impact was noted between the two symbol types when the first manner of sequential ordering was used, however, there were no significant differences noted when the second manner of sequential ordering was used. This implies greater accuracy was recorded when the second manner of sequential ordering was used as this ordering appeared to be “visually easier” for the location of symbols.

Key words in this study are: Augmentative and Alternative Communication (AAC), colour vision, sequential organization, meaningful symbols, non-referential forms, rate, and accuracy.

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CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter serves to provide an orientation and a background to the research. Included in this chapter are the terms and abbreviations used as well as chapter outlines.

1.2 Background and Problem Statement

AAC systems are frequently used to facilitate communication among individuals with little or no functional speech. These generally include both aided and/or unaided systems. Aided systems make use of an additional external device separate to the AAC user's body as part of their communication means (such as real objects, communication boards and/or devices with visual graphic symbols) while unaided systems only use the body and parts of the body (e.g. facial expressions, manual signs, vocalizations and speech). These varying means facilitate in assisting individuals to understand and compose messages for interaction (Beukelman & Mirenda, 2005). The present study is more focused on the use of aided systems, which generally utilize graphic symbols. These symbols are generally static in the AAC users' display (an aspect that is changing with the upgrading and transformation of technology) and are selected from the display through the use of memory (Sevcik, Romski & Wilkinson, 1991). The speed with which these graphic symbols are accessed on a communication display is an important factor in facilitating the rate and accuracy of communication of people who use AAC.

Important aspects of colour use for target symbol location have been discussed in a variety of studies such as that of Wilkinson & Jagaroo (2004), Nagy, Young & Neriani (2004) and Gegenfurtner & Rieger (2000). The manner in which colour has been used in a number of tasks and its significance in people's responses during certain tasks, especially those in

the visual search field, need to be better understood as a basis for enhancing the use of communication boards and overlays in AAC. This study, largely based on that conducted by Wilkinson, Carlin and Jagaroo (2006), found that differing colour symbols do influence the rate and accuracy of the graphic symbol location.

The present study seeks to make use of the software programme, devised for the study of Wilkinson et al. (2006) as a basis to investigate the effect of the sequential exposure of colour conditions on the rate and accuracy of graphic symbol location. Another aspect that was taken into account was the influence of meaningful symbols versus arbitrary ones and how they are affected by colour in specific target selection.

The hypothesis of the present study, based on the hypotheses of the study of Wilkinson et al. (2006) is that the rate of symbol location would be fastest with unique colour stimuli, at an intermediate level with mixed/split colour stimuli and slowest with same colour stimuli. In terms of accuracy of symbol location, the hypothesis of this study is also based on that of the study of Wilkinson et al. (2006), namely that accuracy would be greatest with unique colour stimuli, at an intermediate level with mixed/split colour stimuli and the least accurate with same colour stimuli.

1.3 Terminology

1.3.1 Augmentative and Alternative Communication

Augmentative and alternative communication is the "supplementation or replacement of natural speech and or writing using aided or unaided symbols" (Lloyd, Fuller & Arvidson, 1997) in order to enhance communication in a person with little or no functional speech.

1.3.2 Meaningful Symbols

Meaningful symbols are those that are iconic in nature implying that users can more easily understand the symbols and more easily guess the meanings, even without normal referents (Tönsing, Alant & Lloyd, 2005). Picture Communication Symbols (PCS) were used in the present study. They are a set of symbols made from a pictographic symbol set with a large number of symbols, allowing for the portrayal of a variety of concepts. Research has shown that PCS symbols are more transparent for pre-schoolers without disabilities than other symbol systems (Beukelman & Mirenda, 2005).

1.3.3 Non-referential forms

These are symbols that "bear no physical resemblance to the referrals they represent" (Sevcik, Romski & Wilkinson, 1991, pp. 163). The AAC user must unequivocally learn the meaning of these types of symbols. Examples of such symbols are written words or certain visual graphic symbols such as Lexigrams or non-referential forms (for example shapes).

1.3.4 Colour conditions

The colour conditions in the study are based on those used in the previous study; same colour, mixed colour and unique colour. The same colour condition consisted of red symbols only. The mixed colour condition consisted of both red and yellow symbols, whilst the unique colour condition consisted of different colour symbols. In the present study the colour conditions were divided into two different types of sequential ordering, namely, Set 1 (presentation of same, mixed and then unique colour conditions) and Set 2 (presentation of unique, mixed and then same colour conditions).

1.3.5 Visual Search Task

This is a commonly used task for the study of basic visual processing (Treisman & Gelade, 1980). It involves the use of participants locating a target stimulus amongst an array of other non-targeted stimuli and the measurement of their reaction time.

1.4 Abbreviations

AAC	Augmentative and Alternative Communication
SA	South Africa
VS	Visual Search
PCS	Picture Communication Symbols

1.5 Chapter Outline

The research is presented in five chapters. A synopsis of each chapter follows:

Chapter 1 provides a basic introduction and a rationale for the research.

Chapter 2 provides a theoretical rationale with a critical discussion of theoretical concepts, including theories of visual processing skills, specifically visual search tasks. Theories of colour with reference to target - matching will also be addressed.

Chapter 3 describes the methodology of the research study. It includes a description of the main aim and sub-aims, the research design, the pilot study and main study. Information regarding the participants as well as the materials and equipment used in the study are incorporated in this chapter.

Chapter 4 presents and discusses the research results of the study, with an emphasis on aspects relevant to the study. All components pertaining to the results obtained were integrated in this chapter, together with certain hypotheses relevant to the research.

Chapter 5 briefly reviews the research and evaluates the findings. Recommendations for further research conclude the chapter.

1.6 Summary

This chapter provides a motivation for the study by presenting some background information that led to the study, (as well as a description of the purpose). Outlines, together with aims, of all the chapters are also given.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter aims to describe the theoretical basis for the study by highlighting the important issues related to visual perception as well as symbol characteristics that may impact on rate and accuracy of symbol location. Firstly, AAC device display organization is discussed together with the importance of colour for target symbol location and selection. This is followed by theories pertaining to the importance of visual processing skills and target symbol location. Cultural influences in AAC are briefly discussed.

In addition, research studies most relevant to the present study are briefly described, followed by conclusions and the chapter summary.

2.2 Theoretical Rationale of the Study

To facilitate the reading and understanding of the theory pertaining to the present study, Table 2.1 discusses some of the relevant studies, which were influential to the present study. Please refer to this table in the appendices when further clarification is required (see Appendix A).

2.2.1 AAC and Device Display Organisation

Augmentative and Alternative Communication (AAC) devices/systems are used as a communication means for individuals with little or no functional speech. These devices/systems are composed of varying aspects (such as symbols, aids and techniques) that are used to enhance communication. These devices/systems are used to transmit and receive messages and comprise of *aided systems* (which place reliance on the use of specialised tools and equipment for the conveying of communicative messages) (Glennen, 1997). There are two domains of technology devices available

within the aided system group – the *low technology devices* and the *high technology devices* (Beukelman & Mirenda, 2005). Both of these types of systems incorporate the use of visual symbols. These symbols are composed of many different elements/ characteristics, which are important for defining these symbols.

The aided systems make use of visual symbols on a display (which are dependent on the individual system used), forming part of the device. As the display area on devices is quite limited in size, so too are the number of symbols displayed at a given time. This is why the selection and organization of these symbols is very important for individuals who use AAC, as the limitations in size mean limitations in vocabulary, thus stressing the importance of accurate symbol choice to be made by the user. Simpson, Hux, Beukelman, Lutt and Gaebler (1996) looked into organizing a display so that an attempted match with internal cognitive structures could be made. The reasoning behind this was that these displays could be similar to the organizational structure of the internal cognitive structures, especially in terms of the lexical organizations. Wilkinson and Jagaroo (2004) also propose that the internal cognitive structures are important, but with one major distinction, namely that not only is the physical layout of the displays important but that the actual structure of the symbols is too.

Transparent symbols are those that are iconic in nature. This implies that the symbols are easier to understand and that users easily guess the meanings, even with the absence of the normally necessary referents (Tönsing, Alant & Lloyd, 2005). Non-referential forms, on the other hand, are those that bear no physical association to the referents they characterize (Sevcik, Romski & Wilkinson, 1991). Mizuko (1987) also noted that iconic (meaningful) symbols are often easier to retain over non-referential forms, as the features that are perceptually noted already bear a resemblance to their referents. This is in agreement with the research of Clark (1981) that deduced that normally developing children who were older than three years of age learnt the iconic, visual-graphic symbols more easily than the non-referential forms presented. It has been stated that by the age of four it is likely that children

have reached a higher level of understanding in terms of abstract language. This level allows for a greater comprehension of how people "signal their intention to label, rendering them highly adaptable to various symbolic forms, provided that sufficient cues to labelling are present" (Namy, Campbell & Tomasello, 2004). It is thus important to realise that displays will never consist only of transparent or non-referential forms. The majority of displays contain a combination of the symbols and it is imperative that the person using AAC supplies an accurate, reliable and speedy response when initiating a conversation or responding to a question.

2.2.2 The Importance of Colour Use for Target Symbol Location and Selection

Colour is an important element of AAC displays. It is an element, which is common to all people and can be found in everyday situations in daily life. Moreover, according to Gegenfurtner and Rieger (2000), the processing of stimulus location, recognition and remembrance is helped by colour. It has also been noted that the use of colour in stimuli has helped for the later retrieval of the stimuli, as it is an additional attribute of the image. The retrieval of stimuli when colour is a factor is important in terms of long-term visual memory, as information regarding colour is stored in long-term memory together with other characteristics of objects (Hanna & Remington, 1996). Memory is the ability to recall information that has been previously learnt and subsequently stored. Memory is most apt when it has information that has been processed deeply and includes semantic interpretation and elaboration, relating to prior experience and existing knowledge (Owens, 2001). Memory is, however, not of major importance in this study but one must be aware of its significance in the long-term retrieval of stimuli. This is important for children who use AAC, as their memory is central for symbol placement on device displays regardless of the design layout used. Research has shown that colour allows for greater remembrance of naturalistic scenes, as the receptors respond more easily to the colour schema presented in these scenes as well as to certain components in the primary visual system. This

allows colour to be a contributing factor in perceptual attention or swiftness (Parraga, Troskiano & Tolhurst, 2002). We may ask if this implies that colour plays a role in the effective retrieval of symbols through visual processing. If so, are rate and accuracy of this target symbol location influenced by the use of colour?

By making use of colour, one takes into account the use of the visual accents that are described by Bailey and Downing (1994), whose research shows the importance of visual accents for assisting and guiding the participant towards a stimulus. It was noted that colour, when specifically used with "contrast highlighters", helped draw attention to certain symbols. In the present study, the same results were within the unique colour stimuli arrays as the search rate was most definitely seen to increase when this colour array was presented. This is in agreement with the research of Treisman and Gelade (1980), in which the greater similarities in surrounding stimuli make for an increased slowness of search rate. Thus the target symbol's characteristics, specifically colour, are influential in participant's rate of choice.

As stated previously, an important characteristic of symbols and the display thereof is colour. It has been noted that when colour is used for organizational or coding reasons, it should be easily distinguishable and useful to the user so that communication accuracy is increased (Bailey & Downing, 1994). Colour is a significant part of human life and even though much research has been done on colour and emotions it is not the main focus of this study. It must, however, be accepted that colour can substantially influence choice, and emotions play a definite role in decision-making. However, in the present study, the focus is on the influence of particular colour conditions on the rate and accuracy of locating symbols on a display. Familiar symbols are noted to be easier to recognise and learn for AAC users. In recent years, the use of modern technology has taken this ability to recognise symbols one step further – through symbol manipulation (Stephenson, 2007). The manipulation of symbols can be noted in this context as the changing of symbol colours to better suit the AAC user's

abilities, for example, a severely intellectually impaired user may be able to better recognise a symbol that matches the colour of its referent (linking to iconicity of a symbol). In terms of the present study, the deduction can be made can be that uniquely coloured symbols are more recognised than mixed or same colour symbols as they match to their referents. The research of Rossion & Pourtois (2004) in which coloured line drawings were more quickly and accurately labelled than the black and white drawings is in agreement with this and links again to the research of Johnson, Paivio & Clarke (1996), which suggests that pictures that are coloured in atypical ways are more difficult to recognise than those pictures which are coloured as per the norms (an example of this can be an "atypical" red banana as opposed to a "normal" yellow banana).

This is important as colour is described as an integral constituent that allows for the distinction of a stimulus from its surroundings (D'Zmura, 1991). It has been noted in research that there are three independent fundamental colour-coding mechanisms (Krauskopf, Williams & Heely, 1982) and that the combination of these three mechanisms can increase VS efficiency (D'Zmura, 1991). The advantage of this combination is that this allows for the greater "tuning" into the directions in colour space and, furthermore, facilitate for the searching of a target stimulus (Nagy & Thomas, 2003). This proves that the combination better provides information about the presence or absence of the stimulus. An example of this, which is relevant to the study, is a targeted visual symbol amongst other symbols. In this present study, familiar symbols and non-referential forms were used. The colours of both these symbol types were manipulated into three settings: red (same colour condition), red-yellow (mixed colour conditions) and unique (each colour condition differs from the next) as these were categorised in the prior study of Wilkinson et al (2006). The main requirement from the participant in the study was that he/she had to click on the sample symbol provided and then re-locate it amongst the different colour arrays provided, which were either sequentially ordered in Set 1 or Set 2. When the sample symbol was clicked on, the stimulus disappeared and an array of eight choices appeared on screen. The participant was then required to find the symbol -now a target

symbol- identical to that seen in the sample. This process was consistent with the theory of Carlin, Soraci, Dennis, Strawbridge & Chenchile (2002) that colour can help to guide attention to particular stimuli, notably within a goal-orientated search. An example of this goal-orientated search can be noted in the daily activity of the AAC user, who has to search through different coloured symbols to locate the symbol that is required for effective communication.

2.2.3 The Relevance of Visual Processing Skills in AAC

Visual processing skills are categorized under Visual Cognitive Neuroscience, an area of study where visual and spatial performances with all their neurological fundamentals are explored. Many sub-areas are of interest in the field of AAC, such as visual attention and recognition, spatial representation and planning. The latter are important for eye and limb movement (Farah, 2001). The visual pathways are the pathways most commonly used in communication. It has been estimated that more than 60, 000 visual messages are received daily through a "normally" functioning (non-disabled) individual's eye and that if there is a disability present, the reception of these messages could be hindered (Adams & Faux, 1977). There are many theories regarding the nature of processes involved with visual search tasks, two of which are described as the "top-down" approach and the "bottom-up" approach (Carlin, Soraci, Dennis, Strawbridge & Chenchile, 2002).

According to Carlin et al (2002) the "top-down" process refers to the initial task set or verbal instruction provided to the person. It is an approach that influences the participant's performance in VS tasks as the factors that are influential here in the deciding of the stimuli's search goal are those related to the specific tasks or "verbal instructions" which allow for voluntary control to be exerted when searching in an array (Carlin et al., 2002). The complexity of the task or verbal instruction that is presented to the person may also impact on the processes required for successful performance.

A "bottom-up" approach on the other hand refers to the physical characteristics of the array (such as colour or form) that influences participant's performance in VS tasks by establishing which stimuli will receive attention. These characteristics are determined automatically and may override the voluntary control of the participant's attention (Carlin, Soraci, Dennis, Strawbridge & Chenchile, 2002). When looking at the physical characteristic of colour (which is of great importance in the present study) it has been noted that it is a central facet in a number of tasks and has recently been noted as a direct, influential aspect in people's responses during certain tasks, especially those in the VS field (Carlin et al, 2002).

During visual perception, the visual cortex is able to select and centre attention on an area of interest (Grossberg, 2001). This is enhanced by the fact that the visual cortex contains colour-sensitive neurons which, when linked with other mechanisms, (as stated above) could increase and facilitate the search for a target stimulus (Nagy, Young & Neriani, 2003). This selection and "centred-attention" which allows participants to sub-consciously focus on an area of interest is of great importance in the field of AAC as it implies that the target symbol may still be located with relevant ease with the help of the additional "highlighters" (as discussed before). Thus by increasing the physical disparities within the stimuli of a visual array the "inter-stimuli" confusions could be decreased and, therefore, increase the accurate identification of the target object/symbol (Duncan & Humphreys, 1992), through this "centred-attention" in a VS task. The VS task is a commonly used task for the study of basic visual processing (Treisman & Gelade, 1980). It involves the use of participants locating a target stimulus amongst an array of other non-targeted stimuli and the reaction time is measured. It has been found that the surrounding non-target stimuli affect the degree of accuracy of the targeted stimulus, again linking to physical disparities of the symbols (which are typical of the "bottom-up" approach). The implication is that the more similar the surrounding non-targeted stimuli are to the targeted stimulus, the longer the rate of location will be (Treisman & Gelade, 1980; Wilkinson & Jagaroo, 2004). In the VS

task the discriminating between the stimuli takes place at an almost automated level and it is difficult to deduce which approach will be far more influential. This is because it has been stated that the type of processing used is determined by the nature of the stimuli presented (Carlin, Soraci, Goldman & McIlvane, 1995).

2.2.4 Location of Symbols

As stated previously, the number of symbols that can be placed on an overlay or display is limited. For this reason the types of symbols selected and their location are essential in the facilitation of communication. In terms of learning, location is important, especially when it is considered within a spatially restricted context. In previous studies, namely Chun, (2000), Chun & Jiang (1998) and Chun & Phelps (1999), the participants were asked to search through a display and find the target symbol -a rotated T- as quickly as possible. The display sets were made through repetitions of the blocks used. These were labelled “old contexts” as “new contexts” were randomly generated blocks in the display sets. The results showed that the rate was faster in the “old contexts” showing that the invariant spatial contexts did in fact assist targeted symbol location. The above investigation led to the conclusion that the visual system is linked to spatial relationships and the resulting information is used as a guide for the location of target symbols or items (Olson & Chun, 2002).

In the study of Chun and Jiang (1998) the effects of selective attention to stimuli of a particular colour was explored. It was noted in this study that when the items were configured with a specific colour and paired with the targeted location, the visual search was improved.

2.2.5 Cultural influences in AAC

Culture may be described as software of the mind – a communal training of the mind, which distinguishes the members of the one cluster or class of people from another (Hofstede, 1991). Huer (1997) noted that any means of communication is culturally dependent and thus stresses the importance of

culture in language acquisition. It is believed that within these constraints, different visual perceptions amongst varying cultures exist, as their perceptions of visual images noticeably differ according to experience and knowledge (Segall, Dasen, Berry & Poortinga, 1999). This experience allows the user to move from visual perception to visual discrimination. This is similar to selecting or filtering as the user is concentrating on one stimulus, ignoring surrounding stimuli (Ashcraft, 1998). Understanding of how individuals perceive and interpret visual symbols is thus associated with culture, confirming, "pictorial comprehension is a cultural convention" (Alant, 2005; pp.103). This "convention" acknowledges that certain cultures do not use graphic or pictorial systems in the same way. However, when the association between the picture/symbol and its referent is made known, the skill of understanding the "symbol-referent" is relatively easily acquired.

2.2.6 Earlier Research Relevant to the Present Study

To facilitate reading and understanding of the different theories presented in this study as well as to locate the present study within a wider context, existing relevant research on the subject has been briefly described. These research studies and their findings have been tabulated and are located within the appendices. (See Appendix A: Earlier Research Table).

2.2.7 Problem Statement of the Present Study

The issues surrounding non-target stimuli and its effect on the rate and accuracy in the location of target symbols are of primary concern in the present study. As Neisser (1967) pointed out, the individual already in the pre-attentive processing stage forms an orientation towards where and how to focus attention on a visual array. The question now arises how the use of different types of visual displays in sequence, for example, same colour followed by unique colour would impact on the rate and accuracy of symbol location on a display. As the pre-attentive stage is followed by the attentional or more focused stage, the impact of the type of display the individual is exposed to first might have varied impacts on the accuracy and rate of symbol location in subsequent exposures as this process would

require a re-orientation in the type of visual search processing needed for the individual to be successful.

As evident in the work of (Wilkinson & Jagaroo (2004), Grossberg (2001), Treisman & Gelade (1980), Carlin, Soraci, Goldman & McIlvane (1995), Carlin, Soraci, Goldman & McIlvane (1995), Chun (2000); Chun & Jiang (1998) and Chun & Phelps (1999)) as well as individuals with disabilities (Bailey & Downing (1994), Carlin, Soraci, Goldman & McIlvane (1995), Carlin, Soraci, Goldman & McIlvane (1995)) the more similar the non-target stimuli to the stimulus the longer time is needed for symbol location. This requires an orientation to look for more specific detail on the symbols to identify target stimuli correctly. If the display is followed by a visual display using unique colours, this would require a different type of orientation in locating symbols. The exposure to the first type of visual display might however impact on the individual's performance on the second visual display especially if the two different displays are presented with no or very little time delay which would be typical of the use of dynamic displays on a communication device. One could hypothesize that although rate might be slower for unique colours the impact of first starting with unique colour displays might orient the individual better in coping with different subsequent displays. No research has however been conducted on this aspect and hence the need for the current study.

2.3 Conclusions

We note from previous studies that no sequential exposure of different colour conditions has been investigated. Sequential exposure is important as those children using AAC who switch between one overlay to the next overlay and are exposed to the same symbols on a regular basis. The use of colour can help with the identification of symbols in device displays. The positive results found by Wilkinson et al. (2006) can be attributed to the effective location of target symbols as suggested. This is supported by many other types of research in both the AAC field as well as in the VS field.

2.4 Summary

This chapter dealt with the contributions that colour and visual processing skills could possibly have in AAC device displays. These two aspects were highlighted as no in-depth study has been done in the South African context. Furthermore, the impact of culture was discussed because of its relevance in this study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the methodology used in the study. First, the aims are described, followed by an account of the research design. The selection criteria of the participants are specified as well as the equipment and materials used in the study. The data collection procedures are then discussed, followed by the pilot study and data analysis, and the chapter concludes with a summary.

3.2 Aims

3.2.1 Main Aim

The primary aim of the study was to determine the effect of sequential exposure of colour conditions on the rate and accuracy of locating graphic symbols by typically developing pre-school children. This study is primarily based on the research of Wilkinson et al. (2006) and participants were exposed to three colour conditions (i.e. same colour, mixed colour and unique colour conditions) with specific time lapses between exposures. This study indicates that there is a hierarchy of difficulty levels in the three colour conditions.

The study endeavours to explore this issue further by exposing four comparable groups of participants to 2 sets of colour conditions, i.e. the first one arranged from easy to difficult (unique colour, mixed colour and same colour) and the second from difficult to easy (same colour, mixed colour and unique colour) to investigate the impact of these sequences on the accuracy and time of locating graphic symbols.

3.2.2 Sub Aims

1. To conduct a pilot study to test the appropriateness of the software program used by Wilkinson et al. (2006) for use within the local context. This software program was developed by Dube (1991).

2. To investigate whether there were differences between Set 1 and Set 2 in relation to the rate and accuracy of symbol location and if these differences were also noted between the symbol types.

3. To determine how the colour conditions differ between each other within each Type and Set combination.

3.3 Design

3.3.1 Description of the Research Design

A comparative, non-experimental group design was used in the present study. For the purposes of the study, sixty subjects who conformed to specific selection criteria participated in the study. The homogeneity of the group was ensured by four specified criteria (see section 3.6.1.1). Age and gender, were used for the division of the participants into four groups of fifteen each. This was done to ensure functional equivalence between the four groups (A, B C & D). Two of the four groups were exposed to Type A symbols (meaningful or familiar symbols as described in the previous study) using both Set 1 (i.e. same colour, mixed colour and unique colour) and Set 2 (i.e. unique colour, mixed colour and same colour) and the remaining two groups were exposed to Type B (non-referential forms) with the same Set 1 (i.e. same colour, mixed colour and unique colour) and Set 2 (i.e. unique colour, mixed colour and same colour). This allowed for the comparison between Groups A & C and Groups B & D. Please see Figure 3.1 for clarification of the design.

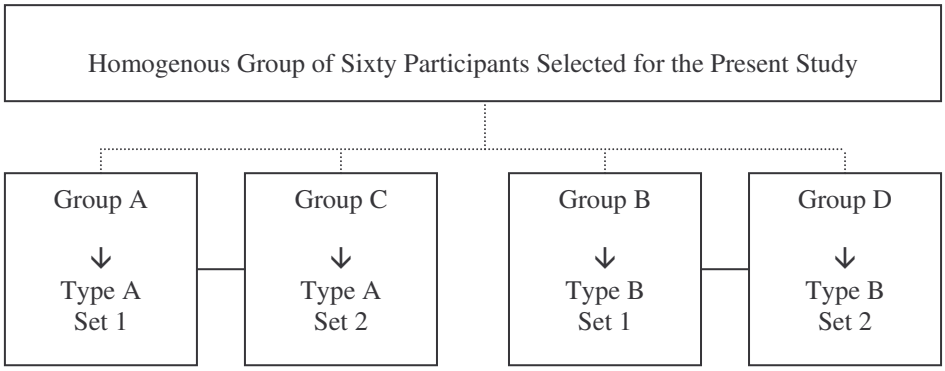

Figure 3(a): Schematic Representation of Comparative Design Used in Study

Each participant in a group was exposed to one type of graphic symbol as well as one set of colour conditions that included all three types of colour manipulations.

3.4 Comparison of Wilkinson et al. (2006) and Present study

Table 3.1: Comparison of Wilkinson et al. (2006) and Present study

Previous Study -Wilkinson et al. (2006)	**Present Study**
Main aim: • The role of colour on accuracy and speed of symbol location.	Main aim: • To determine the sequential exposure of colour on rate and accuracy in comparative groups.
Sub-aims: • To investigate if the time taken to locate a target varies on the basis of whether the stimuli share all, some or no colours with others in an array. • To investigate if there are differences in reaction time patterns when the stimuli are meaningful symbols that make reference to other objects as compared to familiar but non-referential shapes.	Sub-aims: • To conduct a pilot study to test the appropriateness of the software program (developed by Dube, 1991) used by Wilkinson et al. (2006) for use within the local context • To investigate the differences between Set 1 and Set 2 in relation to the rate and accuracy of symbol location and to determine if these differences were also observable between the symbol types. • To determine how the colour conditions differ between one another within each Type and Set combination.
Participants: • 16 participants between the ages of 4 years 4 months and 5 years 9 months. • Typically developing. • All scored within the norms of Peabody Picture Vocabulary Test-III (PPVT-III) and were without any vision or hearing impairments. • Made use of either a mouse or touch screen.	Participants: • 60 participants between the ages of 5 years 1 month and 6 years 11 months. • Typically developing in terms of cognition, colour vision, auditory and receptive language skills.
Task: • Varied, depending on the site at which was tested. If the participant was tested at site 1, a mouse had to be used to guide a cursor to the stimulus. If participant was at site 2, the stimulus had to be touched directly on the touch screen.	**Tasks:** • To complete the colour vision deficiency screener. • To complete the "Draw a person" screener. • To complete the software programme task, in which the participant was expected to click on a targeted symbol in two "rectangular boxes" (see Fig 3.2) • Each participant was exposed to either Set 1 or Set 2 according to the group placement
Materials: • Software programme consisting of a 0-delay matching-to-sample task with meaningful and non-referential forms.	Materials: • Instructions for the colour vision and "Draw a person" screener. • Waggoner colour vision deficiency screener. Refer to Appendix F: Waggoner Colour Vision Deficiency Screener. • Software programme as in the previous study.
Instructions: • Participants were told to touch the sample and it would disappear. When the 8 different choices appeared in another box at the bottom of the screen, the participant had to find the same stimulus in the new box and touch it.	Instructions: • The participants had to follow three sets of instructions for the three tasks which were presented in succession; firstly, the colour vision deficiency screener, secondly the "Draw a person" and finally the software programme

Previous Study -Wilkinson et al. (2006)	Present Study
	task. Please refer to Appendix D (2) for the complete set of instructions.
Data analysis: • A mixed 3x2x2 analysis of variables evaluated the effect of colour, stimulus type and response mode. • Median reaction times were calculated for error-filled and error-free trials. • A paired, two-tailed t-test was also used.	Data analysis: • Analysis of Variance (ANOVA). • Blom Transformation. • Friedman 2-Way Analysis of Variance.

3.5 Pilot Study

The objectives of the pilot study were to determine the appropriateness of the graphic symbols used in the study, the suitability of the instructions, whether the time allocation for participants to complete the task was adequate, and to assess the feasibility of the data retrieval process. As the methodology used in the main study was different from that of Wilkinson et al. (2006), the pilot study was required to pre-test the modified procedures.

Ten participants attending a private school in the Gauteng region participated in the pilot study. Consent was obtained from the principal and parents for their participation in the study (Appendix B & C). The participants met the criteria specified for the participants in the main study (see section 3.6.1 & Table 3.3). According to the teachers and parents all the children included in the study met the developmental norms expected of children of their age. The participants' ages ranged from 4 to 6 years.

Table 3.2 outlines the aims, procedures, results and recommendations of the pilot study.

Table 3.2: Objectives, Recommendations and Results Following the Pilot Study

Objectives	Materials Used	Procedures	Results	Recommendations
1.Software Requirements				
* To determine the appropriateness of the symbols used in the study.	Teachers were asked to comment on the appropriateness of the graphic symbols used in the study/software or comment on these in terms of the participants' ability to recognise the symbols.	The teachers were provided with a checklist regarding the appropriateness of the symbols and asked to give oral responses (Appendix E).	The teachers commented on the meaningful (familiar) symbols stating that the participants, depending on their age, would be able to label the majority of these symbols. They also stated that the older participants could possible recognise some of the non-referential forms, specifically the donut shape and the triangle.	No changes are to be made to the software, as the symbols are appropriate.
2.Participant Requirement				
*To evaluate the understanding of the instructions provided for the testing procedure. These include the instructions for the colour vision deficiency-screener, the "Draw-a-person" screener, as well as for the software programme task.	Participant instructions (Appendix D (1), which included: 1) Instructions for the "Draw-a-man" screener. 2) Instructions for the colour vision deficiency-screening test. 3) Instructions for the software programme of Dube (1991) used by Wilkinson et al. (2006).	The participants were required to complete three tasks, each of which had an individualised method of instruction.	The results indicated that the researcher needed to change the wording of the instruction for the graphic symbol selection task. This was noted as four of the younger participants aged 4,0 to 4,11 years) requested clarification from the researcher.	Adjustments to be made in the wording of the instructions used for the software programme. See Appendix D (2) for the changes made.
* To determine if the colour vision deficiency-screening test was appropriate for the age range of the participants.	Waggoner (2000) "Colour Vision Deficiency Screener" (see Appendix F).	Each participant was shown the screener and asked to tell the researcher what was seen in the pictures shown.	It was noted that not all the younger participants were able to label the boat in the last card. However, they did state that different coloured dots could be	No changes are to be made to the cards – the researcher accepted the alternative answer. The researcher also decided that if the participant could trace the

Objectives	Materials Used	Procedures	Results	Recommendations
			seen – green and red/orange.	outline of the final card that that would be acceptable.
* To determine if the amount of time allocated for each participant was adequate.	30-minute time allocation.	Each participant was allocated a half-hour for the completion of the tasks. The participants were timed by the researcher and were allowed to complete the tasks at hand, within the allocated time.	All the participants with the exception of four of the youngest managed to complete the tasks in the allocated time slots. As time was limited within the school setting, the researcher decided to make adjustments so that all participants would be able to complete the task.	It is recommended that the participants' ages be limited to a range of between 5years 1 month and 6 years 11 months so as to ensure that the time allocated per participant would be adequate.
*To determine a suitable way to reward participants to ensure a high level of participation	Participant instructions (Appendix D (2).	Five of the participants were provided with verbal reinforcement at the end of each set and five received reinforcement only at the end of the first set.	It was noted that the participants who received reinforcement both times were happier upon completion, whereas those who did not receive the reinforcement a second time would provide a comment themselves ("I did good hey?"and "He is saying good job.")	Reinforcement as well as a non-verbal element (sticker) will be given at the end of both sets. See Appendix D (3).
3. Data Requirements				
*To determine if the presentation of the data obtained would be appropriate for analysis by the Department of Statistics at the University of Pretoria	Spreadsheet formulated automatically with the software programme.	The data collected for each participant was stored automatically in a spreadsheet document (as stipulated by the researcher).	The Department of Statistics at the University of Pretoria accepted the data format.	No changes were made.

3.5.1 Results of Pilot Study

The results of the pilot study necessitated minor adjustments to be made in the presentation of the instructions to participants. Refer to Appendix D (2) for the amended instructions.

The participants in the pilot study aged between 4 to 5 years required more time for the completion of the task. It was thus decided to change the age range of the participants in the main study to between 5 years 1 month and 6 years 11 months. Thus, the ages of the participants in the main study was adjusted to be between 5 years 1 month and 6 years 11 months and not from 4 to 5 years as previously determined.

The pilot study established that the data collection procedure was suitable for the purpose of the main study.

3.6 Main Study

3.6.1 Participants

A convenience sampling technique was used. Participants were selected from pre-schools in the Umhlanga region of Kwazulu-Natal, as the researcher was able to gain access more easily to these schools during the time of the study (refer to Appendix G: Consent from Kwazulu-Natal Department of Education). All the participants who complied with the selection criteria were divided into four groups according to age and gender to ensure equality between the groups. All the participants had the necessary consent for participation in the study. Information forms were collected from the participants prior to the commencement of the study to ensure that the groups were statistically equal.

Sixty participants who met the required criteria were identified in the Umhlanga region.

3.6.1.1Selection Criteria

Table 3.3: Criteria for the Selection of Participants

	Selection Criteria	Method of Validation	Comments
1.	Participants should be between the ages of 5 years 1 month and 6 years 11 months.	Date of birth from the school registers and from the participant information forms.	The school register forms were used for the birth dates of participants and the parents were required to complete their child's age in the information form.
2.	Participants should be typically developed in terms of the results of the following: • Teacher opinion regarding auditory skills and receptive language comprehension. • Colour vision deficiency screener • "Draw a person" screener	The teachers of the participants confirmed that each participant had normal language development. Auditory skills were based on the teachers' comments in the respect of the individuals. A colour vision deficiency-screening test on the model of Waggoner (2007) was completed. The "Draw-a-person" test so that a general idea of participants' understanding of instructions could be obtained.	The researcher with the input of the teachers determined the language comprehension (reception), of the participants. The language for the research was English as it is the main medium of instruction in schools ensuring that the participants would readily understand the instructions. Normal colour perception was a necessary skill for each participant, as the tasks of the study involved colour visual matching, listening to and understanding instructions that were related to colour selection.
3.	Gender	This information was obtained from both the school registers and the participant information form	The school register forms were used for the gender of the participants and the parents were required to state their child's gender in the participant information forms that accompanied the consent forms provided.
4.	Participants had to be able to use a mouse appropriately to handle a computer.	This information was obtained from the parents' information form as well as from informal conversations with the teachers	The parents and teachers were required to state whether the participants had previous computer experience, specifically working with a mouse.

3.6.2 Equipment and Materials

3.6.2.1 Computer Software Programme Developed by Wilkinson et al., (2006) to Test Accuracy and Rate of Symbol Location

The program consisted of different target stimuli (which were referred to earlier as meaningful and non-referential forms) and colour manipulations (same colour, mixed colour and unique colour). It consisted of a 0-delay matching-to-sample task. In this task a graphic symbol appeared in a rectangular 'box' above a larger rectangular 'box' on the computer monitor. When the participants clicked on the graphic symbol using the mouse, the symbol would disappear and an array of eight choices would appear in the lower rectangular 'box'. The participants were then required to find the graphic symbol within in the array provided and select it by clicking on it with the mouse.

The instructions were that the participants should look carefully at the picture in the box and after adequate time the picture could be clicked on and it would then "go away". They must look at the different pictures that would come up and find the one from in the top box. Words of encouragement were often provided during the testing.

The software program recorded the reaction time from the time that the stimulus array appeared on screen in the second "rectangular box" until the time that the stimulus was chosen. This allowed for an error-free recording by the researcher. The only choice that the researcher needed to make was to decide whether the data should be stored in an Excel or text file. An Excel file was used as the data was seen more clearly and presented in a tabulated format.

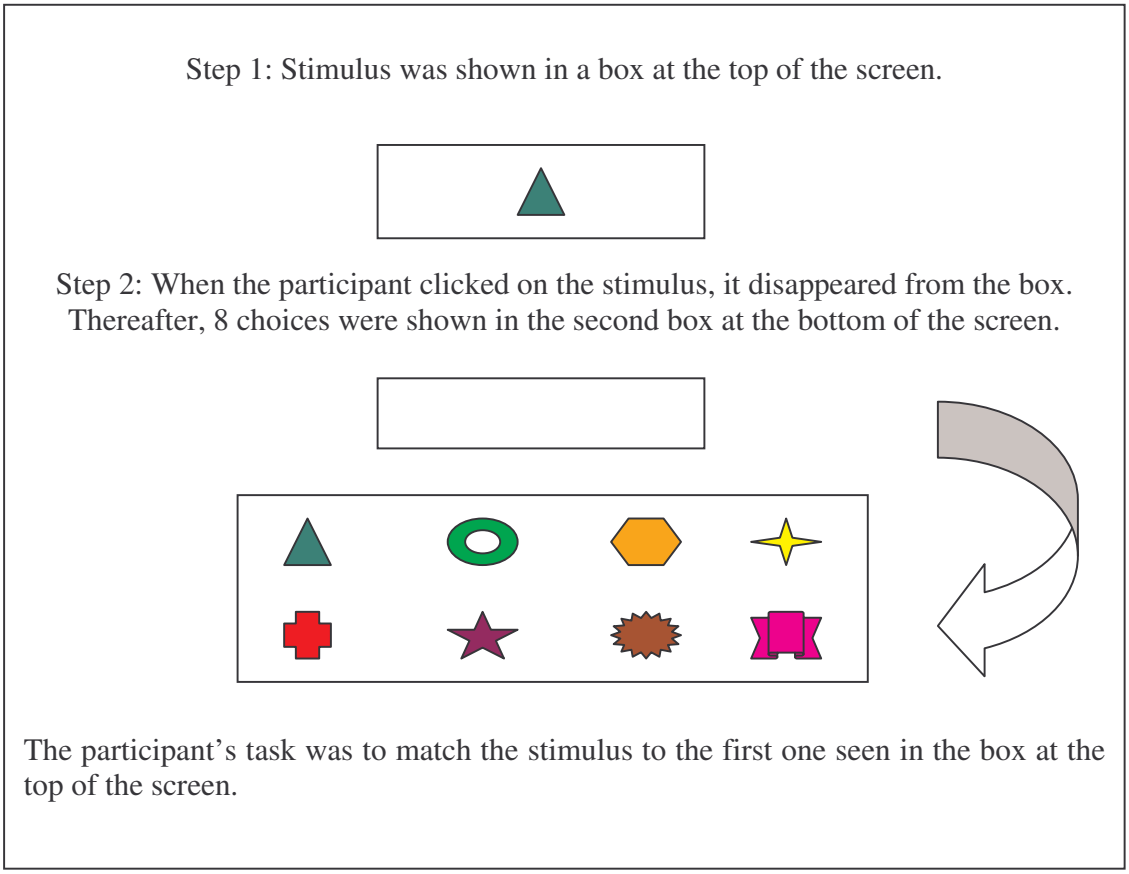

Figure 3(b): Schematic Representation of the Participant Task Used in the Present Study.

3.6.2.2 The Colour Vision Deficiency Screening Test

This screening test was used to determine the colour vision abilities of the participants (Waggoner, 2000). The participants were asked to describe what could be seen in the four cards presented to them. Each card was shown one at a time and verbal praise was given on the completion of all four cards. This test was not conducted in the previous study but research has shown that red-green colour vision impairments affect approximately 6-10% of males and 0.4-0.7% of females (Gordon, 1998). As the incidence of colour-blindness is slowly increasing and is often undetected in younger children it is important that this is done as, according to Waddington (1965), schools are full of colour and colours are important for teaching, especially with younger children.

3.6.2.3 Administration Equipment

The researcher also required the following in the schoolroom set up:

- A table, large enough for the computer and researcher's notes, and of a suitable height for the participants.
- Two chairs for seating at the table provided.
- Recording sheets with each participant's information and participant code.

3.6.2.4 A Personal Computer

The researcher used a portable of an Apple Mac computer, rented from an Apple Mac supplier in the Kwazulu-Natal region, and the software supplied by the previous researchers (Wilkinson et al., 2006) was loaded on to its hard drive.

3.6.2.5 Forms Used for Information Purposes

a) Consent forms to the parents/ caregivers of the participants

The researcher supplied the schools involved with letters of consent addressed to parents (see Appendix C), that provided an explanation of the study, the time needed for its completion and what was expected of participants. The letters stated that if the parents were prepared to give consent, the participant information form should be completed. The researcher's contact details were available on the letter so that if any parent had any questions, these could be addressed. Approximately 10 % of parents made use of this service.

The completed forms and consent letters were collected by the school and given to the researcher, who was then able to allocate the participants to selected groups.

b) Participant information form

The participant information form was attached to the letter of consent. Parents were requested to complete the form if they gave consent for their child to take part in the study. The information form consisted of the following:

- Gender of participant
- Age of participant
- Any known visual or auditory impairments that the participant may have
- Participant ability to control a mouse on a computer.

3.7 Data Collection Procedures

3.7.1 General Procedural Considerations

Procedures used for the obtaining of consent

A copy of the research proposal as well as a letter explaining the research process was sent to the Kwazulu-Natal Department of Education, requesting permission for the study to be conducted at schools in the Umhlanga region. The Department gave the permission (see Appendix G).

The researcher then made contact with schools within the Umhlanga region that were selected to take part in the study. Several schools were approached and three were interested in being involved in the study. Meetings were set up with the principals of the schools to discuss the research study and letters of consent for the participants were provided at the meeting. Upon approval, letters of consent for potential participants were provided to the schools.

a) Information provision to teachers prior to commencement of the study

The teachers were provided with the information pertaining to the study by the principals of the schools. The researcher assured them that their involvement in the study would be minimal and would consist mainly of calling the relevant children for the study.

3.7.2 Introductory Procedures

The researcher visited the school prior to the commencement of the study. The researcher was introduced to the teachers and the consent and parent information forms were provided to the researcher so that the participants could be allocated into groups accordingly. Final time slots were also discussed with the principal with reference to the day of testing.

The researcher also ensured that the room allocated for the data collection was appropriate and had the necessary equipment for the study.

3.7.3 Main Study Collection Procedures

- The researcher arrived at the preschool prior to the official commencement of the school day. The researcher contacted the principal and the teachers of the school and conveyed that she would share the results of the data collection as the day passed.

- The researcher set up the equipment shortly thereafter to prevent the teachers from being disturbed at the beginning of the day.

- The researcher fetched the selected participants from the classrooms and began the testing procedure by introducing herself to the participants and stating that

they would be having some fun by doing three different things – looking at four different cards, drawing a picture and playing a computer game.

- Once in the allocated room, instructions were provided to each of the participants using the participant instruction document (see Appendix D (2)). This helped the researcher to ensure that the procedures used in the study were consistent throughout the study.

- While the participants completed the "Draw a person" screener, the researcher typed in the relevant participant code for the start of the software programme. This action was repeated just before each colour manipulation of each set was done so that the data recorded would have its own accurate code for later statistical purposes.

- After the participant had completed the two screeners, the software programme was started. Verbal reinforcement was provided to the participants, as noted in Appendix D (3). When the participant had completed the task, a non-verbal reinforcement was provided in the form of a sticker.

- The researcher then took the participant back to his/her classroom and fetched the next participant. This procedure continued until the allocated time at the school was used up for the day.

3.7.4 Data Recording, Analysis and Statistical Procedures

On completion of the allocated time at the schools, the researcher copied all data files from the software onto a flash disk, ensuring that there were two copies of the data available for the researcher to code from, thus also allowing for a back-up copy if necessary.

The data was then recorded in an Excel spreadsheet format so that all the information pertaining to each participant would be on one sheet. These sheets of information were compared to those on the original spreadsheet on the Apple Mac computer and when no errors were found the data was printed so that a hard copy would be available.
The data was then sent to the Department of Statistics at the University of Pretoria and results obtained.

3.7.4.1 Methods of data analysis

Non-computerised methods of analysis

- Data was collected from each participant's recorded responses from the software programme and sent to the Department of Statistics at the University of Pretoria for analysis.

Computerised methods of analysis

- The following table describes the statistical procedures (McMillan & Schumacher, 2006) used in the present study:

Table 3.4: Statistical Methods used in Present study

Name of Statistical test used	Purpose of test
Descriptive Statistics	Describe sample
Analysis of Variance (ANOVA)	Determine if method and set have an influence on the score.
Blom Transformation	To help to comply with the requirements of ANOVA
Friedman 2 Way Analysis of Variance	To help to further investigate and analyse the data

- The data was presented in a graphic format and was tabulated with the appropriate figures. These graphics were accompanied by a written explanation of the results.

3.8 Summary

The chapter presented the methodology used in the study. The aims, sub-aims and a description of the research design were discussed. The phases in the study outlined the measures the researcher followed for the completion of the study. The pilot study was undertaken and the recommendation made for the main study. The components discussed with reference to the main study included the participants, materials and equipment. The methods of data recording and analysis were also presented.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

The results of this study will be described and discussed in accordance with the different sub aims stated in the chapter on Methodology. Sub aim 1 was addressed in that chapter and sub aims 2-3 will be addressed in this chapter. In the present study, the symbols were divided into two different sequential organizations. Set 1 referred to the symbols that were presented in a manner that was described as being "difficult to easy", with the same colour symbols followed by the mixed colour symbols, and, finally, the unique colour symbols. The symbols of Set 2 were presented in a manner described as "easy to difficult" with the unique colour symbols presented initially followed by the mixed coloured symbols and finally the same colour symbols. As stated previously, Type A symbols were Meaningful in nature and Type B symbols were Arbitrary in nature.

The data is divided into two sections, i.e. the analysis of rate (the total time taken for symbol location in the study) and accuracy (the total number of correct choices of symbols in the study) for each sub aim. The rate will be discussed firstly then the accuracy. Refer to section 4.2.1.1(a) and then to section 4.2.1.1(b). The differences between one colour condition and another in terms of rate and accuracy will be discussed in section 4.2.1.2.

An analysis of variance (ANOVA) was used to determine if type, set or interactions between type and set had an influence on the rate and accuracy in the target symbol locations. To comply with the assumptions for ANOVA (normal distributed residuals and homoscedasticity), a normal Blom transformation was done on the data. The Friedman Two-Way Analysis of Variance Test was used to compare the rate and accuracy of the colour conditions within each type and set combination. Values, which are statistically different on the 5% level, are discussed further.

Reliability of scoring and recording can be described as high as the software program automatically recorded the participants' responses and the researcher only had to copy the responses into the specified format. An external rater checked the final data so as to ensure that no errors were made in the coding of the data.

4.2 Results

4.2.1 Participant Characteristics Specified in the Main Study

The participants used in the study were subject to four selection criteria; age, gender, level of comprehension for instructions and prior computer knowledge. The ages of the participants were between 5 years 1 month and 6 years 11 months as determined by the pilot study. The average ages for the groups were as follows: Group A – 5 years 4 months, Group C – 5 years 9 months, Group B – 5 years 7 months and Group D – 6 years 2 months. Groups A and C were exposed to Type A symbols and Groups B and D were exposed to Type B symbols. Groups were homogeneous in terms of age, gender (with similar parings of male and female in each group), typical development (in terms of cognition, colour vision, auditory and receptive language skills) and finally previous computer knowledge.

4.2.1.1 Rate and Accuracy of Symbol Location within the Study

The aspect of rate was important in this study. In the Wilkinson et al. (2006) study, there was a difference between the rate and accuracy of specific colour conditions. This study was interested in exploring the influence of context on performance with varying colour conditions by sequencing the colour conditions from "difficult to easy" (Set 1) and "easy to difficult" (Set 2). This was done to determine the impact of sequential exposure on different tasks for the overall rate and accuracy of symbol location. The present study made use of components from the study by Wilkinson et al. (2006) but was structured to explore the rate and accuracy of the different combinations of the colour conditions of the previous study in two arrays. In Set 1 the colour conditions were sequenced from "difficult to easy" et al. and in Set 2 the colour conditions were sequenced from "easy to difficult" based on the results of Wilkinson et al. (2006). In Set 1 symbols were presented

with the same colour symbols followed by the mixed colour symbols and, finally, the unique colour symbols. The symbols of Set 2 were presented with the unique colour symbols first followed by the mixed colour symbols and finally the same colour symbols.[∝] The rate of time for symbol location in the present study is measured in seconds. In terms of accuracy, the maximum possible number of correct symbols per type and set is 24 and in each symbol type combination (i.e. colour condition) the maximum possible number of correct symbols is 8. Thus, accuracy was not measured as a percentage value but rather a value obtained out of a possible 24.

This is particularly important, as children who use AAC are often required to cope with different types of colour conditions on different overlays of devices or pages of communication books. It is thus important to investigate the impact of exposure of colour conditions on rate and accuracy of symbol location.

Type A symbols were those that were meaningful (familiar) to the participants whilst Type B were those symbols that were arbitrary (less familiar).

Sub-Aim 1: To find out if there were there differences between Set 1 and Set 2 in relation to the rate and accuracy of symbol location and were these differences also noted between the types of symbols.

4.2.1.1(a) Discussion of Rate

Table 4.1: Differences Found between Total Rate Values for Types and Sets Using Analysis of Variance

Source	F Value	Pr >F (P value)
Type	2.19	0.1447
Set	1.58	0.2133
Type and Set	4.05	0.0491*

* Significant on 5% level.

[∝] Type A symbols are meaningful symbols, Type B symbols are non-referential forms, Set 1 colour sequence are: same, mixed & unique and Set 2 colour sequence are unique, mixed & same.

As noted in Table 4.1, a significant interaction was presented between Type and Set in terms of rate. This interaction occurred specifically when comparisons between the different combinations were made, for example, Type A (Meaningful symbols) Set 1, Type A Set 2, Type B (Non-referential forms), Set 1 and Type B Set 2. Thus the interactions were not present with the single sources alone (being Type A or Type B and Set 1 or Set 2). For greater detail on the combinations, see Table 4.2.

Table 4.2: Rate Differences Found between Types and Sets Through the Comparison of Mean Values

	Set 1	**Set 2**	**Over Set**
Type A	6.8^{a}	7.2^{ab}	7.0
Type B	8.8^{a}	6.9^{b}	7.8
Over Type	7.8	7.0	

* Significant on 5 % level. Means with no superscript in common differs significantly on a 5% level.

It is important to remember that the values represented in the above table is the total time taken to locate stimuli across all three colour conditions in both Set 1 and Set 2.

The above table indicates the interaction between type and set, including the over-set and over-type values. Over Set implies the comparison of types regardless of the set whereas Over Type implies the comparison of sets regardless of the types. When we look at the interaction between type and set, Type A Set 1 and Type B Set 2 differed significantly from Type B Set 1. It should be noted that the rate for Set 1 (difficult to easy) was lower than for Set 2 (easy to difficult) within the Type A symbols (Meaningful) and that the reverse occurred within Type B symbols (Arbitrary) with Set 1 being significantly lower in rate than Set 2. This is of interest as it was not expected that the rate for the Type A symbols within the second set would take longer to locate than those in the first set (the opposite was expected as the sequential ordering of the first set was noted as difficult to easy as opposed to those in the second set being easy to difficult). A possible explanation is that as the symbols were more familiar to the participants, the rate at which the

symbols were located was positively influenced, regardless of the sequential ordering within Type A symbols.

This consideration, however, is not found within the Type B symbols as it was noted (as hypothesised) that Set 1 did take longer to complete than Set 2 and that these times were longer than those for Type A (again in agreement with the hypothesis of the study). This led to the conclusion that the participants in the present study took significantly longer with the completion of Type B Set 1 than with the completion of the other combinations, specifically Type A Set 1 and Type B Set 2. One could deduce that because the symbols in Type B were arbitrary in nature the participants were not as familiar with these symbols as with those in Type A, which were more familiar in nature as they were meaningful, thus the rate of completion was significantly lower. This lower rate can be explored further through the sequential organization of colours (Set 1) as the sequence here was deduced to be difficult to easy. This was in agreement with the hypothesis of the present study.

The results indicate there was an interaction between the Types and Sets in terms of the rate. On looking at the values in the above table, it will be observed that the combination that showed the fastest rate was Type A Set 1 whilst the combination that took the longest to complete was Type B Set1.

4.2.1.1(b) Discussion of Accuracy

Table 4.3: Differences Found between Total Accuracy Values for Types and Sets Using Analysis of Variance

Source	F Value	Pr >F (P value)
Type	0.38	0.5404
Set	9.02	0.0040*
Type and Set	3.53	0.0653

* Significant on 5% level.[∂]

[∂] Rate measured in seconds; Accuracy – possible maximum correct across Set 1 and Set 2 is 24 and possible maximum correct in any of 3 colour conditions is 8.

Within the accuracy values, it was noted that there were significant differences between the two types of sets. The two different types of sets in the present study, as stated previously, are as follows. Set 1 contained the first sequential organization of symbol colours (difficult to easy: same colour, mixed colour and unique colour) and it was expected that the accuracy would be less within this set, as it was "difficult to easy", and that the participants would initially make more errors and later the errors would become fewer, as the symbols became easier. Set 2 contained the second sequential organization of symbol colours (unique colour, mixed colour and same colour) and it was expected that the accuracy would be higher within this set as it was described as "easy to difficult", thus the participants' error occurrence would be lower and then higher as the symbols became more difficult.

The *p-value* shows a significant difference between the sets. Please refer to Table 4.4.

Table 4.4: Accuracy Differences Found between Types and Sets through the Comparison of Mean Values

	Set 1	Set 2	Over Set
Type A	22.3	23.5	22.9
Type B	22.6	22.7	22.6
Over Type	22.4*	23.1*	

* Significant on 5% level.[∂]

The Accuracy mean score for Set 2 was significantly higher than the accuracy mean score for Set 1. This result was interesting to note as the sequential organization of Set 2, (easy to difficult); was unique colour, mixed colour and same colour implying that completion would be more accurate for this set. This is in agreement with the hypothesis of the study as there was higher accuracy expectancy within this set, showing that regardless of the type of symbol displayed, Set 2 symbols were located with significantly more accuracy than those of Set 1. Easy to difficult sequencing of colour conditions seemed advantageous in accurate location of symbols.

[∂] Rate measured in seconds; Accuracy – possible maximum correct across Set 1 and Set 2 is 24 and possible maximum correct in any of 3 colour conditions is 8.

4.2.1.2 Rate and Accuracy within the Different Colour Combinations of the Study

Sub aim 2: How do the Colour conditions differ between each other within each Type and Set combination?

The following tables compare the colour conditions for each type and set combinations for both rate and accuracy. These are divided into type and set combination (Type A Set 1, Type A Set 2, Type B Set 1 and Type B Set 2) with each colour condition and *p* value. In both tables the values were the means, and these were followed by the standard deviations in parentheses.

Table 4.5: Rate Differences Found between Colour Conditions (Means and Standard Deviations)

		Colour conditions			
Type	**Set**	**Same**	**Mixed**	**Unique**	**P-Value**
A	1	2.29(0.76)	2.31(1.30)	2.26(0.85)	0.3442
A	2	2.72(0.97) [b]	2.33(1.40) [ab]	21.40(0.84) [a]	0.0115*
B	1	3.34(1.06) [a]	2.44(0.74) [b]	3.01(0.93) [a]	0.0067*
B	2	2.88(1.11) [a]	1.87(0.55) [b]	2.18(1.11) [b]	0.0002*

* Significant on 5 % level. Means with no superscript in common differs significantly on a 5% level.

From Table 4.5 it is evident that the "same colour" condition generally took the longest of all the colour conditions to complete. This table also indicates that there were significant differences found between the colour conditions with the exception of Type A Set 1. Thus, when the symbols were familiar and the colour conditions were arranged from difficult to easy, there were no significant differences between the rates of performance on the individual tasks.[∝]

The colour conditions of Type A Set 1 showed no significant differences in rate between the variables, leading to the conclusion that the use of different colours did not influence

[∝] Type A symbols are meaningful symbols, Type B symbols are non-referential forms, Set 1 colour sequence are: same, mixed & unique and Set 2 colour sequence are unique, mixed & same.

the participants' choice and ultimately the rate of their choices in the study. This was interesting as the type of symbols were deemed to be familiar to the participants; and the set was that deemed as "difficult to easy" for completion.

The colour conditions noted in Type A Set 2 showed that there was a difference in the rate of symbol selection between the same colour conditions and the unique colour conditions. This was in agreement with the hypothesis of the study that the rate would be faster with unique colour conditions than with same colour conditions.

Type B Set 1 showed, unexpectedly that the mixed colour conditions differed from the other two conditions. The hypothesis was that the unique colour condition would be the fastest condition in the study and that this would then be followed by the mixed colour conditions and finally by the same colour conditions. An explanation for this could be that the participants were exposed to the most difficult colour condition (same colour symbols) within this set and were thereafter exposed to the mixed colour symbols. The same colour condition provided exposure.

The deduction, therefore, could be that the mixed colour symbols were located at a faster rate because the symbols that were previously presented as a single colour were now being exposed in two differing colours, showing dependence on the symbol's physical appearance (as noted in research by Wilkinson & Jagaroo, 2004), while the unique colours (eight different colours) tended to lead towards a reliance on both the physical appearance and the colours. In this way, an extra element was added which could have slowed down the rate of symbol location.

The results of Type B Set 2 showed that the same colour conditions differed from the other two conditions. This was expected as it was hypothesized that the unique colour conditions would be the fastest condition in the study and that this would then followed by the mixed colour conditions and finally by the same colour conditions. However, it should be noted that it was not expected that there would be similarities in rate between the mixed colour conditions and the unique colour conditions.

Table 4.6: Accuracy Differences Found between Colour Conditions

		Colour conditions			
Type	**Set**	**Same**	**Mixed**	**Unique**	**P-Value**
A	1	7.80(0.41) [a]	6.80(0.41) [b]	7.73(0.59) [a]	0.0004*
A	2	7.73(0.70)	7.86(0.35)	7.86(0.35)	0.9512
B	1	7.93(0.25) [a]	7.8(0.41) [a]	6.86(1.06) [b]	0.0150*
B	2	7.60(0.63)	7.66(0.48)	7.46(1.12)	0.9835

* Significant on 5 % level. Means with no superscript in common differs significantly on a 5% level.[∂]

From Table 4.6 it is evident that only Set 1 (same colour, mixed colour, unique colour) showed up significant differences in accuracy in all the different conditions and types. Thus, when the sequence of the colour conditions was easy to difficult (Set 2), there appeared to be no differences in the accuracy scores between the conditions.

The colour conditions noted in Type A Set 1 showed that there were significant differences found within these variables, leading to the conclusion that the use of different colours influenced the participants' choice and ultimately the accuracy of their choices in the study. The differences were observed between the mixed colour conditions and the other two colour conditions. This was interesting as the most accurate responses were recorded with the same and unique colour and then the mixed colour symbols. This indicated that the accuracy levels were high, low and then high again, this being relative to both types of symbols (meaningful and arbitrary).

The colour conditions noted in Type A Set 2 show that there was no difference found in the accuracy of symbol selection between the colour conditions in the present study. This differs in the proposition of the present study as it was hypothesized that differences in accuracy would be noted with the unique colour conditions being the most accurately chosen symbols followed by the mixed colour conditions and, finally, the same colour conditions. This concurs with the findings of Mizuko (1987) and Clark (1981), both of

[∂] Rate measured in seconds; Accuracy – possible maximum correct across Set 1 and Set 2 is 24 and possible maximum correct in any of 3 colour conditions is 8.

whom had stated that iconic, (meaningful) symbols were easier to understand and ultimately locate in displays.

Type B Set 1 showed that the accuracy of the unique colour conditions symbols differed from the other two colour conditions. This was unexpected as it was hypothesized that the unique colour conditions would be the most accurate condition in the study and that this would then be followed by the mixed colour conditions and finally, by the same colour conditions. A probable explanation for this result is that the participants had taken both the same colours and symbol "shapes" into consideration and applied greater effort into locating the correct symbol, whereas, when the symbols were unique colours, it appeared that not as great an effort was applied in the search. The research done by Wilkinson & Jagaroo (2004) is in agreement with this finding as the importance of symbol structure as well as the layout of the symbols (in communication boards, books and devices) was projected as very important in AAC.

The results of Type B Set 2 showed that there was no difference found in the accuracy of symbol selection between the colour conditions in the present study. This was unexpected as it had been hypothesized that differences in accuracy would be noted with the unique colour conditions being the most accurately chosen symbols followed by the mixed colour conditions and, finally, the same colour conditions.

The results as indicated in the table reveal that accuracy was not affected within the second manner of sequencing (Set 2) regardless of the Type of symbol used (meaningful or arbitrary). This is interesting as it shows that the first manner of sequencing (Set 1) influenced the accuracy within the present study.

Set 1 showed significant difference in accuracy with both Type A and Type B symbols. This means that for both familiar and non-referential forms, the sequence of Set 1 was significant in terms of accuracy. [∝]

[∝] Type A symbols are meaningful symbols, Type B symbols are non-referential forms, Set 1 colour sequence are: same, mixed & unique and Set 2 colour sequence are unique, mixed & same.

4.3 Conclusions

It is clear from the above that there were different patterns emerging in relation to the rate and accuracy scores of the sets and types. It terms of rate, Table 4.5 shows significant differences between the different colour conditions except for Type A Set 1.

The effects of rate within the present study are as follows. The total value found indicated a significant interaction between Type and Set and it was also noted that Type A Set 1 and Type B Set 2 differed significantly from Type B Set 1. When comparing colour conditions the same pattern was not found for the Type Set combinations. As stated already this is what was expected from the hypothesis, as the symbols in Type B were arbitrary in nature, and, the rate of completion was significantly lower. This could be further explored through the sequential organization of colours (Set 1) as the sequence here was predicted to be difficult to easy and was also expected to have a significantly lower rate.

With regards to the rate differences between the colour conditions it was found that there were no influences in colour in Type A Set 1 but there were differences in the other conditions, with the following results: Type A Set 2 showed differences between the same and unique colours, this being in agreement with the hypothesis regarding the rate of the unique symbols. Type B Set 1 showed that the mixed colour condition differed from the other two colour conditions in that it was the fastest located symbol; moreover, the same colour condition differed from the other two in Type B Set 2, this being the slowest in rate.

In terms of accuracy, however, the pattern is different. The sequence of the colour conditions, e.g., same, mixed and unique seem to have a significant impact on the accuracy of the performance on the different colour conditions for both Type A and B symbols. On the other hand, when the sequence is unique, mixed and same there are no significant differences between the accuracy scores on either type symbol. This is

interesting as it could indicate the need for more reflection when exposing children to communication overlays with different types of colour conditions to guide their location of symbols.[∝]

The accuracy values indicated that when the symbols were presented in the second sequential organization (Set 2), the scores were significantly higher than those found in the first set (Set 1). This was in agreement with the hypothesis of the study as it had been previously stated that those symbols in Set 2 were organized from "easy to difficult" and that the accuracy would be expected to be higher as the participants would be able to locate the symbols more correctly and, subsequently, score lower as the colour condition changed to those more difficult in nature. These results were confirmed in the colour conditions with the different types and sets as again the differences were found within Set 1 (with the mixed colours being the least accurate in Type A Set 1 and the unique colour symbols being the least accurate in Type B Set 1).[∂]

4.4 Differences between Present Study and Wilkinson et al. (2006)

There are differences between the present study and that of Wilkinson et al. (2006). When we look at the contexts in which the two studies were done, there are certain noticeable differences. The present study made use of three participating pre-schools and made use of the computer, with a mouse for guidance, provided by the researcher. The study of Wilkinson et al. (2006) made use of two schools (site 1 & 2) where the personal computer with a mouse for guidance and a personal computer with a touch screen, respectively, were used. These differences in the use of the mouse versus the touch screen for guidance could account for some differences.

[∝] Type A symbols are meaningful symbols, Type B symbols are non-referential forms, Set 1 colour sequence are: same, mixed & unique and Set 2 colour sequence are unique, mixed & same.

[∂] Rate measured in seconds; Accuracy – possible maximum correct across Set 1 and Set 2 is 24 and possible maximum correct in any of 3 colour conditions is 8.

The ages of the participants in the studies also differed with those in the present study ranging between 5 years 1 month and 6 years 11 months and those in the earlier study between 4 years 4 months and 5 years 9 months. The differences in age are also linked to the differences noted in the instructions given to the participants. The instructions were important for the manner in which the participants understood and completed the tasks. The tasks in the present study were completed with each participant being exposed to either Type A or Type B[∝] symbols with all three-colour conditions at one sitting. This differs from the exposure of the Wilkinson et al. study (2006), in which there were six separate sessions for each colour condition of both Type A and Type B, thus each participant was exposed to both types of symbols and all colour conditions. It can be deduced that the separate sessions allow for greater time and "ease" of choice, thus making allowances for the younger age range of the participants in the Wilkinson et al. study (2006).

Summarised versions of the results of the two studies are as follows. The results of the present study are that in terms of rate, Type B was lower and that there was a significant interaction between types and sets. It was also found that when the combination of colour and symbol was achieved there were no differences noted within Type A Set 1 but these were present within the remainder of the sets (Type A Set 2, Type B Set 1 and Type B Set 2). In terms for accuracy, the colour conditions in the first set impacted on Types A and B, whilst the second set did not impact the results as greatly, but there was greater accuracy within Set 2 than Set 1.[∂]

In the Wilkinson et al. study (2006) all the results were very similar, with no distinctive differences in terms of the colour conditions for rate. The accuracy was best, however, when "colour and form" (the colour-unique) symbols were used as opposed to the colour-same and colour-split symbols.[∝]

[∂] Rate measured in seconds; Accuracy – possible maximum correct across Set 1 and Set 2 is 24 and possible maximum correct in any of 3 colour conditions is 8.

[∝] Type A symbols are meaningful symbols, Type B symbols are non-referential forms, Set 1 colour sequence are: same, mixed & unique and Set 2 colour sequence are unique, mixed & same.

4.5 Summary

In this chapter the results of the study are discussed in terms of rate and accuracy. These were further analysed in terms of the differences noted between each colour condition with the different Type and Set combinations.

CHAPTER 5: SUMMARY AND CONCLUSIONS

5.1 Introduction

This chapter provides a short summary of the results of this study as well as the clinical implications that it might have within the field of AAC. Furthermore, the study was critically evaluated in terms of its strengths and limitations, with recommendations for further research.

5.2 Summary and Conclusions

The purpose of this study was to determine whether the sequential exposure of colour conditions identified in the study by Wilkinson et al. (2006) had an effect on the rate and accuracy of symbol location. This study used the same software programme developed in the study by Wilkinson et al. (2006). Sixty typically developing pupils between the ages of 5 years 1 month and 6years 11 months took part in the study. Two combinations of the colour conditions were used to ensure variety in the sequence of the colour conditions in the two sets. These colour conditions were based on the findings of the Wilkinson et al. (2006) study and were arranged within two sets, Set 1 and Set 2. Set 1 included the symbols of the study that were organised within an “easy to difficult” sequence whilst the symbols of Set 2 were organised in a sequence that was rated as “difficult to easy”. Type A symbols were those that were meaningful in nature and Type B symbols were arbitrary in nature.

The following results were noted with regard to rate of symbol location: The results of rate showed that the same colour symbols took the longest mean time to complete (Table 4.5). Within the different colour combinations it was found the Type A Set 1 showed no differences while Type A Set 2 showed that the unique colour symbols were located the fastest, followed by the mixed colour symbols and then the same colour symbols. Type B Set 1 showed unexpected differences in terms of the hypothesis, specifically with the

mixed colour symbols, as these were the fastest to be located, followed by the unique colour symbols and same colour symbols. The same pattern was noted for Type B Set 2.

In relation to accuracy the following were noted: Type A Set 1 showed that the most accurately located symbols were the same colour symbols followed by the unique colour symbols and finally the mixed colour symbols. Type B Set 1, however, showed that same colour symbols, followed by the mixed colour symbols and then unique colour symbols were the most accurately recorded combination. The other two combinations, namely, Type A Set 2 and Type B Set 2 had no discrepancies in contrast with major accuracy value discrepancies among the three colour conditions. The results indicate that, regardless of the type of symbol used or the set presented, the same coloured symbols were the most accurately located symbols. This result could be due to the fact that when the same colour symbols are presented, far greater attention must be paid to the actual type of symbols and not only the colour of the symbols. This result is in agreement with previous research of Wilkinson and Jagaroo (2004) in which the physical characteristics of symbols were explored.

5.2.1 The Use of the Meaningful and Non-referential forms

The study of Wilkinson et al. (2006) found that the different types of symbols had very little effect on rate and accuracy and this was similarly found in the present study in that the sequential organization of the colour conditions played a more influential role in terms of rate and accuracy, as noted in Chapter 4.

In the present study, the participants were divided into four specific groups and were exposed to either the meaningful or non-referential forms based on the findings of the prior study of Wilkinson et al. (2006). The findings of the present study, however, largely confirmed the findings of Wilkinson et al. (2006) in that there were no major differences between the types of symbols (Table 4.5 and Table 4.6).

5.2.2 Critical Evaluation of the Study

5.2.2.1 Strengths of the Study

The four sample groups had a high level of homogeneity with regards to participant characteristics. The sample size of sixty participants was also a positive feature as according to Gabor and Ing (1997) a minimum of thirty participants is effective for the execution of statistical procedures. The use of the "Draw a Person" screener was a unique way of allowing the participants to relax as well as to determine that they could understand basic instructions.

The tasks that the participants were required to complete were executed without difficulties as the pilot study highlighted the changes that were required to be made prior to the main study.

5.2.2.2 Factors Negatively and Positively Influencing the Results

There were certain factors that may have negatively influenced the results of the study.

1. If the different colour conditions within the software programme followed one another directly instead of the researcher having to exit and enter each colour condition separately, it may have been possible that a faster rate would have been noted within the sequentially ordered colour conditions.

2. The non-referential forms used in the study were non-referential forms – specifically shapes. Certain of the symbols could have been far more arbitrary in nature as these symbols could still be deemed as familiar (this was noted in the participants' comments during the research i.e. the names of certain of the non-referential forms were said out loud).

Just as there were factors that may have negatively influenced the results, so too were there factors that may have positively influenced the results.

1. The recognition of the familiar symbols allowed for the participants' ease of mind when selecting the target symbol (this was again noted within the study through the participants' comments).

2. The use of positive reinforcement in the study helped to boost the confidence of the participants' as well as build their own self-esteem while completing the tasks.

5.3 Limitations of the Present Study

Using typically developing participants was a limitation to the study. The accuracy and rate of the target symbol location would quite possibly be noted as different when participants with disabilities are used as factors such as rate of participant movement, co-ordination of movement, use of external devices such as a head pointer or eye gaze technology may influence results. The use of non-disabled participants, however, has been accredited in previous studies so this research study can be seen as viable in the field of AAC.

5.4 Recommendations for Further Research

The following are recommendations for further research:

1. This study used a homogeneous group of typically developing children as participants, but it would be useful to follow up these findings and those of Wilkinson et al. (2006) by using participants with disabilities.

2. The specific tasks used in this study were short and quite easy, but it would be interesting to investigate the impact of colour conditions on tasks of different levels of difficulty.

3. To ensure the social validity of this study it is also recommended that an application of this study be made to demonstrate the use of the different colour conditions in real-life communication situations using communication boards.

This would be particularly relevant in the use of communication books and files, which necessitate the use of different overlays.

5.4 Summary

In this chapter the conclusions and clinical implications of the research were presented and discussed. The critical evaluation of the study was then followed by the recommendations for future research.

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Appendices

Appendix A: Earlier Research Table

Appendix A: Earlier Research Table

Title of Study	Aims of Study/Research Description	Researcher	Findings	Relevance to Present Study
Pre-schoolers' Speed of Locating a Target Symbol under Different Colour conditions.	To determine if any differences were made by preschoolers in speed for the location of a target symbol under different colour conditions.	Wilkinson, Carlin & Jagaroo (2006)	The findings show that accuracy and rate in target symbol location were greater when a unique colour condition was used as opposed to the use of a same or split colour condition.	Suggest the existence of a hierarchy of difficulty when dealing with these colour conditions within the context of the methodology used: 10-minute tasks with breaks to reduce the impact of the exposure of one colour condition on the other
Sensory and Cognitive Contributions of Colour to the Recognition of Natural Scenes.	To determine if colour played a role in the recognition of natural scenes. Delayed match-to-sample tasks were used to test the role of colour vision in recognition of briefly presented images of natural scenes (with ½ the scenes in colour and the other ½ in black & white). The process of cognitive facilitation was taken into account – this was the process where differences in colour were evident, thus allowing for the comparison of the target image to that in the memory.	Gegenfurtner & Reiger (2000)	The research states that the recognition of images presented and tested in colour were better than those in black and white. Colour leads to a coding advantage, showing that colour recognition was good. Clues are provided for image segmentation and then for retrieval. Helps for the faster and better recognition.	The present study makes use of the delayed match-to-sample task. The results of the study suggest a coding advantage towards unique colour symbols, something that was hypothesised in the present study.
Guided Visual Search in Individuals with Mental Retardation.	To determine if colour could be used as a defining feature in a visual search task with individuals with intellectual and developmental disabilities.	Carlin, Soraci, Dennis, Strawbridge & Chechile (2002)	The research findings were that colour could be used as a dimension to rapidly segment arrays and assist in guiding attention to particular stimuli.	

Earlier Research Table (continued)

Title of Study	Aims of Study/Research Description	Researcher	Findings	Relevance to Present Study
	Participants initially assessed to determine ability to detect a colour target amongst a set of symbols in the opposing colours.		The top-down control of the visual selective stimuli allow for a goal-orientated search.	The present study shows the differences found between the colour conditions and the sequential ordering of symbols, thus suggesting that colour does visually guide the user.
Combining Information in Different Colour-Coding Mechanisms to Facilitate Visual Search.	To determine if the combination of diverse colour coding mechanisms facilitate visual search operations. This was elicited through the use of different summing models (linear vs. non-linear).	Nagy, Young & Neriani (2004)	Results of the research propose that certain signals in cardinal colour mechanisms may be used for the selection and/ or segregation of stimuli when needed for specific interest. The favouring of non-linear selection was noted as the increase in the degree accuracy could be found in search tasks.	The present study defines the differences between the colour conditions and how the selection of colour impacts on participants' choices.
Colour in Visual Search	To determine if colour truly plays a role in visual searches.	D'Zmura (1991)	Results indicate that colour does help in the effective identification of a stimulus in its surroundings.	The use of the different colour conditions in the present study is suggestive of the influence of distinction in the surrounding stimuli in terms of rate and accuracy.
Contributions of Principles of Visual Cognitive Science to AAC System Display Design	To determine if the four areas of visual cognition (organization of array, location colour & contrast and symmetry & axial orientation) played a major role in influencing AAC device displays. The focus is on the perceptual structure of visual symbols and	Wilkinson & Jagaroo (2008)	The study revolved around the use of grids vs. naturalistic scenes. For organizational purposes, it was found that both displays had advantages but further research was needed. Symbol location was influenced by mainly perceptual bias, which can be perceived either as "left-right bias" and "central-peripheral bias".	The present study suggests that a certain amount of reliance on the visual perception of the participants is necessary in the location of symbols, in conjunction with the different colour conditions presented.

Earlier Research Table (Continued)

Title of Study	Aims of Study/Research Description	Researcher	Findings	Relevance to Present Study
	arrays in supporting processes of online communication.		Most people seem to have a "right-centre bias". Colour is influential in the perception, recall and learning of AAC symbols. In grids, the "McCollough" effect (1965) may interfere with this as a contingent colour after effect may be present, but within a naturalistic scene this may either support or distract the user. Structure and alignment play a role in that less complex symbols are easier to identify as well as those that are vertical or horizontal.	
Using Visual Accents to Enhance Attending to Communication Symbols for Students with Severe Multiple Disabilities	To determine if the use of certain visual accents (size, colour, contrast, shape and graphic patterns) could increase the user's attention to an adapted or unique visual symbol.	Bailey & Downing (1994)	The use of visual accents is indeed positive and assists in the viewing and seeing of "targeted" communication symbols. The larger the size of a symbol the greater the chance of visual attention being drawn to the stimulus. Colour and contrast highlighters draw attention to certain symbols and can enhance attention levels.	Suggests that colour as a visual accent assists in drawing attention to the positive identification of a symbol
Linking the Laminar Circuits of Visual Cortex to Visual Perception: Development, Grouping and Attention.	This is an investigation into how laminar circuits of the visual cortical areas execute context sensitive binding processes (for example perceptual grouping and attention) and how these allow neural responses to be influenced by external stimuli.	Grossberg (2001)	The visual cortex is able to execute many types of contextual processes at a single time, thus, allowing for interaction between the processes, which can ultimately allow for focus on areas of interest. This is common practice in perceptual grouping.	The present study determines how the participants' focus on target symbols through the use of colour and through symbol formation – thus deducing that these are areas of visual interest.

Earlier Research Table (continued)

Title of Study	Aims of Study/Research Description	Researcher	Findings	Relevance to Present Study
	This is influenced by the Adaptive Resonance Theory, which allows for focused attention on relevant information.			
A Feature Integration Theory of Attention.	To determine the effectiveness of a visual search task in the finding of a target stimulus within an array of non-targeted stimuli.	Treisman & Gelade (1980)	The findings are in agreement with those of related research in that the more similar the surrounding stimuli are, the slower the rate of finding the correct symbol.	Suggests that the same colour conditions were slower in rate and accuracy in certain participants' choices.
Visual Search in Unidimensional Arrays: A Comparison Between Subjects with and Without Mental Retardation.	To determine how colour influences rate in visual search efficacy	Carlin, Soraci, Goldman & McIlvane (1995)	Findings show that visual search efficiency varied across the many diverse stimuli; however, when the coloured conditions were presented, rate was equally as rapid across the altering stimuli presentations.	The researchers' hypotheses agree with my study,, in that certain colour conditions make for the faster rate and greater degree of accuracy of symbol location.
Further Considerations of Visual Cognitive Neuroscience in Aided AAC: The Potential Role of Motion Perception Systems in Maximising Design Display.	To examine the processing of motion-perception and its relevance to AAC (determining the advantages for motion use)	Wilkinson & Jagaroo (2008)	Findings indicate that motion is beneficial for a number of AAC functions such as the provision of greater attention, providing a sense of novelty, provision of contrast in device displays as well as the provision of a realistic emphasis for symbols. User must make use of higher cognitive processes, thus increasing the learning and structural output of symbols.	As with colour, motion can help to increase the learnability and help with the location of symbols. The sequential organization of motion symbol is also important as a means to overcome visual overload and/or habituation.
Contextual Cueing of Visual Attention. **Contextual Cueing: Implicit Learning and Memory of Visual Context Guides Spatial Attention.**	To examine the effects of location on targeted symbols and items.	Chun (2000); Chun & Jiang (1998) and Chun & Phelps (1999))	Findings indicate that if the target symbol were placed in a location that had underlying spatial relationships and that the information was used appropriately; attention could be guided to the targeted symbol.	The suggestion was made that colour plays an important role in the guidance of visual attention.

Earlier Research Table (continued)

Title of Study	Aims of Study/Research Description	Researcher	Findings	Relevance to Present Study
Implicit Memory Deficits for Implicit Contextual Information in Amnesiac Subjects with Hippocampal Damage.				
Examining Perceptions in Graphic Symbols Across Cultures: Preliminary Study of the Impact of Culture/ Ethnicity	To examine the perceptions of different graphic symbols across various cultures. Groups of individuals from 4 different nationalities were expected to rate the iconicity of chosen symbols on a 7-point scale.	Huer (2000)	Findings suggested that culture had an impact on the translucency ratings assigned to the different symbols used in the study.	The present study does not place heavy reliance on culture; however, one must show awareness as to how different cultures play a role on the visual perception of an individual.

Appendix B: Consent Letter to School

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YUNIBESITHI YA PRETORIA

Centre for Augmentative and Alternative Communication & INTERFACE

Sentrum vir Aanvullende en Alternatiewe Kommunikasie

University **of Pretoria**

2004 *T-Systems Age of Innovation & Sustainability Awards: Excellence in Innovation and Sustainability: Social*
2003 *National Science & Technology Awards: Corporate Organization over the last ten years.*
2002 *Shirley McNaughton Award for Exemplary Communication received from the International Society for Augmentative and Alternative Communication*
1998 *Rolex Award for Enterprise: Associate Laureate*
1995 *Education Africa Presidential Award for Special Needs*

Website: http://www.up.ac.za/academic/caac
Fax/Faks: (012)420-4389
Tel: (012)420-2001
E-mail: erna.alant@up.ac.za
Faculty of Education / Fakulteit Opvoedkunde
Centre for Augmentative and Alternative Communication
Sentrum vir Aanvullende en Alternatiewe Kommunikasie
University of Pretoria, Lynn wood Road
PRETORIA, 0002
SOUTH AFRICA

The Principal
SAHETI PRE-PRIMARY SCHOOL
Civin Drive
Senderwood
2007

Madam

REQUEST FOR PARTICIPATION IN FINAL YEAR RESEARCH PROJECT

I am a master's student at the University of Pretoria, presently conducting a research project in the field of Augmentative and Alternative Communication (AAC), under the supervision of Prof. E. Alant. The title of my research project is "The Effect of Sequential Exposure of Colour Conditions on Rate and Accuracy of Target Symbol Location".

An AAC system is used as a communication modality for individuals with little or no functional speech and is available as various types of communication devices, so that communication can occur with other people - communication that is a vital part in daily living and functioning. The problem with presently available devices is that the layout of the symbols in these displays can be difficult to see and, thus, are not very user-friendly for the younger Users of AAC. This would, thus, decrease the opportunities for interaction and communication, as users would not be able to effectively communicate with others.

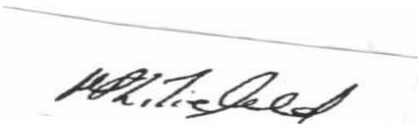
The focus of my study is to determine what the effect of colour would be on the rate and accuracy in target symbol location- specifically with typically developing children. Even though these devices are unfamiliar to typically developing children they are familiar with

the vocabulary, which could be used on these devices. I plan to conduct this study by having your Grade 00/0 learners (aged between 5 years, 1 month and 6 years, 11 months) listen to a set of provided instructions and then choose the target symbols from various arrays, which will be provided. The instructions are simple and your learners will feel like they are playing a new computer game. It will take the learners approximately 30 minutes each to complete and will be taken in class context, so as to not disrupt the school schedule. Thus, I would like to request your learners' participation in this study. The information gained from this study will be of great value in determining the effect of colours on rate and accuracy in target symbol location, so that children with disabilities may too have equal opportunity in their future selection of vocabulary on the available devices.

It would be highly appreciated if you would allow all the Grade 00/0 learners to participate in this study and also allow the completion of the measurement on school premises, during school hours, as this would be convenient for the learners. I will then make contact with the parents of the learners' through consent letters and request their cooperation. The identity of all participants will remain in strict confidence.

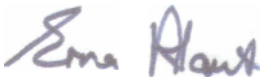
My research components are to be completed by the last week of July 2007 and I would therefore appreciate your response as soon as possible. My contact details are 082 416 8596.

Yours faithfully,



Anna Kolatsis
Researcher

Dr. M.S. Lilienfeld
Lecturer



Prof. E. Alant
Head of Department: Augmentative and Alternative Communication
University of Pretoria

Appendix C: Consent Letter to Parents

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Centre for Augmentative and Alternative Communication

Sentrum vir Aanvullende en Alternatiewe Kommunikasie

&

INTERFACE

University of Pretoria

2004 *T-Systems Age of Innovation & Sustainability Awards: Excellence in Innovation and Sustainability: Social*
2003 National Science & Technology Awards: Corporate Organization over the last ten years.
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Faculty of Education / Fakulteit Opvoedkunde
Centre for Augmentative and Alternative Communication
Sentrum vir Aanvullendc en Alternatiewe Kommunikasie
University of Pretoria, Lynn wood Road
PRETORIA, 0002
SOUTH AFRICA

Dear Parent

REQUEST FOR PARTICIPATION IN RESEARCH PROJECT

I am a master's student at the University of Pretoria, presently conducting a research project in the field of Augmentative and Alternative Communication (AAC), under the supervision of Prof E. Alant. The title of my research project is " The Effect of Sequential Exposure of Colour Conditions on Rate and Accuracy of Target Symbol Location".

An AAC system allows children who have not developed (functional) speech to communicate. It includes speech-generating devices that allow these children to communicate in a way that is understandable to other children. Many of these devices use printed overlays of icons or picture symbols and we need to find ways to make these overlays more user friendly for young children who require AAC.

The focus of my study is to see whether colour can be used to help children to quickly and accurately locate specific icons and pictures. If it can help typically developing children it will also require AAC due to a disability. Computer software has been designed that will allow me to compare what colour combinations help young children. The instructions are simple and your child will feel like they are playing a new computer game. It will take approximately 30 minutes for your child to complete and will take place at school in a room that is convenient for the school. The results will then be collected and interpreted for research purposes alone. The date for the completion and collection of the results is the final week in July 2007.

On completion your child will receive a certificate stating that he/she has successfully taken part in a research study for the University of Pretoria.

I would like to inform you that the participation in this study is on a voluntary basis and you are at liberty to withdraw your child from the study without any negative consequence.

There are no risks or discomforts involved and you can be assured of your child's anonymity throughout the research study, as he/she will be given a numbered code and is not required to write his/her name.

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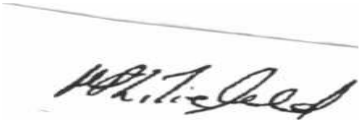
If you are or are not willing to have your child participate in this study, please complete and return the attached slip by the 19th July 2007. If you have any queries, please feel free to contact me at 082 416 8596 after hours.

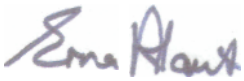
Your child's participation in this study will be highly appreciated.

Yours faithfully,

Anna Kolatsis
Researcher



Dr. M.S Lilienfeld
Lecturer



Prof. E. Alant
Head of Department: Augmentative and Alternative Communication
University of Pretoria

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Title of research project: " The Effect of Sequential Exposure of Colour Conditions on Rate and Accuracy of Target Symbol Location".

Researcher; Anna Kolatsis

Supervisor; Professor Erna Alant
Centre of Alternative and Augmentative Communication
University of Pretoria

I understand what the study entails, how and why it is being done. This is that my child would be asked to complete a computer software programme during school hours for research purposes. I understand my child's rights as a research participant and do or do not consent for him/her to participate in the study.

Signature of participant's parent: _____ Printed name:

_____

Signature of supervisor:_____

Signature of researcher:_____

Date: _____

✂.....

Please complete the following information if you have given permission for your child to partake in the research project. This information is strictly confidential and will be used for research purposes only:

1. **Gender:** Male Female
2. **Age**: _____
3. **Home language:** _____
4. **Able to use a mouse on a P.C:** Yes No
5. **Visual Problems:** Yes No

(If Yes, what problems?_____)

6. **Hearing Problems:** Yes No

Thank you for taking the time to complete this form!

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Appendix D (1): Participant Instructions

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Participant Instructions

We going to play some games today but first there are some pictures that I want you to look at. (Show cards 1-4 of Colour Vision Deficiency Screener)

Can you tell me what you see in these cards?
That's great – well done!!! Now let's get ready to play some games on my computer.

We are going to look at a picture in the box… when you think that you know the picture I want you to click on it. This will make the picture go away!!

Then some more pictures are going to come in another box under that one. I want you to find the same picture that you saw in the top box/ other box.

What's also cool is that my computer talks sometimes – if he likes what you are doing he will make a noise for you. It sounds like this: doo-doo-doo, but sometimes he is also quiet but that's ok because he likes playing this game too.

The only thing is that my computer says I can't help you but that's ok because I'm going to sit here with you anyway!

Let's get ready to play!!!!

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Appendix D (2): Amended Participant Instructions

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Amended Participant Instructions

We going to play some games today but first there are some pictures that I want you to look at. (Show cards 1-4 of Colour Vision Deficiency Screener)

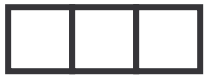
Can you tell me what you see in these cards?
That's great – high five!!! Now let's play some games on my computer.

We are going to look at a picture in the box (point to top box)… when you think that you know the picture I want you to click on it. This will make the picture go away!!

Then some more pictures are going to come in this box (point to box under). I want you to find the same picture that you saw in the top box.

The only thing is that my computer says I can't help you but I'm going to sit here with you and help you to get to the next level. (If asked how many levels there are say 3)

Let's get ready to play!!!!



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Appendix D (3): Verbal Reinforcement

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Verbal Reinforcement

- Good Job!
- Excellent work!
- You are a super star!
- I'm so proud of you!
- Good try!
- Nice!
- High Five (with action)

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Appendix E: Teacher Symbol Checklist

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Teacher Symbol Checklist

1. Do you think that the following symbols will be recognised easily and/ or are familiar to children between the ages of 4 years – 6 years?

2. In your opinion would children be able to provide a label for these pictures?

    - I would like to determine if the fruit pictures displayed are indeed more recognisable/ familiar than the random shape pictures displayed.

    - This would help to determine the appropriacy of using these picture symbols in a South African context, as they are American based pictures.

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Appendix F: Waggoner Colour Vision Deficiency Screener

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Appendix G: Consent Form Kwazulu- Natal Department of Education

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