COLOUR-OBJECT INTERFERENCE IN 5 - 8 YEAR OLD KANNADA SPEAKING CHILDREN: A STROOP EFFECT

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This Dissertation is submitted as part fulfilment

for the degree of Master of Science in Speech- Language Pathology

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May 2015

CERTIFICATE

This is to certify that this dissertation entitled **"Colour – Object Interference in 5 – 8 year old Kannada Speaking Children: A Stroop Effect"** is a bonafide work in part fulfillment for the degree of Master of Sciences (Speech-Language Pathology) of the student (Registration No. 13SLP021). This has been carried out under the guidance of a faculty of this institute and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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DECLARATION

This is to certify that this dissertation entitled **"Colour – Object Interference in 5 – 8 year old Kannada Speaking Children: A Stroop Effect"** is the result of my own study under the guidance of Mr. Rajasudhakar.R, Lecturer in Speech Sciences, Department of Speech Language Sciences, All India Institute of Speech and Hearing, Mysore and has not been submitted earlier to any other University for the award of any other Diploma or Degree.

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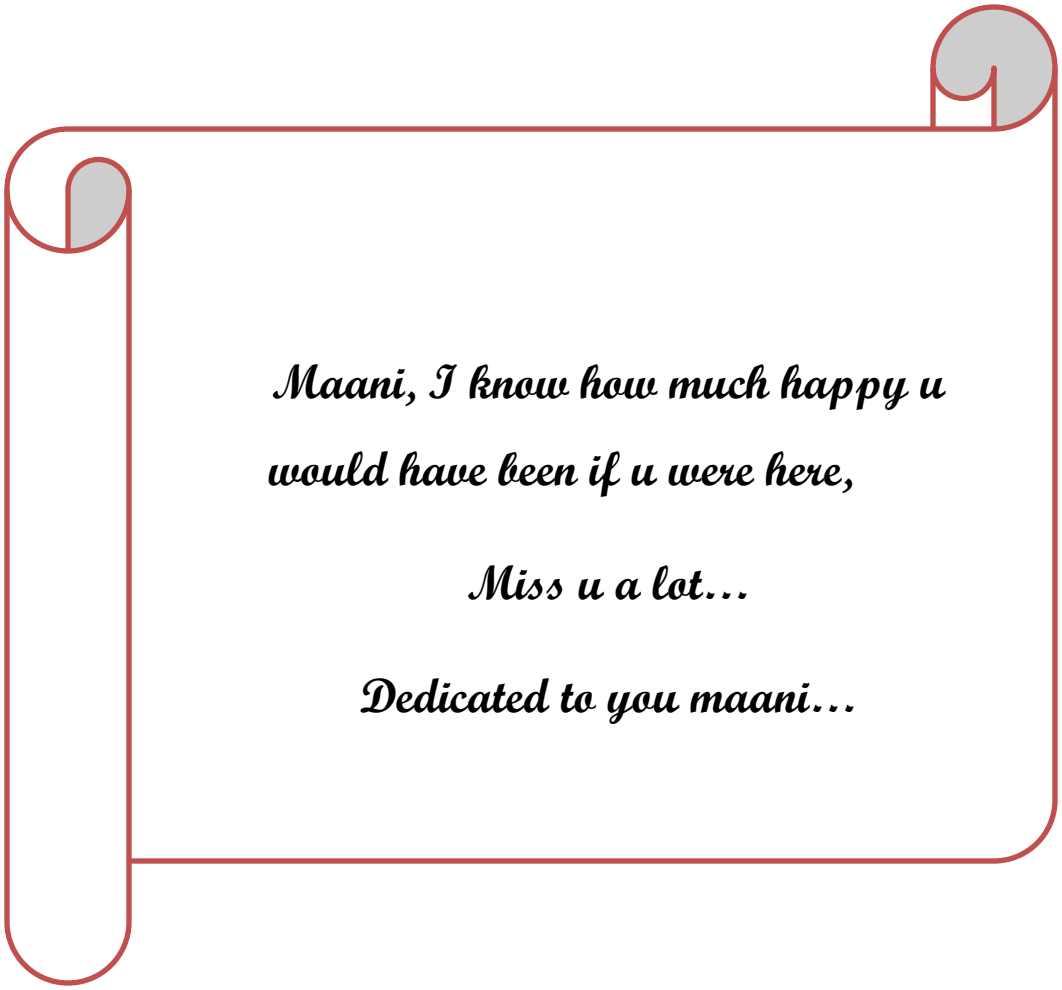
Maani, I know how much happy u
would have been if u were here,
Miss u a lot…
Dedicated to you maani…

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LIST OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The classic Stroop test is to supress the ability to read and name the colour i.e., to name the colour of the text/font not to name the colour. For example, the word 'green' printed in 'red' colour ink, the individual should name the colour as 'red' and not 'green'. This inhibitory effect is called 'Stroop Effect'. The standard Stroop tasks have *congruent condition* (corresponding in character- the word red printed in red colour), *incongruent condition* (Incompatible/ not congruent-the word 'green' printed in 'blue') and *neutral conditions* (Words with no particular colour-all words printed in black).

The same Stroop effect can be created by replacing colour-word with the colour-picture. As in standard Stroop test, here also different conditions can be created with pictures like *congruent condition* (familiar objects in their usual colour, such as apple in red colour), *incongruent condition* (familiar objects in aberrant colour, such as apple in yellow colour) and *neutral conditions* (familiar objects with no particular colour associated with them, such as blue book) and in addition to the other conditions a *baseline object/colour naming condition* can be present.

This helps in understanding the executive functioning. Executive function is an umbrella term for cognitive processes including working memory, reasoning, task flexibility, attentional flexibility, problem solving, planning and execution, and inhibitory control processes including resistance to temptation.

The Executive functions (EFs: also called executive control or cognitive control) refer to a family of top-down mental processes needed when you have to concentrate and

pay attention, when going on automatic or relying on instinct or intuition would be ill-advised, insufficient, or impossible (Burgess & Simons, 2005; Espy, 2004; Miller & Cohen, 2001).

Executive Functions in children is an area of interest because of the following difficulty:

- Tasking switch or stopping.
- Planning
- Multitasking
- Attending and concentrating for long time

There are three cores for this executive functions: inhibition, working memory and cognitive flexibility. Inhibition includes inhibitory control and interference control. Inhibitory control is nothing but the self-control and interference control is selective attention and cognitive inhibition.

These behaviors can be measured in certain executive functions like Stroop test, Counting Stroop test, Fruit Stroop, Animal Stroop task etc. In all the above mentioned tests, the individual has to inhibit the dominant response and excite the non-dominant response.

At the same time, all these tests cannot be used for all the populations. Executive function may differ according to the age, familiarity of the task. It is not possible for young children to perform the classic colour-word Stroop test. As the children are not experienced readers it might hinder their performance. Hence, it is important to consider the aspects in which the children are good at. Colour-Object interference is one such test and interesting to study the interference in young children.

Hence, the present study aimed to develop Picture Stroop Test (colour-object), to know the developmental trend and to determine the normative data for young children from Kannada speaking background.

Implications of the study:

- The present study will be useful to know the inhibitory control and task switching mechanisms in typically developing young children of 5-8 years of age.
- The developed test would be employed to assess the Stroop effect among children from all language background as it is language free test.
- It can be used to assess the Stroop effect in pre-school children (if they co-operate) where reading ability is not a pre-requisite for this test.
- It can be used in different clinical population to assess the mechanism of inhibitory control functions.

CHAPTER II

REVIEW OF LITERATURE

The classic Stroop test (Stroop, 1935; MacLeod, 1992) is one of the most commonly used test to assess the cognitive functions. Stroop test assess more than a cognitive curiosity it plays a key role in understanding 'attention'. From past researches, we can say that, Stroop effect is a well-known attentional phenomenon. Stroop test is popular for many reasons. There are two important reasons. First, the effect is large and is statistically reliable. Second in the eighty years of existence, the Stroop effect has never been adequately explained, making it a source of continuing theoretical fascination.

There are several paradigms in order to measure the Stroop effect like colour-word interference, Counting Stroop- digit naming versus counting the number of digits (Bush, Whalen, Rosen, Janike, McInerney, & Rauch, 1998), naming the direction of an arrow versus reading the direction word inside the arrow (Baldo, Shimamura & Prinzametal, 1998), naming a line drawing versus reading the name of a different object printed inside the drawing (Rosinski, Golinkoff, & Kukish, 1975) , reading location words printed in incongruent locations [Spatial Stroop] (Lu & Proctor, 1995) and colour-form/ colour-object interference (Mernard-Beteau & Cavanagh, 1984; Glaser & Glaser, 1993; Naor-Raz, Tarr, & Kersten, 2003). The major difference between colour-word Stroop task and colour-object Stroop task is with respect to semantic categories, colour-word Stroop task is from the same semantic category against one another (naming an ink colour and reading a colour-word) whereas the colour-object interference it's about different semantic categories (Object kind and colour kind).

The review is organised under the following headings;

- ***Conceptualization: Form and colour development in children***
- ***Memory for colours***
- ***Brain and executive functions***
- ***Colour-object Stroop in children***
- ***Other Stroop- An inhibitory measure in children***
- ***Colour-object Stroop in adults***

Conceptualization: Form and colour development in children

Kagan & Lemkin (1961) aimed to study the conceptual preferences of children for form, colour or size between 3.9 to 8.6 years of age. 35 females and 34 males participated in the study. 9 stimuli were presented in a series of white paper upon which various geometrical cut-outs differing in shape, colour and size were pasted. Standard stimulus and the comparisons were provided for the same. The task was to select the comparison stimulus which was same as standard stimulus. For 1-3 stimulus two comparisons and 4-9 stimulus three comparisons were given. The results indicated more females than males preferred form to colour in this particular age for conceptualization. Colour was not a preferred hypothesis for children in the studied age group. This was found out when the stimulus were colour and size, where the children did not know what to respond and the response was found to be better when form was presented. This shows that colour hypothesis is weaker than form. The results were better for girls because they driven the meaning from the label attached to the stimulus like triangle, square rather than just the

physical quantity colour. The authors haven't discussed how quick and accurate they were in responding.

Following the above study, Corah (1964) studied the further on the colour-form issues in young (3.10 to 5.8 years) and old (7.11 to 9.9 years) children. Each group had 80 children with 40 males and 40 females each. A stimulus booklet was made where sheets were covered with the matte acetate. 10 stimuli figures were considered, each figure (stimulus figure) was drawn on top of the white sheet and comparison figures were given below that, on either side. Both the comparison figures matched the stimulus figure either in colour or in form each. Each child was tested individually; the task was to match the stimulus figure to one of the comparison figures. The results were in concordance with Brain & Goodenough's (1929) study. Children less than 3 years give preference to form over colour; 3-6 years give preference to colour over form and greater than 6 years gives again preference to form over colour. The possible reasons given by the author for dissimilar results with Kagan & Lemkin (1961) were difference in the stimulus and instructions. The authors said colour was dominant character of the figure. As the development happens, perception and judgement become decentred and attends to all of the characteristics of a configuration.

Brown & Campione (1971) studied the effects of independently evaluated colour-cue preferences on dimensional dominance. A total of 104 subjects considered for the study, 52 3-year old (26 males and 26 females) and 52 4-year old (27 males and 25 females) children. For the cue preference test, they considered two black boards with ten white cards in a rectangular pattern were pasted on each of the black boards. These white cards contained either a square of colour or a black form. The form and colour cue-

preference cards were presented twice with 10 available cues. The subject had to point to the card which they like the best and don't like at all. The cues were divided as preferred, non-preferred or neutral cues for both form and colour.

From cued preference test, the neutral forms (ellipse and diamond) and colours (grey and light green) were considered for the dimensional test. The pattern stimuli consisting of coloured forms on white cards. On each trial, cards were presented in a triangular order apex for reference card and two comparison cards at the base of the triangle. The test stimuli consisted of 18 set of three cards. The first six sets formed a redundant-cue series (colour and form cues were completely correlated) and the next 12 set of opposed cues (matching would be based either on colour or form). The task was to either match the colour or form.

From cued preference test, the authors found the most preferred colour as red and least preferred colour as brown. The results found that, majority of 3-year old children were dominant for colours. Most of the 4 year old children, showed a mixed dominance i.e., dominant for forms when it was neutral cue condition and dominance was for colour when the cue was in their preferred or non-preferred condition.

Memory for colours:

Bartleson (1960) investigated the nature and consistency of memory colours related to ten well-known objects. A total of 50 subjects participated in the study. 29 subjects had no experience of participating in previous experiments of colour matching, 17 subjects were scientist or technicians and 4 subjects were experts in this regard. 931 Munsell patches ($_{1/2 \text{ by } 5/8 \text{ in}}$) were used for the study which was arranged in 7 cardboard

bases. In a neutral grey colour background, the colour patches were displayed which was approximately 200ft-c at the viewing plane. The objects used for the study are red brick, green grass, dry grass, blue sky, flesh, tanned flesh, broad-leafed summer foliage, evergreen trees, inland soil and beach sand. The subjects were instructed to indicate the nearest colour of the object named. It took almost 15 minutes for each participant to complete the task. The results indicated that the mean memory colours for the well-known objects studied are not of the same colours as the original object colours. There was an evidence of increased saturation in the memory for colours. The authors have not mentioned about the participant's age range, gender and possible reasons for the results.

Brain and executive functions:

Smith and Jonides (1999) reviewed the neuroimages different tasks of working memory and attentional phenomenon. The authors used either positron emission tomography (PET) or functional magnetic resonance imaging (fMRI) to study when the subjects are engaged in different cognitive tasks. Tasks like verbal item recognition task, verbal 2- back tasks, object item recognition task, spatial item recognition task and Stroop tasks are considered. The results revealed for

- Item recognition results in the activation of left posterior parietal cortex, Broca's area, left supplementary motor and premotor areas.
- Spatial storage activates the right premotor cortex, verbal tasks activate left hemisphere speech areas, and the object storage activates more of ventral regions of Prefrontal cortex.
- For Stroop Task, activation was found to be in anterior cingulate cortex and dorso-lateral prefrontal cortex.

Banich, Milham, Atchley, Cohen, Webb and Wszalek (2000) studied behavioural and neural activation patterns in the classic Stroop task and the colour-object Stroop task using fMRI in adults. Both the tasks were counterbalanced between the subjects. One half of the subjects were given Colour – Word Stroop Task and the other half was given Colour – Object Stroop Task. The results found that, the participants were slower in naming the incongruent colour condition than neutral condition in both the tasks. From fMRI results, it was evident that similar regions of the frontal cortex got activated in both the tasks. For incongruent colour naming condition, dorsolateral prefrontal cortex (areas 9 and 46) got activated for both the tasks whereas it was anterior cingulate cortex for the neutral colour naming conditions. Also, for incongruent Colour – Word Stroop Test, additional frontal areas got activated. The reason given for this by the authors was Colour – Word Stroop Test is of the same semantic category i.e., to name the colour of the ink and to read the word whereas Colour – Object Stroop Task is of the different semantic category i.e., object kind and its colour. Hence the additional activation was noted. And posterior regions got activated on congruent versus neutral tasks. For word processing left precuneus got activated whereas for object processing middle temporal gyri and the inferior and middle occipital cortex activated for colour – object tasks.

In similar lines, Bush, Whalen, Rosen, Jenike, McInerney and Rauch (1998) studied the neuroimages of Counting Stroop task and reported that Anterior Cingulate cortex gets activated.

Colour-object Stroop in children:

Cramer (1967) studied the colour-object interference in 22 children (12 male and 10 female) in the age range of 4-5 years old. Three cards were taken for three tasks, all the cards were arranged as such four rows and five columns are present. In first card, four patches of red, yellow, blue and green were presented in a random order; on the second card four line-drawings of four familiar objects (apple, sun, water and tree) and in the third card, the same items in its incongruent conditions, differed in positions. Task was to name the form and the colour as instructed. Results indicated that the children had more interference effect (more reaction time) for incongruent coloured stimuli than for object naming. The authors concluded that for preschool children, the dominance lies for form. Hence, greatest interference can be obtained for form versus colour. Cramer has suggested that both age and intellectual status of children had contributed to the form-dominance. In a longitudinal study, one can trace the changes in colour to form dominance or vice versa. The researcher has not mentioned how the reaction time was measured.

Prevor & Diamond (2005) studied the colour-object interference in 168 young children of 3.6 to 6.6 years old with 6months age interval. Total of 46 picture cards with line drawings in different colours were presented to the children. Set A was a canonical condition with 12 items. Set B was non-canonical condition with 12 items. Set C was neutral condition with 11 items and set D was abstract condition with 11 items. The colours selected for the study are red, orange, yellow, green, purple and brown. Half of the children were asked to name the colour (12 per each age) and another half were instructed to name the object (12 per each age). Speed of response and accuracy were

analysed. All the sessions were video recorded with a millisecond timer for later analysis. The authors took help from two highly trained coder to analyse the samples for reaction time. The authors found that children could name the colour faster and correctly when they were not able to name the shape (abstract) than for incongruently coloured stimulus. They found colour naming was influenced by the kind of stimulus. Colour naming was quick if it was for abstract forms, slower for the incongruent condition and in-between for other kind of stimulus. The stimuli were presented a manually and recording was done with a millisecond timed-video recorder, they haven't reported how the analysis was done. And the authors haven't commented anything about the accuracy of responses in children.

Other Stroop- An inhibitory measure in children:

Wright, Waterman, Prescott, & Murdoach-Eaton (2003) studied the Animal Stroop Test, an alternative Stroop like measure of inhibitory control using pictures. One hundred and fifty five children between the age ranges of 3 to 16 years participated in the study:

	Age in years													
	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Male	5	5	5	5	5	7	5	8	6	7	5	5	5	5
Female	6	6	5	5	5	5	8	5	6	5	5	7	5	5

Conners' Teachers Rating Scale (short form, CTRS-R) behavioral questionnaire was completed by Teachers for the parameters- oppositional, cognitive problems,

hyperactivity and ADHD index. It was as a means of linking task performance with behavioral aspects of inhibitory function such as hyperactivity. The stimuli are images of a cow, a pig, a sheep and a duck. There were two tasks in the experiment. One is congruent condition, where children were asked to name the animal as quickly as possible. Second is incongruent condition, for example body of cow with face of pig / body of cow with a circle face were presented; the children were asked to name the body of the animal as quickly as possible by ignoring the face of the animal. They had four blocks with two congruent and incongruent conditions with a total of 36 stimuli each. All the blocks were counterbalanced well before presenting to the children. Each stimulus was preceded by 0.5 second fixation point followed by 3 seconds for the stimulus presentation and 1 second interval before the presentation of next fixation point. Stimuli were presented through a laptop and responses were recorded through a microphone via a 'voice-key' hardware. Along with the vocal response from the children, the experimenter manually rated the responses for accuracy at the beginning of the vocal response. The variables measured are response time and percentage of errors.

The authors reported that children were slow in naming the incongruent Animal-Stroop task compared to the congruent ones and found a decreased response time pattern with increase in age. Also, when behavioural and cognitive measures were compared, children with hyperactivity or higher rating for ADHD performed poorly in incongruent Animal-Stroop task. The authors concluded that, it is a sensitive tool to assess the inhibitory functions in children below 7 years of age. Drawback: They have not excluded children with higher rating for ADHD and the gender wise comparison wasn't considered for the study.

Catale and Meulemans (2009) investigated the development of inhibitory control in 5-9 year old children (90 in number) using a computerized real animal size test (RAST) and to compare the obtained data in children with ADHD. The test includes presentation of stimulus using four pictures (2 small and two big pictures). The test has four conditions: two control conditions (animal and rectangle control condition), incongruent animal condition (small horse) and congruent animal condition (big horse).

In animal control, the children were instructed to respond to 20 line drawings of animals by looking at their semantic property. In rectangle control condition, the children were supposed to judge the form (big and small rectangle). The last two conditions were combined where the pictures of 32 congruent and 32 incongruent pictures of animals were presented randomly. The task was to judge the real size of the animal and not on-screen size. In all the conditions, the mode of response was by pressing a key. But the authors haven't mentioned which key needs to be pressed. The reaction time and number of correct responses were noted for each condition. Raven's Coloured Progressive Matrices Test was administered to all the children to test the effect of intelligence.

The results revealed that, the reaction time for rectangle control condition was more automatic than all other conditions. There was a significant difference between the reaction time of incongruent and congruent animal conditions in all age groups considered but there wasn't any change in the accuracy of response across age range. Even though statistical significant difference was not there, the authors said RAST could differentiate control group from the clinical group.

La Heij & Boelens (2011) further tested an executive control of colour-object interference following Prevor & Diamond (2005). In this study, three different experiments were carried out.

In the first experiment, they have studied the pattern of development on colour-object interference in children and adolescence. A total of 180 children and adolescents participated in the study which included: 6-year old (45 in number), 8-year old (44 in number), 12-year old (45 in number) and 16-year old (46 in number). The test was programmed using E-Prime software with a microphone and PST serial response box was used for verbal response. The stimuli were presented in an LG monitor which was connected to the Compaq notebook computer. 56 stimuli of meaningful pictures (28) and abstract forms (28) were selected for the study. Four demonstration trials and 16 practice trials were given before the presentation of 56 trials of the original test stimulus. The subjects were instructed to name the pictures as soon as possible. There was 750 msec fixation point, following which 2000 msec stimulus was presented at the centre of the screen for the subject to respond. The investigator manually judged the response as correct, incorrect or by inappropriately triggering the voice key by pressing the keys on the response box. The responses were measured for reaction time and accuracy. The authors reported that, the colour-object interference was found in 6-8 year old children and not 12-16 year old children. The reason attributed for this by the authors was young children doesn't have the interference control as like the adolescents and adults. Hence, there is colour-object interference in young children which can be attributable to the immature executive control in developing children and disappears as the age advances.

In the second experiment, the aim was to study whether children take more time to sort meaningful cards or abstract cards manually. 23 children (9 males and 14 females) between the age ranges of 5 to 6.75 participated in the study. A total of 48 laminated cards, 24 meaningful pictures and 24 abstract forms were considered. On the table, black trays with colour labelled on it for the colours-blue (left), red, green and yellow (right) was provided. The cards were divided into 12 items of four sets. The division was in terms of high saturation and low saturation of colours of the cards for meaningful and abstract pictures. The experiment had two investigators, one delivered instructions and another gave the cards. The children were given practice trials followed by test trials. The whole testing was video recorded to observe behaviour in them. The net sorting time for high saturation meaning picture and abstract form was 20.1sec and 21.2 sec, respectively. Net sorting time for low saturation meaning pictures and abstract forms were 21.2 & 21.3secs, respectively. The deck of saturated colour was sorted 1.2 seconds faster than unsaturated colours. The results revealed that the colour-object interference vanishes when task conflict is reduced or eliminated by changing the main task from colour naming to manual card sorting.

In the third experiment, the aim was to compare between the results of colour naming task and subitizing task (to make rapid, accurate and confident judgement of small number of items just by seeing it). A total of 26 children (6 males and 20 females) in the age range of 5 to 6.75 years participated in the study. The test was programmed using E-Prime software with a microphone and PST serial response box was used for verbal response. The stimuli were presented in a LG monitor which was connected to the Compaq notebook computer. The stimuli taken for the study were 32 meaningful pictures

and 32 abstract forms. One session was dedicated for colour naming and the next session was dedicated for naming the number of stimuli on the screen. The investigator manually judged the response as correct, incorrect or by inappropriately triggering the voice key by pressing the keys on the response box. The responses were measured for reaction time and accuracy. The results indicated that the presence of colour-object interference in 5-7 years children in naming the colour of set of objects and not in their number naming.

From all the three experiments, it is clear that colour-object interference would be seen in children and fade off gradually in adolescence as the prior group have immature executive functions. When the task was manual card sorting and subitizing task, the interference wasn't present as for colour-object interference.

Okuzumi, Ikeda, Otsuka, Saito, Oi, Hirata, Haishi, & Kokubun (2015) studied the interference in Fruit Stroop task. The authors investigated the interference effect between the congruent and incongruent colours of fruit and interference from incongruent colour to word reading. Participants in this particular study are typically developing children and young adults. A total of 271 subjects participated in the study and they were divided into five age groups. 5-6 years (64 children-28 males & 36 females), 7-8 years (65 children-32 males and 33 females), 9-10 years (60 children-29 males & 31 females), 11-12 years (46 children-22 males & 24 females) and 18-36 years (36 young adults - 19 males & 17 females). The participants selected based on their ability to read and pre-schoolers were not considered for the study. The materials used for the study are paper and pencil type of fruit test. The test consisted of two conditions x three tasks, in total six conditions were presented for all the participants. The conditions/tests are 1. Canonical colour task (control), 2. Canonical colour task (interference), 3. Superficial colour task (control), 4.

Superficial colour task (interference), 5. Fruit name task (control) and 6. Fruit name task (interference). The target pictures are strawberry, banana and melon and the target colours are red, yellow and green. The stimulus was presented in each paper with the drawing at the left side and three target colours in rectangular blocks on the right side.

In test 1, participants were given one by one colourless drawings of three fruits and colour choice of red, yellow and green were given in a rectangular block beside the line drawings. The task was to match the colour to the fruit. In test 2, the pictures of fruits were presented in non-canonical colour of the target colours and the task was to identify the canonical colour for the non-canonical fruits from the choice. In test 3, three geometric forms-triangle, square and circle were presented in red, green and yellow colours one by one. The task was to match the colour to the choice given on the right side of the sheet. In test 4, the fruits were given in the non-canonical colours; the task was to make the choice from the three colours given in the rectangle. In test 5, the line drawings of fruits were given and the orthography of the fruits was given on the right side of the test sheet and the task was to choose the name of the fruit. In test 6, the non-canonical fruits were given with the orthography on the right side; the task was to choose the name of the fruit from the choice. Here, tests 2, 4 & 6 are interference tests, where they have to suppress the superficial colour and try to choose the canonical colour of the fruit. For each test, number of correct responses were out of 60 test trials were recorded. The interference score was calculated using the formula:

Interference score = 100 x (correct responses in the control condition-correct responses in the interference condition)/ correct responses in the control condition.

For all age groups, the study resulted significant difference between canonical colour tasks and superficial colour tasks and between canonical colour tasks and the fruit name tasks. In 5-6 years age range, there was significant difference between superficial colour task and fruit name tasks. For superficial tasks, difference was seen between 5-6 years and other age groups. The accuracy couldn't be assessed as all the participants were very accurate in their responses and it didn't follow normal distribution. The authors have not mentioned anything about the instrument used for the measurement of time.

Colour-object Stroop in adults:

Few other researchers (Menard-Buteau & Cavanagh, 1984; Glaser & Glaser, 1993; Naor-Raz et al., 2003) investigated the colour-object Stroop interference in adults. Menard-Buteau & Cavanagh (1984) found that young adults were slower in naming the colours of incongruent coloured objects compared to neutrally coloured objects. They also found that they took longer time to discriminate the colours of two incongruently coloured objects than that for neutrally coloured objects.

Glaser and Glaser (1993) investigated colour-object interference in adults; the stimulus used was outline drawings of everyday objects each with canonical condition and non-object condition. The task was to name the everyday objects whose outlines are showed and to name the incongruent colour condition. They found that there was no difference in reaction time in naming the congruent condition but had difference for non-congruent condition for both object and colour naming.

Monsell, Taylor & Murphy (2001) proposed a theoretical framework on the colour-object interference on the executive control functions. They said the Stroop effect

is because of the competition in the task sets. Also, the competition depends on the picture familiarity i.e., easy or hard to name. They said that the letter string activates the reading ability in adults, in the similar way of the meaning of the picture activates set of picture naming in young children.

Naor-Raz, Tarr, & Kersten (2003) conducted similar experiment in adults in colour naming task for congruent and incongruent objects. They had four experiments in their study. Experiment 1 was to name the colours of typical and atypical colours of the diagnostic colour objects. The results indicated that individuals had longer reaction time for naming incongruently coloured objects. Further in Experiment 2, they assessed the Stroop effect in colour-word with the same stimulus and word combination. Here, the typical condition producing longer response times than the atypical condition. As there was discrepancy between first and second experiment, the authors thought there can be methodological difference. Hence, in experiment 3 the previous experiment was repeated by presenting the stimulus manually. The results indicated that at multiple levels, color as an intrinsic property for object representation. In Experiment 4, along with experiments 1 & 2 lexical decision task was also added. Priming for these associates was observed following color naming of words, but not pictures. Further evidence suggest that the color-shape associations responsible for the differing effects obtained in experiment 1 and 2 are due to the automatic activation of color-shape associations at different levels of representation.

From the above published studies on colour-object interference, it is evident that colour object interference is present both in children and adults. There are only a few empirical studies done in children on colour-object interference. As children are not experienced readers or master in reading for colour-word Stroop task (Classical Stroop Test). It is interesting to study colour-object Stroop effect in young children.

CHAPTER III

METHOD

The study was planned to be carried out in six phases.

I. Development of the test material

II. Programming of the stimulus

III. Selection of the subjects

IV. Administration and scoring

V. Data Analysis

Phase I: Development of the test material

Outline of the test

The test material consisted of 48 pictures which were drawn using Corel DRAW graphics suite X7 software. The pictures were 800 x800 in dimension and were in Bitmap format. The pictures selected were familiar and common to typically developing children. Four major colours such as red, green, yellow and black were selected and the pictures were of these colours. According to Receptive and Expressive Language Test (RELT) (Bzoch & League, 1971), the colours taken up for the study is achieved by 3-3.6 years of age. Hence, it can be used for the present study where the selected age range is 5-8 years.

Description of each condition

The study consisted of four blocks. Block I would be object naming, Block II would be colour naming of congruent stimuli, Block III would be colour naming of incongruent stimuli and Block IV would be colour naming of neutral stimuli. Three

object/items for each colour were selected for the material. A total of twelve test items (3 objects x 4 colours) would form the material in each condition.

Table 3.1: *Framework of the test material designed for the study*

Blocks	**Task**	**Example**	**Target**	**Total No. Of Items**	**Max Score**
I	Object Naming (Line Drawings)	Banana	Banana	12	12
II	Colour Naming (Congruent)	Yellow Banana	Yellow	12	12
III	Colour Naming (Incongruent)	Red Banana	Red	12	12
IV	Colour Naming (Neutral)	Green Chair	Green	12	12

The test consists of 2 tasks, one is object naming and another is colour naming. The stimuli for task one (Block I) was 12 in number and second task (Block II-IV) was 36 in number. The total 12 items are given in Appendix I. Exemplars of the stimuli are depicted in Appendix II.

As a part of stimulus selection, the prepared stimuli were given for validation/familiarity testing to three experienced Speech-Language Pathologist (SLP), three primary school teachers and three parents who were dealing with/had children from the selected age range 5-6 years, 6-7 years and 7-8 years respectively to evaluate the picture acceptability and colour suitability. They were asked to rate each stimulus on a three point rating scale (0-not appropriate; 1-somewhat appropriate; 2-appropriate), on

picture acceptability and colour suitability. At least two out of three judges should agree with each other for the selection of the picture. The agreement also was taken into consideration across the teachers, parents and SLPs two out of three agreement were considered to select the stimulus. The list of stimuli that were selected after the validation given in Appendix I. For both object and colour naming, each block has 12 items. The stimuli have been divided into blocks for colour naming in order to get clear idea about it and there was no demarcation as congruent, incongruent and neutral blocks in the presentation of the stimuli.

A pilot study was conducted for finalizing the stimulus, presentation duration, response duration and to check the kind of response with 20 children. On observation, the task was more of picture naming when the presentation duration and the response time were 3500 msec and 2500 msec. The Stroop effect wasn't seen for that particular duration. Hence, change in the presentation duration of the stimulus and response duration was done to 1000 msec and 1500 msec respectively.

Phase II: Programming the stimulus

The stimulus for the study was programmed using DMDX software-Auto mode (Forster and Forster, 2003). The syntax for the program has been given in Appendix III. CheckVocal software version-2.2.6 was used to record the verbal response of the participants along with the DMDX software. Each stimulus presentation would be 1000 msec and duration of 1500 msec would be given for the child to respond verbally. The stimulus was presented using an Acer Aspire laptop (Acer Aspire 4750z) of screen width 14 inches.

Phase III: Selection of the subjects

Participants

The present study included young typically developing children of 5-8 year old. A total of eighty three participants from schools of Mysore locality was considered in the study. The participants were divided into 3 age groups. Group I included children of 5-6 years of age (13 males and 15 females), group II included children of 6-7 years of age (14 males and 13 females), and group III included children of 7-8 years children (15 males and 13 females). Thus, a total of 83 children participated in the present study. Table 2 shows details of the participants of the study

Table 3.2: *Details of the participants*

Age Range	**Groups**		
	I	**II**	**III**
	5-6 years	**6-7 years**	**7-8 years**
Males	**13**	**14**	**15**
Females	**15**	**13**	**13**
Total	**28**	**27**	**28**

Participant's selection criteria

All the children demonstrated the following criteria;

- No history of speech, language, hearing, neurological, developmental and intellectual disorders, which was ensured using WHO Ten question disability screening checklist (Singi, Kumar, Malhi & Kumar, 2007).
- Participants belonging to middle socio-economic status was selected in the study, which was ensured using NIMH Socio-Economic Status Scale [SES] Revised version developed by Venkatesan (2011).
- Children whose mother tongue is Kannada and medium of instruction is English was selected.

Phase IV: Administration and scoring

Collection of the data was carried out in the schools in and around Mysore. The objectives and the outcomes of the present study were explained to the teachers. Written consent was obtained from teachers (Appendix IV). Each participant was seated comfortably on a chair facing the laptop in a quiet and distraction free room. For each child, approximately 15 minutes was taken. Before starting the task, the necessary demographic data from the participant were collected. The first task would assess reaction time for object naming for line drawing. The participants were instructed to name the object verbally as soon as it appears on the screen. The second task would measure the colour reaction time for the picture appears on the screen. They were instructed to name the colour verbally and not the picture as quickly as possible. This task would include all the three colour naming conditions together (congruent, incongruent

and neutral conditions). The stimuli presentation was randomized between three blocks II, III & IV which are colour naming conditions. There was no gap between blocks II, III & IV for presentation of the stimulus; the term block was used simply to indicate the characteristics of the conditions as congruent, incongruent and neutral stimulus.

Above mentioned procedure was demonstrated by the investigator and practice trial was provided for each child before testing. After the task the participants were reinforced with a pencil each. Here the pencil acted as both reinforcer and distractor. The reinforcer prevented the children to discuss about the experiment rather they discussed about the pencil which acted as a distractor. In the same manner, all the subjects from the selected age range were tested.

Scoring

The verbal responses were analysed for reaction time and accuracy measures. Reaction time was measured from the onset of the picture on the screen to the onset of the verbal response by the children. The accuracy was calculated based on the number of correct verbal response by the children. Measures were taken to calculate only the reaction time of target word and not the interjections. If interjections were present, the onset of the correct verbal response was taken into consideration. Each correct response was scored as '1' and incorrect/absent response as '0'. The following table shows the parameters assessed.

Table 3.3: *Details of the blocks*

Sl No.	Blocks	Abbreviations
1	Object Naming Reaction Time	ONRT
2	Neutral Reaction Time	NRT
3	Incongruent Reaction Time	IRT
4	Congruent Reaction Time	CRT
5	Object Naming Accuracy	ONA
6	Neutral Accuracy	NA
7	Incongruent Accuracy	IA
8	Congruent Accuracy	CA

Phase V: Data Analysis

The measured reaction time and accuracy were tabulated and compared between the three age groups and between the four blocks (object naming, congruent, incongruent and neutral conditions). Scores were tabulated separately for each age group and gender using SPSS 21.0 - statistical software.

Statistical Analysis:

- Descriptive statistical analysis was used to compute mean and standard deviation of the reaction time and accuracy for the three groups and four conditions separately.
- Further, Test of normality was done to see whether the data followed the normality. All the data were subjected to test of normality using Shapiro-Wilk test of normality where the reaction time parameters followed normal distribution and the accuracy parameters didn't satisfy normality.

- Hence, parametric tests were done for reaction time parameters and non-parametric tests were done for accuracy parameters.
- In parametric tests, Mixed ANOVA, Two-way MANOVA, Duncan's Post-hoc test and repeated measures ANOVA was done.
- Mixed ANOVA was done to see the main and interaction effect for age, gender and task. Bonferroni pair-wise comparison was done to see the task effect. Duncan's post-hoc test was done to see the age effect.
- Further, two-way MANOVA was done to see the age and gender interaction effect.
- Repeated measure ANOVA was conducted to inspect which specific age group and gender differed significantly for all the tasks.
- In non-parametric tests, Mann Whitney U Test was done to compare gender wise performance within each age group. Since there was no difference for males and females, Kruskal Wallis test was done by combining the scores of male and female to compare the accuracy scores of all the four conditions across three age groups.
- Further, Pairwise test was done to see the difference between accuracy scores of the four conditions.
- Friedman Test was done to see the effect of the conditions on accuracy within each age group. If obtained p value is < 0.005 Wilcoxon Signed rank test was used to determine which pair showed significant difference in performance in accuracy in each age group.

CHAPTER IV

RESULTS AND DISCUSSION

The objectives of the study were to investigate the effect of age, task and gender on colour object interference in 5 – 8 year old young Kannada speaking children. For this purpose, the test material was developed. A total of four conditions were employed in the study to examine the objectives. Reaction time and accuracy for all these four conditions were measured and compared. A total of 8 parameters were considered for the analysis. Out of 8, the first four are the reaction time scores and the next four are the accuracy scores for the four conditions.

1. Object Naming Reaction Time (ONRT)
2. Congruent Colour Naming Reaction Time (CRT)
3. Incongruent Colour Naming Reaction Time (IRT)
4. Neutral Colour Naming Reaction Time (NRT)
5. Object Naming Accuracy (ONA)
6. Congruent Naming Accuracy (CNA)
7. Incongruent Naming Accuracy (IA)
8. Neutral Naming Accuracy (NA)

The reaction time and accuracy obtained from four conditions were tabulated and statistically analysed using SPSS software version 21.0. Descriptive statistics, parametric and non-parametric tests were used to compare across age groups, gender and conditions.

The number of participants in the study was 90. The data was subjected to box plot where the data with extreme scores were excluded from the study. Seven such data were excluded. 2 males in 5 – 6 years, 1 male and 2 female in 6 – 7 years and 2 females in 7 – 8 years were excluded.

The results are discussed under following subheadings:

1. Reaction Time
2. Accuracy

1. Reaction Time

The results revealed that the mean reaction time decreased with the increase in age. The mean reaction time for all the tasks considered followed a consistent performance pattern in all age groups. The children in group I (5-6 years) performed comparatively slower than the other groups whereas, faster reaction time was found in group III children (7-8 years). Table 4.1 shows the mean and SD of reaction time across different conditions and groups.

Table 4.1*: Mean and Standard deviation (SD) of Reaction Time (in milliseconds)*

Group	**5 – 6 years**				**6 – 7 years**				**7 – 8 years**			
Gender	**Male**		**Female**		**Male**		**Female**		**Male**		**Female**	
Parameters	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
ONRT	1165.6	106.4	1193.9	138.2	1036.9	180.4	1019.6	112.2	1019.4	181.3	885.7	81.9
CRT	1168.3	172.0	1322.0	234.8	1072.9	112.5	1098.9	134.9	1028.7	204.4	949.9	93.3
IRT	1151.7	134.9	1282.8	244.8	1111.5	178.3	1064.0	145.0	999.7	178.9	931.2	76.8
NRT	1104.9	149.5	1243.9	195.5	1032.9	123.1	1067.6	183.7	1004.3	196.4	904.2	91.0

ONRT: Object Naming Reaction Time; CRT: Congruent Reaction Time; IRT: Incongruent Reaction Time; NRT:Neutral Reaction Time

Mixed ANOVA for comparison of RT across tasks, age and gender were done. Main and interaction effect between these variables were examined. Results revealed that there was significant main effect for ***task*** [F (3) = 6.429, p < 0.01] and ***age*** [F (2) = 20.11, p < 0.01] found, but ***not for gender*** [F (1) =0.32, p = 0.858] and a significant interaction effect was seen between age and gender [F (2) =3.79, p = 0.027], whereas no interaction effect was found for task x gender [F (3) =2.77, *p* = 0.058], task x age [F (6) =0.540, *p* = 0.777] and task x age x gender [F (6) =0.951, *p* =0.459]. Table 4.2 shows the results of Mixed ANOVA for Reaction Time across different conditions.

Table 4.2: *Results of Mixed ANOVA for Reaction Time across different conditions*

Source	**df**	**F**	**Sig.**
Task	3	6.42	0.00 *
Age	2	20.11	0.00*
Gender	1	0.32	0.85
Task * Age	6	0.54	0.77
Task * Gender	3	2.77	0.05
Age*Gender	2	3.79	0.02*
Task * Age * Gender	6	0.95	0.45

('' indicate significance at 0.05 level)*

Results of Bonferroni pairwise comparison test revealed that there was a significant difference between ONRT – CRT (*p = 0*.018) and CRT – NRT (*p = 0*.001), whereas no significant difference for other pairs noticed.

Results of Duncan's post – hoc test revealed that overall; the three age groups differed significantly for the reaction time. Table 4.3 shows the results of overall Duncan's post-hoc test.

Table 4.3: *Results of Duncan's post-hoc test (Overall)*

Age Group	**Subset**		
	1	**2**	**3**
5 -6 years	968.8065		
6-7 years		1063.0899	
7-8 years			1208.1900

Further, test revealed that for ONRT, there was a significant difference found between group I (5-6 years) and group II & III (6 – 8 years). Among group II & III there was no significant difference in terms of reaction time. Table 4.4 shows the results of Duncan's post-hoc test for ONRT.

Table 4.4: *Results of Duncan's post-hoc test (ONRT)*

Age Group	**Subset**	
	1	**2**
5 -6 years	1180.7991	
6-7 years		1028.5970
7-8 years		957.2990

Results of Duncan's post – hoc test revealed that the three age groups differed significantly for the reaction time for CRT. Table 4.5 shows the results of Duncan's post-hoc test for CRT.

Table 4.5: *Results of Duncan's post-hoc test (CRT)*

Age Group	**Subset**		
	1	**2**	**3**
5 -6 years	1250.6693		
6-7 years		1085.4597	
7-8 years			992.1352

Results of Duncan's post – hoc test revealed that the three age groups differed significantly for the reaction time for IRT. Table 4.6 shows the results of Duncan's post-hoc test for IRT.

Table 4.6: *Results of Duncan's post-hoc test (IRT)*

Age Group	**Subset**		
	1	**2**	**3**
5 -6 years	1221.9226		
6-7 years		1088.6383	
7-8 years			967.9335

Results of Duncan's post – hoc test revealed that the three age groups differed significantly for the reaction time for NRT. Table 4.7 shows the results of Duncan's post-hoc test for NRT.

Table 4.7: Results of Duncan's post-hoc test (NRT)

Age Group	**Subset**		
	1	**2**	**3**
5 -6 years	1179.3690		
6-7 years		1049.6647	
7-8 years			957.8582

Results of two-way MANOVA revealed that there was an interaction effect seen between age and gender for NRT (p = 0.027) and CRT (p = 0.044). Table 4.8 shows the results of two-way MANOVA for age and gender interaction.

Table 4.8: *Results of Two-way MANOVA for age and gender interaction*

Tasks	**df**	**F**	**Sig**
NRT	2	3.767	0.027*
IRT	2	2.867	0.063
CRT	2	3.261	0.044*

*(*Indicates significant at 0.05 level)*

Results of repeated measure of ANOVA revealed that there was a significant difference found for group I females (p = 0.022) for CRT and NRT. Table 4.9 shows results of repeated measures ANOVA.

Table 4.9: *Results of Repeated measures ANOVA*

Age	**Gender**	**df**	**F**	***p* value**
5-6 years	Male	3	1.640	0.197
	Female	3	3.548	0.022*
6-7 years	Male	3	2.530	0.071
	Female	3	1.433	0.249
7-8 years	Male	3	0.370	0.775
	Female	3	2.201	0.105

***Indicates statistically significant difference at 0.05 level*

The results of Mixed ANOVA revealed there were a significant task and age effect and the interaction of age and gender effect. This could be due to the differences in the task i.e., object naming and colour naming. Age effect could be because of the three developmentally different age groups which were considered in the present study.

Further, Bonferroni's post-hoc test revealed that there was a significant task difference across all the age groups except for object naming where group I was found to be significantly different from group II & III i.e. the performance of children in group II and III were very similar. From this, it can be said that, there is a developmental pattern seen in all the three age groups for each of the tasks. With lack of normative data in Indian context, the obtained data can be considered as a reference for the performance of the children in the studied age range. Further exploration in this regard is required.

In Bonferroni pair wise comparison, there was a significant difference found between ONRT – CRT and CRT – NRT whereas there was no significant difference found for CRT – IRT; IRT – NRT; ONRT – IRT; and ONRT – NRT. First, the differences in ONRT – CRT might be because of the differences in the tasks i.e., object naming and colour naming requires naming of entirely different domains for which areas responsible are also different in the brain. Left hemisphere is responsible for the object naming whereas right hemisphere responsible for colour naming (Sperry, 1981).

Second, CRT – NRT was found to be significantly different. On observation, Neutral object naming was found to have lower RT than Congruent object naming. This is because of children initially are exposed to the neutral items in multiple colours in their environment and not the same for congruent items. There was no significant difference seen for CRT – IRT which could be because of dominance given to the 'form' over 'colour' which is supported by Brain & Goodenough's study (1929).

Now-a-days children are exposed to more of cartoons, where they can find many incongruent items like eyes of the girl in red, blue, yellow and other colours. Hence, it

can be said that children give more preference to 'form' rather than 'colour' for their perception. And the present study has also found the same. Also the stimulus presentation duration (1000 msec) and the response time (1500 msec) given for the children in this study is relatively more; it was more like naming task than the Stroop task and there was less interference seen. Hence there was no difference seen between the tasks (CRT – IRT, IRT – NRT, ONRT – IRT and ONRT – NRT).

Further, age and gender interaction effect was seen for group I females and not for any other age groups or gender which could be attributed to the presence of faster plasticity development in females than males and the heterogeneity of the participants. Since, the samples were collected only from two schools and these results might vary with other schools/ institutions depending on the instructional methods followed to teach the children.

2. Accuracy

The results of descriptive statistics revealed that the mean and median accuracy scores obtained are similar across age groups and gender whereas, on comparison across tasks, the median was found to be 11 in group I whereas for group II & III it was 12. Table 4.10 shows the mean, SD and median of accuracy scores across different tasks and groups.

Table 4.10: *Mean, Standard Deviation (SD) and Median of accuracy scores*

Age Group	Gender		ONA	CA	IA	NA
5-6 years	Male	Mean	12	10.77	11	11.15
		SD	0.00	1.48	1.78	1.14
		Median	12	11	12	11
	Female	Mean	11.93	10.93	10.80	10.73
		SD	0.26	1.27	1.21	1.83
		Median	12	11	11	11
6-7 years	Male	Mean	11.86	11.42	11.57	11.57
		SD	0.36	0.76	0.64	0.64
		Median	12	12	12	12
	Female	Mean	11.69	11.54	11.23	11.23
		SD	0.63	1.13	1.48	1.36
		Median	12	12	12	12
7-8 years	Male	Mean	11.93	11.73	11.6	11.53
		SD	0.25	0.46	0.74	0.92
		Median	12	12	12	12
	Female	Mean	11.84	11.31	11.77	11.84
		SD	0.38	1.18	0.44	0.38
		Median	12	12	12	12

ONA: Object Naming Accuracy; CA: Congruent Accuracy; IA: Incongruent Accuracy; NA: Neutral Accuracy

Further, to examine significant difference, Mann-Whitney U test was used and the results revealed no significant difference between the genders for all the age groups considered ($p > 0.05$). Hence, the scores of males and females were combined into one group. Table 4.11 shows the results of Mann-Whitney U-Test comparing accuracy scores across tasks and age group.

Table 4.11: *Results of Mann-Whitney U- test comparing accuracy scores across tasks and age group*

Condition		**ONA**	**CA**	**IA**	**NA**
5-6 years	*Z* value	-0.931	-0.267	-1.104	-0.542
	p value	0.352	0.789	0.270	0.588
6-7 years	*Z* value	-0.647	-0.991	-0.29	-0.116
	p value	0.518	0.322	0.977	0.908
7-8 years	*Z* value	-0.730	-0.871	-0.396	-0.836
	p value	0.465	0.384	0.692	0.403

Note: For all the conditions, $p > 0.05$

The accuracy scores of all the four conditions were compared across three age groups using Kruskal Wallis Test. The results revealed a significant difference between the three age groups for CA, IA and NA [CA (χ^2 (2) = 6.270, $p < 0.05$), IA (χ^2 (2) = 6.314, $p < 0.05$) & NA (χ^2 (2) = 7.506, $p < 0.05$)], but no significant difference was found in ONA across the age groups [ONA (χ^2 (2) = 3.231, $p > 0.05$)].

Further, pair-wise comparison between the age groups for CA, IA and NA was done using Mann-Whitney U Test. The results revealed CA scores of group II was significantly better than scores obtained by group I (Z= -1.995, p<0.05). Whereas, IA and NA was not significantly different between group I and II. Similarly no significant difference among CA, IA and NA was found between group II and III. However, all the three naming accuracy (CA, IA & NA) were significantly different between group I and III. Table 4.12 shows results of pair-wise comparison using Mann-Whitney U-Test between groups.

Table 4.12: *Results of pair-wise comparison using Mann-Whitney- U -Test between groups*

Task / Group	CA	IA	NA
I v/s II	$\|Z\| = 1.995$, $p = 0.046$*	$\|Z\| = 1.630$, $p = 0.103$	$\|Z\| = 1.602$, $p = 0.109$
II v/s III	$\|Z\| = 0.173$, $p = 0.862$	$\|Z\| = 0.739$, $p = 0.460$	$\|Z\| = 1.045$, $p = 2.96$
I v/s III	$\|Z\| = 2.217$, $p = 0.027$*	$\|Z\| = 2.416$, $p = 0.016$*	$\|Z\| = 2.687$, $p = 0.007$*

Friedman Test was carried out to examine the accuracy scores across conditions in each age group. Test revealed significant difference among the tasks in group I (χ^2 (3) = 23.799, p< 0.01). Whereas, no significant effect was found in group II (χ^2 (3) = 2.515, p > 0.05) and group III (χ^2 (3) =3.680, p> 0.05). The decreasing rank order of the scores of the tasks in group I is as follows; ONA followed by CA, IA and NA (ONA > CA = IA = NA). Further, pair-wise comparison between the tasks in group I was done using Wilcoxon Signed Rank Test which revealed ONA was significantly higher than CA, IA and NA. Whereas, no significant difference was found across other conditions (IA-NA, CA-IA or NA-CA). Table 4.13 shows the results of Wilcoxon Signed Rank test showing pairwise comparison of accuracy scores.

Table 4.13: *Results of Wilcoxon Signed Rank test showing pair wise comparison of accuracy scores*

	CA-ONA	**IA-ONA**	**NA-ONA**	**CA-IA**	**CA-NA**	**IA-NA**
Z value	-3.496**	-3.337**	-3.460**	-0.268	-0.730	-0.454

** $p < 0.01$.

The performance for the accuracy was similar for all the children across the age groups. There was no significant gender effect but a significant task effect was seen. Hence, both the gender in each group were combined and compared across the tasks. For CA, there was a significant difference between group I & II; and I & III. For IA and NA, significant difference was found for I & III. In all the three conditions i.e., CA, IA and NA, there was a significant difference across the extreme groups. From this, developmental pattern can be seen across the three age groups although no known normative data exists. Also, the results revealed that ONA differed significantly from all the other conditions (CA, IA and NA). It can be inferred that children give importance to the colour as a whole; hence there was a significant difference across the accuracy of colour naming and object naming.

In the present study, verbal mode of response was incorporated for measuring the reaction time and accuracy. If it was a manual task (pressing the key) the responses would have been much faster. To name the stimuli the children would take more time to respond due to the strategic processing like language selection to name and environmental distractions.

CHAPTER V

SUMMARY AND CONCLUSIONS

Executive functioning is one of the important cognitive domains that has to be assessed in children which helps in the development of many other skills like tasking switch or stopping, planning, multitasking and attending and concentrating for long time. There are several tests to assess executive functions in adults which might not be applicable to children. The well-known test to assess executive function was developed by Stroop in 1935. Keeping in mind the children's literacy level and to make the assessment more interesting, the classical Colour- word Stroop test was further modified as Colour – object interference, day- night test, animal Stroop test, fruit Stroop test and so on. To assess the developing executive functioning in children Colour – Object interference test has been widely used and outcome of the test has been found to be reliable by several researchers. Hence, it was interesting to study the same in Indian context.

The present study aimed to develop colour- object interference test and evaluate the stroop effect in young children between 5 – 8 years of age. The objectives of the study were to determine the development trend on reaction time and accuracy scores and to see any task and gender differences (if any). A total of 48 pictures (outline drawings, congruent, incongruent and neutral conditions) were developed using Corel draw software. The stimulus was presented in DMDX software and the verbal response time was recorded using CheckVocal. The presentation duration for the stimuli was 1000 msec and 1500 was given to respond. A total of 83 children in the age range of 5 – 8 years were considered for the study. There were two tasks: Object naming (12 stimuli) and

Colour naming (36 stimuli). The children were instructed to name the object in task 1 and colour in task 2. Reaction time and accuracy were considered for the analysis. A score of 1 was given to correct response and 0 for incorrect response. The obtained data were subjected to descriptive and inferential statistical analysis using SPSS software 21.0.

Results revealed that in all the tasks, group I children performed poorer (longer RT) compared to that of group III children. As the age increased the performance became better. But, there was no statistical significant difference noticed among the three age groups on RT. Among the children, females of group I had a significant difference for NRT and CRT which could be due to the presence of spurting of plasticity development in female children than males at that stage which needs further investigation. Children of all the groups were equally accurate in naming both colour and object.

Clinical Implication:

- The present study will be useful to know the inhibitory control and task switching mechanisms in typically developing young children of 5-8 years of age.
- The developed test would be employed to assess the Stroop effect among children from all language background as it is language free test.
- It can be used to assess the Stroop effect in pre-school children (if they co-operate) where reading ability is not a pre-requisite for this test.
- It can be used in different clinical population to assess the mechanism of inhibitory control functions.

Limitations of the present study

- The presentation duration of the stimuli and response time was relatively more for the Stroop task.
- Children from diverse educational background were not selected.
- Testing environment could have been controlled by making them sit in quiet environment. Sound proof recording of the responses could have been done.
- The blocks for the stimulus presentation could have been counterbalanced.
- Small sample size was taken for the present study.

Future Directions:

- The test can be assessed by reducing the presentation duration and response time.
- The children can be made to respond for the tasks, by manually pressing the key as 'right' or 'wrong' (binary choice) instead of verbally naming the colour where the latter increase the cognitive demand.
- To consider the children for the validation of the stimuli along with teacher, parent and SLPs.
- Other softwares like E-Prime with a microphone and PST serial response box can be used for the presentation and measurement of the stimuli.

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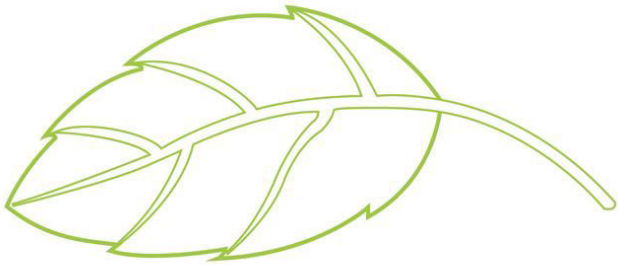
APPENDIX I

LIST OF TEST STIMULI

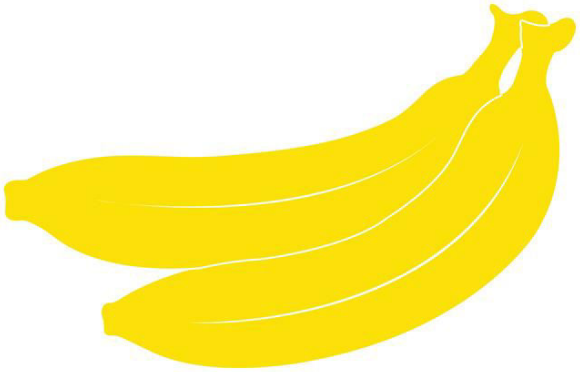
Object Naming	**Colour Naming (Congruent)**	**Colour Naming (Incongruent)**	**Colour Naming (Neutral)**
Grapes	Green Grapes	Red Grapes	Green Shirt
Rose	Red Rose	Green Rose	Green Chair
Eyes	Black Eyes	Yellow Eyes	Green Fan
Apple	Red Apple	Green Apple	Red Umbrella
Chick	Yellow Chick	Black Chick	Red Car
Sun	Yellow Sun	Black Sun	Red Bucket
Leaf	Green Leaf	Black Leaf	Yellow Ball
Crow	Black Crow	Yellow Crow	Yellow Cup
Post-box	Red Post-Box	Yellow Post-Box	Yellow Butterfly
Hair	Black Hair	Green Hair	Black Bag
Banana	Yellow Banana	Red Banana	Black Watch
Tender coconut	Green Tender Coconut	Red Tender coconut	Black Shoe

APPENDIX II

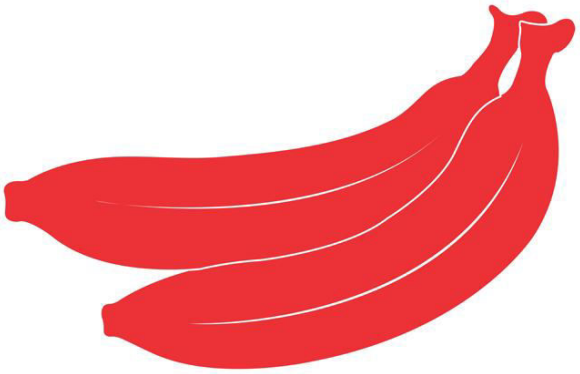
BLOCK I - OBJECT NAMING (LINE DRAWINGS)



BLOCK II - CONGRUENT CONDITION



BLOCK III – INCONGRUENT CONDITION



BLOCK IV – NEUTRAL CONDITION

APPENDIX III

Syntax for Object and Colour Naming condition

<ep> <n 30> <azk> <cr> <dbc 255255255> <dwc 0> < dfd 17 > <d 125> <id "KeyBoard"> <id DigitalVOX> <id RecordVocal 0,1500> <nfb> <t 2500> <eop>

0 <ln -2> "Name the picture as fast as possible" , <ln 0> "Press spacebar to begin" ;

=1 <ms% 500> <bmp> * "1" <ms% 1000>/;
=2 <ms% 500> <bmp> * "2" <ms% 1000>/;
=3 <ms% 500> <bmp> * "3" <ms% 1000> /;
=4 <ms% 500> <bmp> * "4" <ms% 1000> /;
=5 <ms% 500> <bmp> * "5" <ms% 1000> /;
=6 <ms% 500> <bmp> * "6" <ms% 1000>/;
=7 <ms% 500> <bmp> * "7" <ms% 1000>/;
=8 <ms% 500> <bmp> * "8" <ms% 1000> /;
=9 <ms% 500> <bmp> * "9" <ms% 1000> /;
=10 <ms% 500> <bmp> * "10" <ms% 1000> /;
=11<ms% 500> <bmp> * "11" <ms% 1000> /;
\=12 <ms% 500> <bmp> * "12" <ms% 1000> /;
0 "Thank you" ;

Same syntax with 36 items was presented for colour naming.

APPENDIX IV

All India Institute of Speech and Hearing, Manasagangothri,

Mysore, 570006

Topic: 'Colour-object interference in 5 - 8 year old Kannada speaking children: A Stroop effect'

I, Rekha D, Master student, doing dissertation regarding the above mentioned topic under the guidance of Mr Rajasudhakar, Dept of Speech Language Sciences at AIISH. I would require the audio samples from the children. I would spend around 15-20 minutes each of the participant. All the samples will be kept confidential. Through this study, the executive functions of 5 to 8 year old Kannada speaking children can be established. It will be helpful in knowing the developmental trend and to determine the normative data for young children from Kannada speaking background.

Consent

I have been informed about the aim of the study mentioned above. I hereby permit Ms. Rekha D (MSLP, AIISH) to allow my students to be a part of her study.

List of Students:

Signature of the Teacher