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SINHALA FONTS AND DYSLEXIA.
Adopting Latin Script Based Research in to Sinhala Reading Materials.

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Abstract
Typefaces and fonts designed for the purpose of dyslexia and the dyslexic reader have increased over the recent years among scholars and designers due to the increase of literature on the disability and the development of research on the subject of typography. These research and designs are more focused towards the font's visual characteristics such as the stroke variation, size, space etc. meanwhile the cases discussed are predominantly based on languages that use Latin script. Research related to Sinhala typeface and fonts related to dyslexia is rare even though there are reading material and learning aid composed with the Sinhala script. As a pinor research this paper aims to findout the most appropriate Sinhala font to increase reading performance of children with dyslexia. To achive this the research discusses literature on Latin fonts and typefaces that addresses dyslexia in comparision to Sinhala fonts and futher addresses ways of adopting Latin font based research to Sinhala fonts. This paper is compiled with secondary data gathered through a literature review and primary data was gathered through a qualitative analysis on the selected three Sinhala fonts' and their characteristics to achieve the best parameters required for the reading performace test. As an outcome of this research it was identified that some concepts from Latin font based research such as increasing the legibility of letters by increased font size and spacing, could be adopted to Sinhala fonts despite the difference in the two scripts. However, it was further concluded that compared to phonological complexities of the languages, Sinhala dyslexic readers could benefit more from a visual solution such as type design. Hence, there is a need to further research and to identifying the visual parameters of Sinhala font that works best for dyslexic children. The findings of this research can be applied to learning aids for Sinhala dyslexic students. Moreover, it can be a guide for typographic design for reading disabilities in the future.

Keywords: *Developmental Dyslexia, Sinhala fonts, Readability*

1. Introduction.

'Reading', like speaking and listening, is a mode of communication that let humans share ideas, thoughts and knowledge. It can be defined as a process of "transforming visual symbols and converting them in to linguistic meanings" (Bessemans, 2016). Faults in this process can be identified as a 'Reading Disability'. Dyslexia is a reading disability that effects 1 out of 5 people in the world. It has 2 main forms such as: developmental dyslexia and acquired dyslexia. Developmental Dyslexia is considered to be genetic and present in a child from birth, hence, considered critical as it impairs one's ability to gather knowledge by reading since their birth. Acquired Dyslexia can occur due to brain damage at any age of a person's life. Dyslexic children are commonly misdiagnosed as less intelligent and/or 'lazy' due to their poor reading performance in school. Since the academic evaluations in school systems, especially in countries like Sri Lanka, are strongly based on a child's ability to read and write, dyslexic students often perform poorly despite being well prepared. This results in individuals with damaged self-image and self-esteem growing up to become adults with persisting frustrations, stigma and emotional effects (Sykes, 2008). This research only focuses on children with developmental dyslexia.

Some of the common signs of English reading children with dyslexia are: letter and/or word reversal, transpositions, inversion, trouble with sequence, avoiding punctuation, stress under pressure and substitution (Gregor and Newell 2000; Hoffmeister 2016). Sinhala dyslexic children show similar signs of word/letter reversal but also show omission and substitution of vowel modifiers (Wijesekara, 2018). A dyslexic child may not display, and may also not be limited to, all the above signs.

Over the years, many solutions has been presented to support and improve the reading skills of children with developmental dyslexia. In many western countries like U.S.A., educational institutions has a legal obligation to provide special support (additional time and notes) to students with dyslexia. It has been found out through research that typography effect the reading performance of dyslexic readers. However, all the research on dyslexia, fonts and readability are done based on Latin script. There are different language systems and script types in the world. For the purpose of this study, language systems

will be divided in to two as phonological and less phonological languages. English is a phonological language that uses an alphabetic script system.

Sinhala language in particular, is a more visually complex language rather than a phonologically complex language. It has 5 main visual forms as: vowels as letters, medial vowel signs, consonants as letters, combined consonants and other special signs (Samarawickrama, 2017). There are very few evidence on the effects of such languages on dyslexia. Therefore, evaluating the effects of different visual characteristics of Sinhala fonts help determine if a visual approach as a solution is worthwhile for Sinhala dyslexic readers.

Currently, there is little to no research related to dyslexia and Sinhala language. There is also no known effective and certified Sinhala typographic guideline to be used on their reading materials. Academic research, experiments or designs that explores the possibilities of Sinhala language in support of learning disabilities like dyslexia, is a crucial necessity. Adopting the findings from foreign research to identifying appropriate typographic parameters will lead towards developing effective learning aid for Sinhala dyslexic children that will help them overcome their struggles with reading.

2. Latin Script Research on Dyslexia and Typography.

Education systems in the western world, nowadays encourage dyslexic students to use computers for text manipulation as a successful method of alleviating problems where they are able to change the font size, font type and other parameters to suit their need. There are special fonts made for dyslexics, such as; Dyslexie, Read Regular, Open Dyslexic and Sylexiad. Existing font, such as; Arial, Helvetica, Calibri and Century Gothic have been recommended by accredited associations; BDA (British Dyslexia Association) and IDA (International Dyslexia Association) for use in materials for dyslexic readers.

2.1. MANIPULATING TYPOGRAPHY TO INCREASE READABILITY.

Readability directly depends on the legibility; i.e. the clarity of the presentation of type and layout of the text (Erdmann and Neal, 1968, cited by Hoffmeister, 2016). Strong legibility is when a text is easier to read and understand whereas low legibility is when the text is hard to read or comprehend by the standards of the general reader. In other terms: increased text difficulty challenges cognitive processing capacity of the brain resulting in poor reading (Hoffmeister, 2016). Increasing legibility of a text can be done by altering the text layout as well as altering the typographic characteristics such as font type, font size, spacing and the background-foreground contrast (Hughes and Wilkins, 2000).

2.1.1 Font size and spacing.

It is recommended to use larger font sizes for children around 6-7 years of age while using smaller font sizes for children around the age of 10 (Shaw:1992; Tinker:1959; Burt:1959; as cited by Hughes and Wilkins, 2000) . In 1991, Cornelissen, Bradley, Fowler and Stein did a research to find out the correlation between visual perception and special dimensions of text. They tested this by giving 3 different word lists, all in Helvetica font type, but in 3 font sizes. The results of their research show that the children make more errors in reading when the print size is reduced (as cited by Hughes and Wilkins, 2000).

However, for the dyslexic students, it is recommended by The British Dyslexia Association to use a font in sizes between 12-14 pt. or larger as per the child's request (BDA II, 2018). Some dyslexic research participants has even selected font sizes larger than 12 pt when given the chance (Gregor & Newell, 2000). According to Hoffmeister (2016), dyslexic individuals get easily affected by visual clutter. As Hill (2010) presents, "they are distracted by the words around the word they are trying to read" (as cited by Hoffmeister, 2016). Therefore, larger font sizes that provide more spacing between the letters are beneficial for dyslexic readers (Chung, 2007; Martelli, Di Filippo, Spinelli, Zoccolotti, 2009, as cited by Hoffmeister, 2016). According to Gregor and Newell (2000), the appearance of lacking enough spacing is why dyslexic readers does not prefer bold texts.

2.1.2. *Font type.*

Latin fonts can be divided in to two categories as serif and sans serif fonts based on their visual features. Serif fonts are the fonts with decorative element of fine extensions of lines at the top and bottom of the letters. The most common example of the font is 'Times New Roman' (in which this text is composed). Sans serif are the fonts without extensions of line or decorative elements. 'Arial' is the most common example. The only serif font recommended for use by International Dyslexia Association for dyslexia is Times New Roman (Rello & Baeza-Yates, 2013). The British Dyslexia Association specifically recommend using sans serif fonts such as Arial, Verdana, Tahoma, Century Gothic, Trebuchet, Calibri and Open Sans (BDA II, 2018), because they appear less crowded for dyslexic readers.

In a study by Woods & Scharff (2005) on the effects of typeface and font size on the legibility of children, it was discovered that Arial (sans serif font) was the most legible font among all grade levels (as cited by Hoffmeister, 2016). In another research done by Gregor & Newell in 2000, on the alleviating problems encountered by dyslexic readers using computer techniques, the sans serif typeface Arial was rated as the best by almost all the participants. The reasons as to why they preferred Arial was because it's simplicity. The participants of that research in fact explained Arial as a 'clear', 'basic', 'rounded' and 'straightforward' font compared to other 'flowery', 'complicated' fonts. This goes on to show that manipulating the font type or the visual parameters of font type could in fact effect legibility. Contrary to those findings, Arditi and Cho (2005) claims that, because of the added separation of the letters due to extensions, serif fonts may have an effect on legibility for the dyslexic readers.

What works for dyslexics among serif fonts and sans serif fonts is not yet clear. Hillier's research in (2008) suggests that what matters the most for readability is not if the font is serif or sans serif, but whether the letter form is clear, distinctive and different from each other. Therefore, it can be concluded that typographic characteristics in text presentation has an effect on the readability of people with dyslexia.

2.2. SPECIAL FONTS FOR DYSLEXIA

As discussed in 2.1.2, font Arial has a positive effect on the reading performance of dyslexic children. But, Arial, and other fonts commonly recommended for dyslexia, were not initially designed for dyslexic readers (Hillier, 2008; Rello & Baeza-Yates, 2013). This issue begs the question whether the typographic forms used in these fonts are the most ideal for dyslexic readers, or with more understanding of the condition could we specially design a better font for dyslexic audiences. Perhaps, that's how the idea of special fonts for dyslexia came to be. Sylexiad, Dyslexie, Read Regular and OpenDyslexic are some of the examples for specially designed fonts for dyslexia. According to Rello & Baeza-Yates (2013) the common theory behind all these fonts is to differentiate each letter of the font compared to regular fonts.

In 2013 research by Rello and Baeze-Yates, 12 latin fonts were tested to find out the 'Good Fonts for Dyslexia'. In their research they chose to test Arial, Arial italic, Computer Modern, Courier, Garamond, Helvetica, Myriad, Times New Roman, Times New Roman Italic, Verdana, OpenDyslexic and OpenDyslexic italic. Arial and Times New Roman was selected by them as the most common fonts used on screen and printed text. Helvetica and Myriad were tested as the most commonly used fonts in graphic design. Garamond had been tested as it claims to have strong legibility. Other fonts were selected to be tested as they were either recommended for dyslexic readers or are specially designed for dyslexia.

Through their research, Rello & Baeza-Yates found out that fonts designed especially for dyslexia such as OpenDyslexic, did not result in positive or negative change in readability. They concluded that Helvetica, Verdana, Courier and Arial are good fonts for dyslexia over fonts specially designed for dyslexia. On par with these results, Marinus et. al. (2016) & Kuster et. al. (2017) concluded through their research that dyslexic readers preferred fonts Arial and Times New Roman over Dyslexie. They also pointed out that Dyslexie font works only because of its spacing settings and not because of the letter shape design.

Similarly as Dyslexie, OpenDyslexic is a typeface developed by a fellow dyslexic, Abelardo Gonzalez and (Hoffmeister, 2016) and the letters have strong lines at the bottom as an attempt to anchor the letter on its right direction. Each letter also has a unique shape in order to prevent visual confusion. It also has wider spacing. Apparently, these new fonts were based on expired concepts on dyslexia such as perceiving letters and forms in reverse (optical reversibility theory of dyslexia) and inherent special disorientation (spatial confusion theory of dyslexia) (Velluntino et al., 2004). Therefore, these special fonts has not proven sucess as intended.

Sylexiad is a more successful typeface design. It is a typeface developed by another dyslexic, Robert Hillier, for adult dyslexic readers through research on legibility and readability (Hillier, 2008). He started with his font Dine 3 which had radical and unfamiliar word forms. By testing Dine 3 against Times New Roman, Arial and Sassoon Primary, he concluded that unfamiliar designs could reduce the readability for dyslexic readers. He further suggested that light letterforms and large interspatial word qualities can be favorable in minimizing effects of unfamiliar designs. By developing his font further he noticed that the letters took more conventional forms. Therefore, he concluded that familiarity of the font is what's important for the dyslexic readers. He utilized these findings in designing and developing the font Sylexiad. Sylexiad was designed with light letter strokes, long ascenders and descenders, clear & distinct characters and generous inter-word spacing. Sylexiad was preferred by dyslexic adults over Times New Roman when it comes to comprehension and visual ease.

According to all the above research we can conclude that it is not the design of the individual letterform that matters but the collective appearance of the font size, spacing, weight and overall form of a typeface. Arial is successful among dyslexic users as it is visually simple and letter forms are more familiar, which results in good legibility and readability.

3. Methodology.

In foreign font testing research, fonts has been selected based on recommendations, special uses, claims of legibility, and font popularity (i.e. frequency of use). Serif and sans serif features of font design had also been tested in many research though the years. When selecting Sinhala fonts for testing, fonts can be selected based on the popularity of the font use and claims of legibility since there are no recommended or special use fonts for dyslexic readers.

Visual features of Latin fonts are different from Sinhala fonts. Instead of serif and sans serif feature of letter form design, Sinhala fonts can be selected based on their modulated letter forms and mono-linear letter forms. But, as similar to Latin fonts, Sinhala font can also be recognized as with open counter designs and with closed counter designs. In Latin script 'x' height is used to measure the size of the fonts. In Sinhala language, ratio of the upper and lower portions of letter 'm' (pa) is used.

3.1 IDENTIFYING SINHALA FONTS USING THEIR BASIC VISUAL FEATURES.

Sinhala fonts are commonly categorized based on their design element of being a modulated font or a mono-linear font (stroke thickness). When testing the effects of type design in Sinhala fonts, it is better to compare the effectiveness of these two visual features.

For the purpose of this study three fonts wth different visual features were selected based on the frequency of use: most commonly used fonts in printed, screen or in graphic design and a font designed with strong legibility. FMAbaya, FMMalithi and Noto san Sinhala UI was identified as fonts with different visual characteristics with the help of a specialists in type design field. FMAbaya is also identified as the most commonly used font in Sri Lanka. It is also considered to be one of the best Sinhala type designs of all time. FMAbaya is freely available for use. FMMalithi was identified as the font commonly used in children's story book printing. Noto san Sinhala UI is the Sinhala font available in

android devices. It claims to have been designed with strong legibility due to requirement of mobile and other small screen viewings. Visual uniqueness among these fonts can be described as follows.

3.1.1. Modulated vs mono-linier type design.

A modulated font is when the font has both thick and thin strokes. A common example for a modulated Latin font design is 'Georgia' (figure 3.1). Mono-linier fonts, as by the name implies, has comparatively uniform thickness of the line throughout the letter. A Common example is the font Arial (figure 3.2). Likewise, FMAbaya is a modulated font where as FMMalithi is a Mono-linear font.

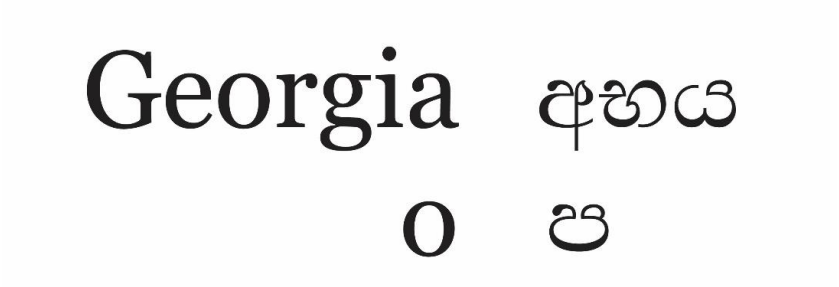

Figure 3.1: Visual comparition of Latin serif font (Georgia) and modulated Sinhala font (FMAbaya). Source: Author

Figure 3.2: Visual comparition of Latin san serif font (Arial) and mono-linear Sinhala font (FMMalithi). Source: Author

3.1.2. *Difference in 'pa' height.*

The character size in Latin fonts are measured based on the measurements of the font's x character. The distance from the top to bottom of the x character is known as the font's x height. Whereas in Sinhala fonts the character size is measured based on the measurements of the font's m (pa) character. Hence it is called the 'pa' height. In Sinhala characters the pa height is the ratio between it's upper letter portion to the lower letter portion. Therefore it is presented as a ratio rather than a length. Therefore in adopting recommendations of Latin research for Sinhala fonts, the Latin font recommendation of x-height of 2.3mm can not be taken as the required pa-height for the Sinhala fonts. Because, with the difference of the ratios of the 'pa' height, the letter may appear contracted or expanded.

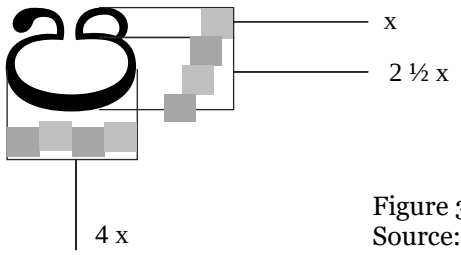

Figure 3.3: Measuring 'pa' height for Sinhala fonts
Source: Author

However, when considering the 3 selected Sinhala fonts, they all have different character sizes for the same font size of 18pt. Therefore comparable font sizes which have the same character size of ~2.6 mm was considered in comparing other features.

3.1.3. Counters and open counters.

Figure 3.4: Counters and open counters of the selected fonts (Source: Author)

In typography, a counter is the area of a letter that is entirely or partially enclosed by a letter form or a symbol (Maxymuk, 1997). Letter O is a letter with a counter in the middle. But letter C is not entirely enclosed. Thus it has an open counter. When considering the 3 selected fonts FMAbaya and FMMalithi seems to have features of both counters and open counters, but Noto sans Sinhala UI has more open counter features.

4. Most Appropriate Sinhala Font for Dyslexia.

According to foreign research on the effectiveness of special fonts for dyslexia and existing fonts, letter form have little to no effect on readability. On the otherhand, internal spacing and external spacing does. Generous internal and external spacing of a letter helps in clearly identifying the elements in a letter, hence resulting in accurate reading. Therefore, when considering Sinhala fonts, there is no need for exaguration of shapes, but differenciation of similar features is important as to keep the legibility of the letter which will result in good readability.

Sinhala font FMAbaya has more distinctive letter shapes within the typeface and withing other two selected fonts. On the other hand, if font familiarity is effective in the readability of text for dyslexic children, FMAbaya is one of the most commonly used fonts in Sri Lanka. Therefore, FMAbaya can not be recommended for the use in dyslexia materials by only considering the font familiarity factor, but familiarity of the letter form should also be considered. However, one may argue that since the thickness of the letter is focused on the bottom of the letter form, it helps to anchor down the letter, which will help reduce letter reversal in dyslexic readers. Even though English reading dyslexic readers show signs of letter rotation (ex: reading ‘b’ as ‘p’) There is no record of Sinhala dyslexic readers who rotate letters in reading. Therefore, it is difficult to recommend such modulation as an effective visual feature for dyslexia font designs.

Sinhala language has many similar letter forms with slight changes in the anatomy. As an example;

ෙ ම ඹ ඔ ග ශ හ ඟ ී ර රැ රෑ

ජ ඡ ෂ ප ඛ ත න ට ච ච

When comparing these similar letter forms in the three selected font; Noto Sans Sinhala UI seems to have the largest spacing. This extra spacing supports the claims of Noto sans Sinhala UI being a more legible font. Noto sans Sinhala UI also has a bigger character size in a given font size (see figure 4.1).

Based on the results of latin font research and visual characteristics of Sinhala font, Noto Sans Sinhala UI can be identified as a more appropriate font among the most frequently used Sinhala fonts. It has to be noted that Noto Sans Sinhala UI is designed to be used on android devices. It is not fully compatible with other operating systems. Therefore, there is the need for further developing the Noto sans Sinhala UI font or design a special Sinhala font for dyslexia using the effective features of the above discussed fonts.

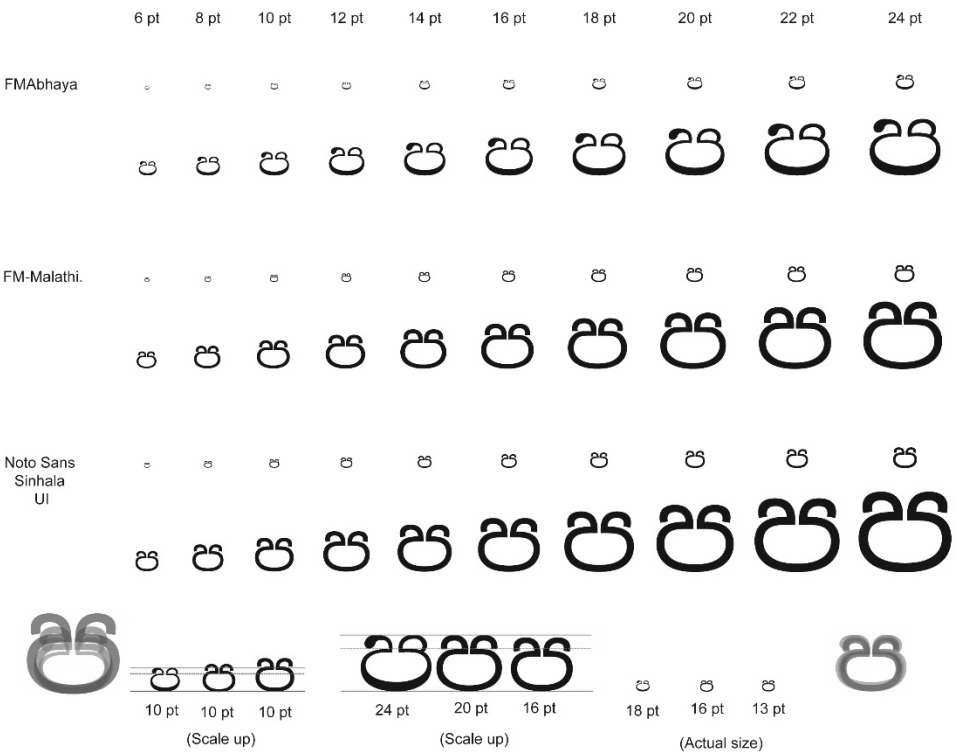

Figure 4.1: Comparing font sizes and letter spacing of selected fonts.
Source: Author

5. Conclusion.

Dyslexia is the most common learning disability accounting for ~20% of the words population. Multisensory educational materials are the most famous approach to supporting dyslexic children. Organizations like the International Dyslexia Association (IDA) and the British Dyslexia Association (BDA) has proposed typographic guidelines for the use of dyslexic children. There are both recommended fonts for dyslexia as well as specially designed fonts for dyslexia. In latin script based research compairing exsiting fonts and special font, it is found that font familiarity and generouse letter spacing are the key factors in improving readability for dyslexia readers. This theory was applied to the most frequently used Sinhala fonts. Noto sans Sinhala UI can be identified as an appropriate font for Sinhala dyslexic readers. However, for further accurate recommendations, there is the need for more research on both areas of Sinhala Typography and Dyslexia in Sri Lanka.

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