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Exploring Typeface Characteristics And Their Impact On Legibility: A Research Perspective

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Abstract:

Researchers who were interested in reading voiced optimism at the beginning of the 20th century that the scientific study of reading would increase the readability of typefaces with time. The creation of typefaces, on the other hand, was difficult, costly, and impracticable for reading research, which was consequently limited to the use of conventional commercial fonts. The utilization of computer typography in the field of readability, research makes the process of measuring, modifying, and developing experimental fonts more straightforward. Additionally, the presentation of text on computer displays makes reading research more accessible. Because of these technological advancements, novel research has been prompted. Some researchers continue to examine typefaces for effective reading with low vision as well as normal vision, while others use unique fonts to investigate visual mechanisms in reading. Both types of findings are presented in the following paragraphs. Some experimental fonts integrate color and animation characteristics that were either impractical or impossible to implement in standard typography. The investigation and comprehension of the nature of reading are both expanded as a result of these developments, despite the fact that it is not quite certain that they will accomplish the hopeful aims that were set a century ago.

Keywords: Typography, Typeface Features, Legibility, Font Design, Readability

Introduction:

According to the statements of early reading researchers, the optimistic goal of researching and refining letter shapes is expressed in the following way: Over the course of more than thirty millennia, the characters that humans have used to record its thoughts have developed almost without any conscious effort, as a result of the force of circumstances. This is the product of our modern writing, which ranges from the writing of a young school child to the most elegant typography. It is an offense to good taste, and the only reason it is accepted is because of the habit that has been passed down from generation to generation for generations. titled "Javal, 1905"

In all likelihood, the letter forms that have been passed down to us through the years have never been modified in order to cater to the requirements of the reader... There is not the slightest bit of doubt that shapes can be conceived of that will be significantly more legible than these old symbols that have been around for centuries. The year is 1908 (Huey). This observation raises the theoretical question, "What are the factors upon which legibility depends?"

Every reader has noticed that all of these different letter-forms are not equally legible. This observation raises the question. What are some practical steps that one should take in order to improve the legibility of printed letters? In other words, what are some practical steps? In 1912, Roethlein did it.

After some time had passed, Miles Tinker conducted a review of the study on legibility that had been conducted over the course of four decades.

Prior to the eighteenth century, the primary focus was with the aesthetic look of printed materials. Two new elements entered the picture as a result of advancements in printing technology: the cost-effectiveness of printing and the incorporation of traditional practices. Due to the fact that these practices and perspectives exist, the development of a typography that is truly scientific has been gradual. According to Tinker (1963), page 3.

However, by the beginning of the 21st century, reading research had recovered in general and in particular through the use of psychophysical theory and methods.

An excellent example of a psychophysical variable is legibility, which is dependent on the properties of the physical stimuli, but is ultimately influenced by the characteristics of visual processing. Other examples of psychophysical variables are color and brightness. This is according to Legge (2006), page 108.

The Making of Type, Traditional and Modern:

In order to study legibility, it is helpful to have some knowledge of the language associated with type as well as how type was and is constructed. During the age of metal typography, which lasted for five hundred years, a "font" was a collection of cast metal letters and characters that were of a specific size and style. The contoured surfaces of the metal that were inked and imprinted on paper during the printing process were referred to as a "typeface." This "typeface" was responsible for the appearance or design of a particular style. In modern times, the term "font" refers to either a typeface or a font, which can refer to either the appearance or the digital file.

Fig. 1. *Punches of a Baskerville font, cut by John Handy circa 1757.*

Traditional Type:

Beginning in the 15th century and continuing until the end of the 19th century, skilled artisans were responsible for the production of type. These artisans would hand-cut letter representations in relief on steel "punches" for each letter, regardless of its size or style. Take a look at Figure 1. In order to create recessed impressions, sometimes known as matrices, finished punches were hammered into copper blanks. These matrices were then used as a basis for hand-casting type (Dreyfus, 1995). Few extremely experienced letter engravers, who are sculptors of miniature shapes, continue to practice the craft of hand punch-cutting (Gable & Paput, 2016). This art form is considered to be a masterpiece.

Punch-cutters worked at the real size of a typeface, and as a result, they viewed, tested, and corrected letter forms at the same size as readers saw them. On the other hand, type designs have been generated at bigger sizes, approximately 75–150 mm, since the end of the 19th century. These designs are then scaled down to smaller reading sizes using mechanical means, photographic means, or computational means.

A typeface is said to be more beautiful when it possesses regularity (which includes formal repeatability and symmetry), clarity (which includes neatness and smoothness), good taste (which includes simplicity and pleasing chiaroscuro of black and white), and grace, which is a quality that Bodoni himself found difficult to describe precisely. Bodoni made this statement in the year 1818. Even spacing of strokes within letters and between letters, which results in a visually regular rhythm; regular thicknesses of strokes (both for thick and thin strokes); replication of similar forms such as serifs or bowls of 'b' and 'p'; consistent gray tone so that no letter appears darker or lighter than others; visually regular horizontal alignments of letters along the baseline, x-height, and capital height are some of the aesthetic principles that are manifested by the majority of text typefaces designed for continuous reading.

Digital Type:

Letter forms are typically defined by software fonts as mathematical outlines that are composed of straight lines and curves that are referred to as "splines." When it comes to computer typefaces, the outline letter shapes can be linearly adjusted to any size that is practically applicable. After being scaled, the outlines are rasterized, which means they are turned into pixels (also known as "picture elements"), for the purpose of digital output in computer display or printing. Figure 2 is an illustration of a letter that has been rasterized and has an outline.

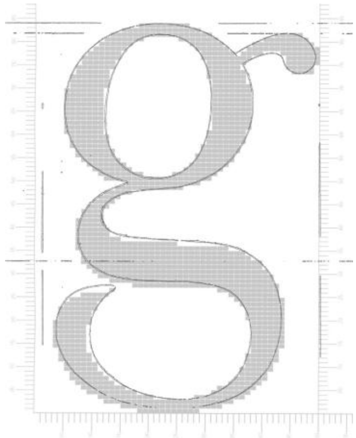

Fig. 2. *Digital Baskerville g. Spline outlines with rasterized bitmap.*

Software fonts are more useful in reading research than metal and photo fonts from earlier eras. This is due to the fact that software fonts are simpler and less expensive to create or modify, easier to measure precisely in terms of sizes and features, easier to test on screens or in print, easier to reproduce, and more portable across digital media and computer systems.

With the advent of software tools, the vast majority of type designers are now able to produce typefaces by drawing big letter outlines on computer screens (Fig. 3). The following font software tools are available: FontForge, FontLab, Fontographer, Glyphs, OTMaster, Robofont, TypeTool (Tools, 2019), and Metafont (Knuth, 1986). Cheng (2006) provides an explanation of the fundamentals of type design, which includes classifications, feature variables, and design principles, for the purpose of developing fonts through the use of instructional exercises.

Size:

Perhaps the oldest forms of readability study are those that investigate the effect of print size on reading, specifically the minimal size that allows for simple reading. This is due to the fact that print size is significant not only perceptually but also economically. The usage of smaller sizes, which take up less space for a given amount of text and, as a result, consume less paper and result in lower printing costs, is preferred by printers. Print sizes that are large enough to make reading easier are typically preferred by readers. As a result, there are compromises that can be reached between desires that are in conflict with one another. (In this context, the phrases "print size" and "type size" are used interchangeably; however, the term "type size" can also refer to the size of the screen in addition to the size of the print.)

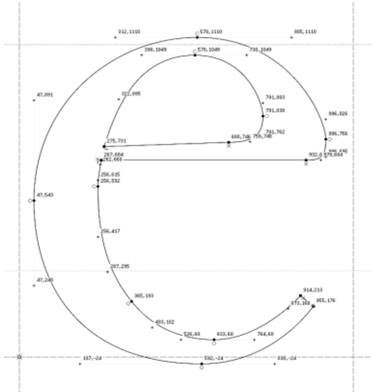

Fig. 3. *Baskerville letter e in Bézier spline curves.*

It is the outline of the letter that is defined by solid lines. Important points or "knots" on curves, tangents, and corners are denoted by dots that have coordinate pairs associated with them. The borders of the letter width that are "sidebearing" are denoted by dashed vertical lines. The font baseline is represented by the dashed horizontal line near the bottom, while the font x-height is represented by the dotted horizontal line near the top. Within the realm of vision research, Legge and Bigelow (2011) provide a number of justifications for the utilization of x-height as a standard measure of character size. According to the illustration in Figure 4, the x-height of a typeface is determined by measuring the distance from the implicit "baseline" on which letters stand to the top of the lowercase 'x'.

The heights of "small" letters such as "a," "e," and "o" are measured by certain studies. These letters are very slightly taller than the letter "x," but when compared to the typical type sizes used for reading continuous text, such as 9 point to 16 point, the difference is insignificant for the majority of applications.

When it comes to digital fonts, the x-height of a font can be stated as a fraction of the complete font body size, and it is also possible to determine it with pinpoint accuracy. In the case of an OpenType font, where the coordinates of the body size, which is also referred to as typographic "em," are located on a Cartesian grid measuring 1000 × 1000 units, the x-height of Times Roman is 450 units, and the x-height fraction is 0.45.

It is possible to calculate the visual angle of x-height subtended at the eye as a single psychophysical measure when the reading distance and the physical x-height are both known.

Legge (2006) provides a summary of the findings of various trials that investigated the effect of character size on reading speed. He discovered that the pace of reading remains relatively unchanged within a tenfold range that extends from 0.2 to 2.0 degrees of visual angle (x-height). When the visual angle is less than 0.2 degrees, the rate of reading decreases rapidly, however when the angle is greater than 2.0 degrees, the rate of reading goes down gradually. The term "critical print size (CPS)" is defined by Legge as the "smallest print size below which reading speed begins to decline sharply." He also mentions that "a consensus value for the CPS for normally sighted readers is 0.2 degrees (12 min-arc"), which is the number that is generally accepted across studies.

As an illustration, the x-height of a 9-point Times Roman font at a reading distance of 40 centimeters subtends approximately 0.20 degrees of visual angle from the horizontal. Approximately two degrees of visual angle are subtend by the x-height of 90 point Times when viewed from a distance of forty centimeters. The type size range of a print newspaper is generally equivalent to this span, which includes everything from running text to huge headings.

The size of the physical type on the screen of a computer, tablet, or smart phone may be different from the font point size of the menu, depending on the screen resolution, the options available if the display may be adjusted, and the word processing application itself. Therefore, the measurement of the actual, physical type size that is displayed on the screen is frequently more precise than the font point size that is displayed in a word processing menu.

A. Linear Scale:

It is almost always the case that computer software typefaces are scaled in a linear manner. This means that letter forms are multiplied by a constant that is fixed in both dimensions, which maintains geometric resemblance. When it comes to reading studies, linear scaling offers simplicity, economy, and predictability. This is because the proportions and shapes of letters remain the same regardless of the size of the letter. As an illustration, the Times Roman typeface is linearly scaled for all sizes in the MNREAD acuity chart (Mansfield, Legge, Luebker, & Cunningham, 2006). This chart is designed to examine the influence that different print sizes have on reading ability.

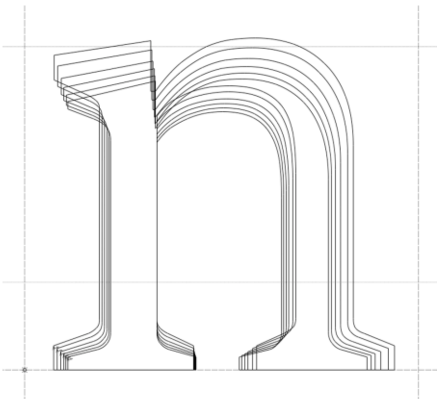

Fig. 5. *Six optical scales of a letter 'n' in the "Sitka" typeface series.*

The shape that is the tallest, widest, and thickest is for the size-specific scale that is the smallest (referred to as "Sitka Small"), while the outline that is the shortest, narrowest, and thinnest is for the size-specific scale that is the largest (referred to as "Sitka Banner").

Type Features:

Typefaces are collections of graphical characteristics and differences, such as the following: roman against italic; normal versus light or bold weight; normal width versus condensed (narrow) or extended (broad) aspect ratios; and normal width between bold and bold weight. Other variations include the presence or absence of serifs (serif versus sans-serif), a large or small ratio of thick to thin strokes (high versus low "ty-pographic contrast"), proportional-spacing (different letter widths) versus monospacing (typewriter-like fixed-widths), and capitalization versus lowercase or lowercase letters. There are a number of important distinctions that may be observed in three well-known type families.

Both Times and Courier are seriffed with roughly comparable x-heights; however, Times has a significant contrast between thick and thin features, is proportionally spaced, and has a small lowercase. Courier, on the other hand, has a proportionally spaced lowercase. Additionally, Courier is monospaced, has a narrower width than Times, and has a low contrast. Helvetica is a sans-serif font that is proportionately spaced, has a lower contrast, is proportionally spaced, and can be smaller than Courier but broader than Times. It also has a bigger x-height than either Times or Courier. Helvetica is a typeface that is quite similar to the standard sans-serif typeface known as "Arial."

It is possible that differences in features can have an effect on readability; however, it can be difficult to discern which aspects are more significant, as this may depend on the reader's vision as well as the design of the typeface. According to the findings of Mansfield, Legge, and Bane (1996), readers with normal vision read Times Roman 5% faster than Courier Bold at moderate print sizes (above critical print sizes for the respective fonts). However, when the fonts were printed at tiny sizes (below critical print sizes), Courier Bold was read up to twice as fast as Times. Readers with low vision read Courier faster than Times at both moderate and tiny print sizes. It is also possible for legibility to change depending on the size, width, and boldness of the type, and it is also greatly influenced by the reader's eyesight, which indicates that legibility is not just a pictorial characteristic. According to Tarita-Nistor et al. (2013), For readers with macular degeneration, Courier was found to be superior to Times Roman in terms of reading acuity, but it was not superior in terms of maximum reading speed.

New Forms of Fonts:

There has been a tendency for digital print and screen types to adhere to the black-and-white traditions and forms of writing and printing. However, high-resolution color displays on mobile phones, computer screens, and other digital reading media may now include color, gray tone, motion, and other features that can serve as the foundation for non-traditional type forms. Additionally, the proliferation of emoji pictograms and ideograms that have colors, tones, and detailed details is a phenomenon that is a growing phenomenon that also attracts research.

In the field of vision research, experimental typefaces are often optotypes, which consist of only a few letters or symbols and are used to test thresholds of perception and recognition of letter and number forms. Tinker (1963) argued that the limits of economics and tradition had slowed down the development of scientific typography. These do not adhere to the aesthetics that Bodoni (1818) expressed, nor do they follow the constraints of tradition. In spite of this, the study of readability has advanced in ways that were not predicted by prior studies thanks to the introduction of new experimental fonts. The Pelli Lab has produced a number of new optotypes in recent years.

A. Sine Wave Modulated Letters:

The "second-order" gray-tone letters were developed by Oruc, Landy, and Pelli (2006) in order to examine the spatial frequency channels involved in letter recognition procedures. The Sloan optotype letters were represented as modulated sine wave patterns that were both vertical and horizontal in orientation. Even though the modulated letters do not have a strong brightness contrast, they are still recognizable. They are not able to be rendered using the normal digital font technology; but, they are able to be exhibited and printed using other imaging techniques. Although they might not meet Bodoni's express requirements for beauty, they possess sufficient eerie allure to suggest the development of a whole alphabet.

B. Checkers Alphabets and Perimetric Complexity:

The researchers Pelli, Burns, Farell, and Moore-Page (2006) developed straightforward "Checkers" alphabets in order to explore the complexity of characters and the detection of features about letter recognition. A total of 26 simple and random block patterns consisting of 2 × 3 and, separately, 4 × 4 block patterns are considered to form the alphabets. Once a sufficient number of trials have been completed, the authors assert that the 2 x 3 Checkers font is comparable to Braille and can be taught and read effectively. In addition, this study presents and examines a feature that has not been previously explored in the field of typography. This feature is known as "perimetric complexity," and it is defined using the formula: perimeter squared divided by interior area times 4π. According to the findings of a laboratory study conducted by Pelli and colleagues, the efficiency of letter identification is higher for simpler forms than it is for complicated forms. Typographers appear to implicitly agree with this result from the fact that they typically use types with simpler letter forms for running text at small sizes, but they occasionally use types with more formal complexity for brief texts at large sizes. In his discussion of the mathematics of perimetric complexity in geometric and digital images, Watson (2012) makes an unintended suggestion as to the reason why perimetric complexity was not investigated in conventional typography. In spite of this, some of the most talented artists working in the field of conventional type punchcutting, such as Robert Granjon, Pierre-Simon Fournier, and Bodoni himself when he was younger, were able to cut intricate ornamental characters that were integrated into patterns but not alphabets.

C. Pelli Font:

When Pelli et al. (2016) were designing a clinical test for visual crowding, which is a constraint on the detection of cluttered symbols, they produced an opto-type font of numerals with an exceptionally narrow aspect ratio of 5:1 – tall but narrow – which can be detected at minuscule widths. This typeface was meant to be able to be recognized at very small widths.

Conclusion:

Throughout the first century of study on legibility, the primary focus was on the operational impacts of typeface characteristics on the economy of reading and publishing. Over the course of the last few decades, digital typographic tools have made it possible to experiment with greater ease while also providing better precision. Digital type techniques have led to new insights and broader agreement on the impacts of type size on reading, as well as some agreement on the effects of width and weight. These findings are a continuation of prior studies that shown the aforementioned effects. There are several persistent concerns of comparative readability that continue to resist easy analysis. Several examples of these questions include the comparison of serif and sans-serif fonts, as well as capitalization versus lowercase. The design and testing of fonts for low vision, macular degeneration, developmental dyslexia, and other reading difficulties that are neglected by commercial typography have been greatly facilitated by digital type technology. In general, digital type technology has greatly facilitated general studies of the psychophysics of reading and legibility. In recent times, unique fonts with unexpected shapes have been developed for the purpose of doing fundamental research on visual phenomena such as crowding, perimetric complexity, and spatial frequency channels. It is possible that the hope that was voiced by early researchers on readability more than a century ago may be justified by the widespread availability of new typefaces for digital reading platforms that are currently available.

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