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Neural processing differences in reading print and cursive

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Abstract

This research examines the hypothesis that individuals can read print, also known as block lettering, better than cursive script because of the brain's preferential processing of print using more easily accessible neural pathways and due to certain phenomena, that delay cursive processing. The research investigates how variation in the neural mechanisms involved in visual recognition, letter formation, and reading fluency is responsible for such an occurrence. The research analyzes the contribution of neural processing efficiency, in which the brain engages print-related areas faster and with reduced cognitive effort than those engaged in cursive handwriting. The results suggest that the brain's difference and excess effort in processing cursive writing can result in more fluent reading of print, lending support to the hypothesis that print is more readily processed by the brain than cursive handwriting. This study extends our knowledge of cognitive processes.

Keywords: Neural Pathways; Neural Mechanisms; Print and Cursive Script; Hypothesis

1. Introduction

The human brain processes handwriting—whether printed or cursive—through a complex interplay of motor, perceptual, and cognitive systems. Among these two styles, *print*, also known as block lettering, involves writing each letter discretely, whereas *cursive* connects letters in a fluid, continuous motion. Despite widespread instruction in both styles during early education, most individuals report finding print handwriting easier to read, even when the handwriting is unclear or partially illegible.

This observed preference raises the possibility that the brain may be inherently more efficient at processing print than cursive. Such a tendency could stem from differences in the neural mechanisms involved in visual recognition, letter segmentation, and reading fluency. Print may allow for quicker and more accurate letter identification due to simpler visual features and reduced ambiguity in character shapes. In contrast, cursive requires the reader to parse overlapping and interconnected letter forms, which may demand greater cognitive effort and involve more complex neural circuits.

In this paper, the hypothesis is explored that the brain prefers print over cursive due to more efficient activation of specific neural pathways. It is examined as to how visual processing, polysemy, and segmentation are related and consider implications for literacy education, accessibility, and cognitive neuroscience.

1.1. Hypothesis

People can read print more easily, even illegible or unclear, as their brains are wired to more readily process print than cursive handwriting. Differences in neural processing mechanisms involved in the visual recognition of letters, letter formation, and reading fluency cause a preference for legibility in print over such same legibility or better legibility in a

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sample of cursive handwriting. The brain areas that process the print are more readily activated than those that process cursive handwriting.

2. Methods

This section provides a glimpse into the processes used in collecting data from the participants, which led to the results and observations.

The procedure involved participants completing a survey questionnaire. The maximum number of participants were in the 15–20-year age group, with a few being in the 40–60-year age group as well. These participants are mostly students and employees, who encounter written documents almost daily. Most of the questions were multiple-choice with only two or three short answers in case they needed to elaborate on the choice of the previous question. Toward the end, the participants were asked to judge the legibility of a given handwriting/font on a scale of 1-5 (1: very difficult to read, 5: very easily readable). Informed consent was obtained from all individual participants included in the study

Number of participants: 60 (total)

Questions:

- Name
- Age
- Gender
- Do you wear glasses?
- How often do you encounter handwritten documents
- Which handwriting do you find the easiest to read?
- How do you typically respond when you cannot read someone's handwriting?
- Do you often have trouble reading certain handwriting styles?
- If yes, which one?
- On a scale of 1 to 5, how would you rate your ability to read different handwriting styles? (1 = very difficult, I'm not good at reading other handwritings, 5 = elementary, I can read most handwritings)
- Which type of handwriting do you prefer to write in
- Did you ever change your handwriting over the years?
- If yes, what was the reason?
- Please rate the legibility of the following handwriting samples on a scale of 1 to 5. They include 6 cursive handwriting samples with both legible and slightly illegible handwriting and 4 print-type handwriting samples, which also had legible and illegible samples.
- Can practicing with different handwriting styles improve your reading ability?
- Has the increased usage of tech and online fonts impacted your ability to read specific handwriting?

3. Results

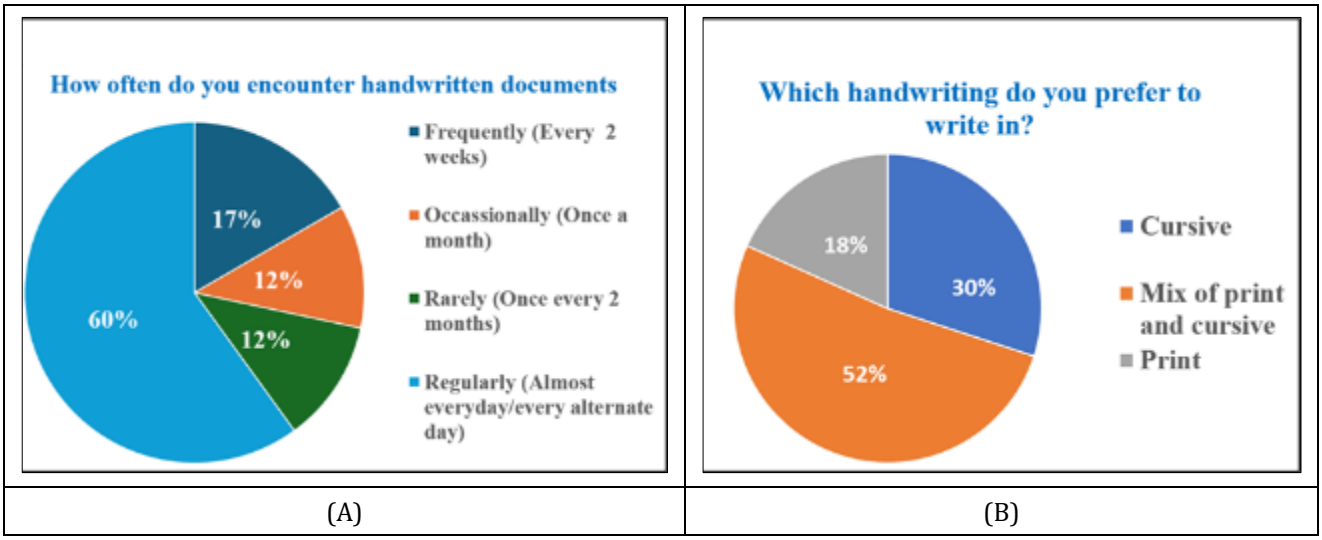


Figure 1(A) Pie chart characterizing the responses to the question: How often does the participant encounter handwritten documents? (B) Pie chart characterizing the data related to which handwriting styles the participants prefer to write in

3.1. Prior exposure to the type of handwriting influences interpretability

As seen in Figure 1A, 60% of the participants encounter handwritten documents daily. It can be inferred that if they are used to handwritten documents every day, their brain's ability to adapt and rewire through experience can lead to improved skills in interpreting handwriting. Additionally, writing regularly also increases the hippocampus activity associated with memory and learning.

The observation, as shown in Figure 1B, is that 52% of the participants prefer to write in a mix of cursive and print, whilst 30% and 18% each writing in pure cursive and print, respectively. If this is the case, the participants should be equally comfortable reading both print and cursive (assuming the font is legible). This can be inferred because if someone is comfortable writing in cursive and print style, they should also be able to read it.

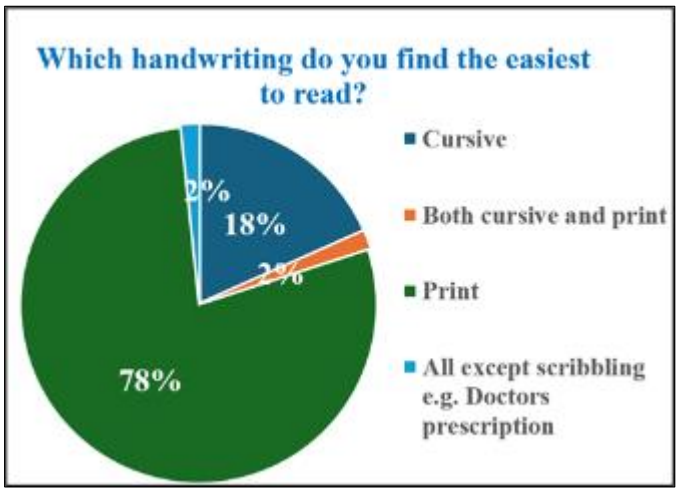


Figure 2 Pie chart characterizing the responses to the question: which handwriting style the participant finds the easiest to read

3.2. Why Print Is Perceived as Easier to Read

Figure 1 suggests that since most participants were regularly exposed to handwritten documents, their brains would have become accustomed to different types of handwriting. Most participants also reported writing in a mix of cursive

and print. Yet 78% of the participants find print easier to read than cursive (Figure 2). This begs the question: Why is print easier to read than cursive even when there are clear advantages of cursive? As compared to print, cursive is quicker to write as the letters are all connected, requires fewer stops, the pen is lifted less frequently, and every letter begins at the baseline and moves steadily from left to right. Yet, the reason that cursive is harder to interpret by the brain has a lot to do with the strokes, loops, and the processing done. Optimal Viewing Position (OVP) is proposed to be one of the reasons for this. OVP is linked to an advantage when compared to the handling of a printed font to a cursive font.

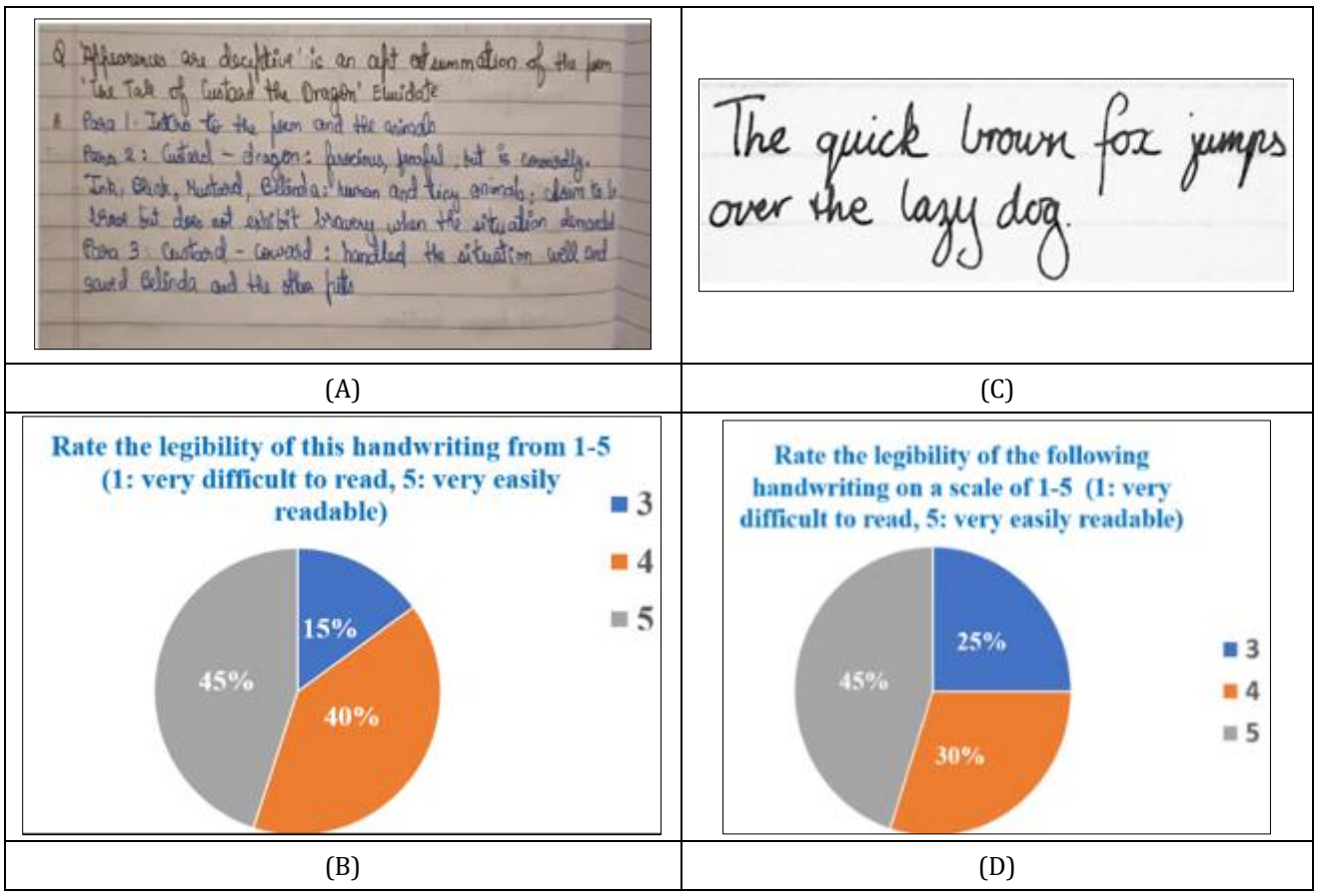


Figure 3 The above were samples provided in the survey, and the participants had to rate their legibility on a scale of 1-5, with 1 being very difficult to read and 5 being very easily readable. 2 represents difficult to read, 3 is not easy to read and 4 indicates easily readable According to the Cambridge dictionary, legibility is defined as "the fact of being easy to read, or the degree to which something is easy to read (A) and (C) Samples provided to the participant representing handwritten cursive (B) and (D) Pie charts characterizing the responses of the legibility rating of the aforementioned samples A and C, respectively

3.3. Quantifying Readability: Participant Response Trends

The responses recorded for the above sample (Figure 3A) are as given above (Figure 3B). 45% of participants chose 5 (Very Easy to Read), closely followed by 40% of the people who chose 4, and a small minority of 15% chose 3. It is found that most of the participants can read it very easily, with some people struggling a bit. For Figure 3C, the corresponding chart (Figure 3D) shows the respondents' rating of the legibility of the sample. Unlike the previous one, there is more variety in the rating, with 45% saying that it is very easily readable, 30% giving it a 4 and indicating that it is easily readable, and 25% saying that it is not that easy to read.

3.4. Noise Tolerance in Print Versus Cursive Handwriting

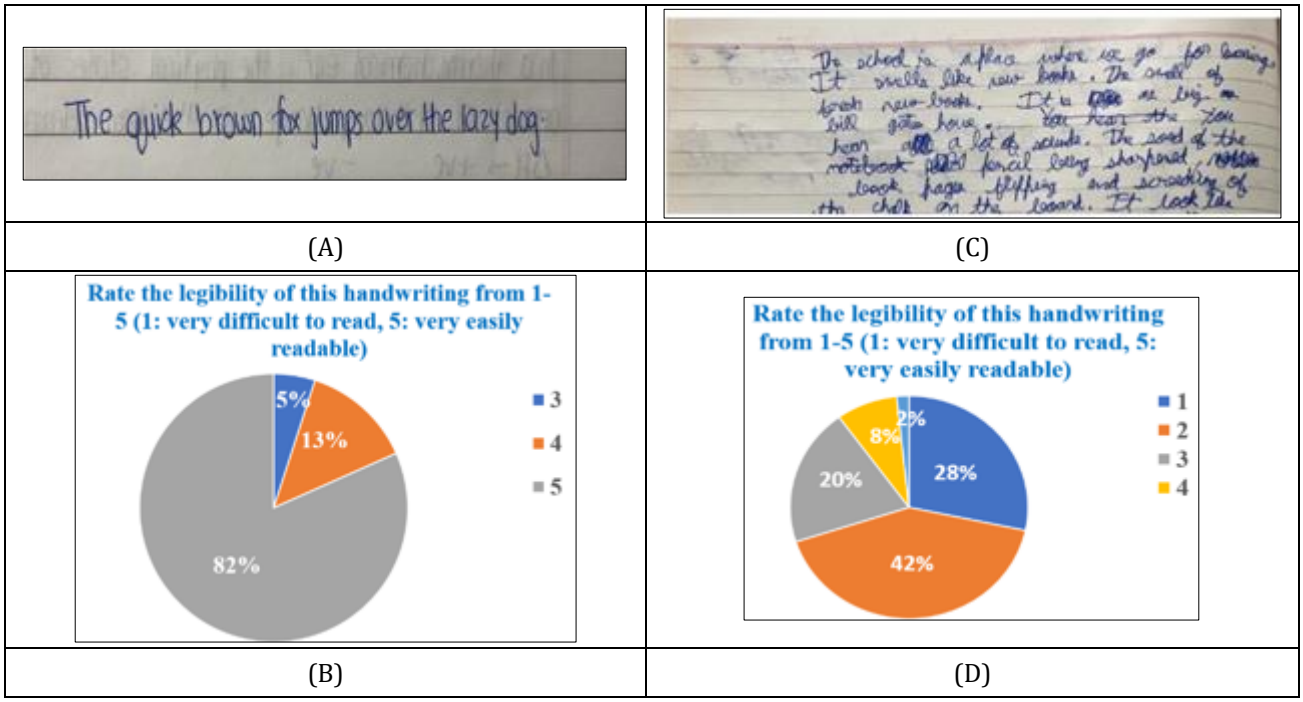
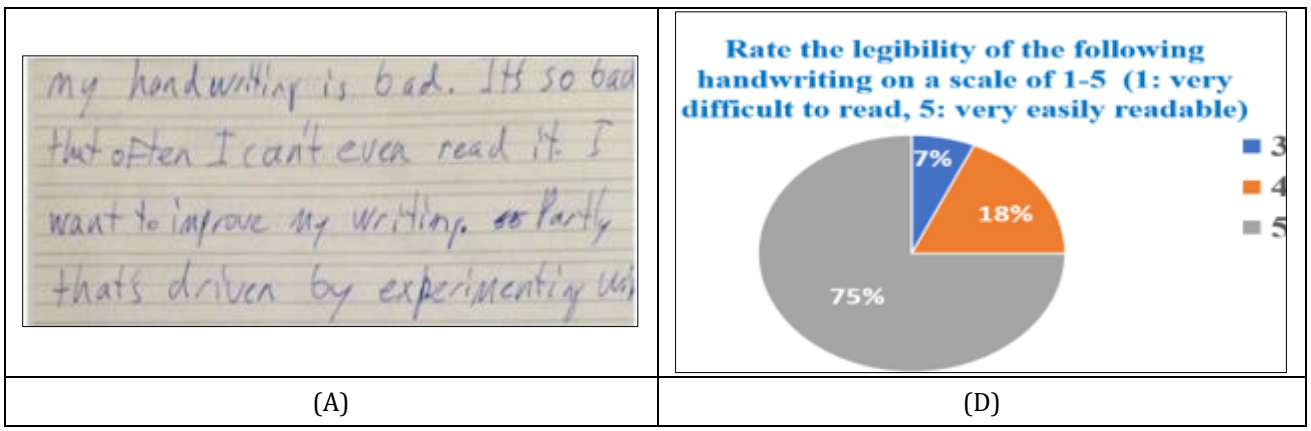


Figure 4 (A) and (C) Samples provided to the participant representing handwritten print and cursive samples respectively, with sample C being comparatively illegible (B) and (D) Pie charts characterizing the responses of the legibility rating of the aforementioned samples A and C, respectively

Figure 4A was a handwritten print sample. When asked to rate its legibility (Figure 4B), majority of participants 82% rated it a 5 (very easily readable), with 13% participants rating it a 4 followed 5% of the people rating it a 3.

Figure 4C is of a relatively illegible cursive handwritten piece. 42% rated this a 2, indicating that it is difficult to read (Figure 4D). Remaining participants divided themselves into the remaining 4 parts of the scale, with 28% saying it's very difficult to read, 20% saying it's not easily readable



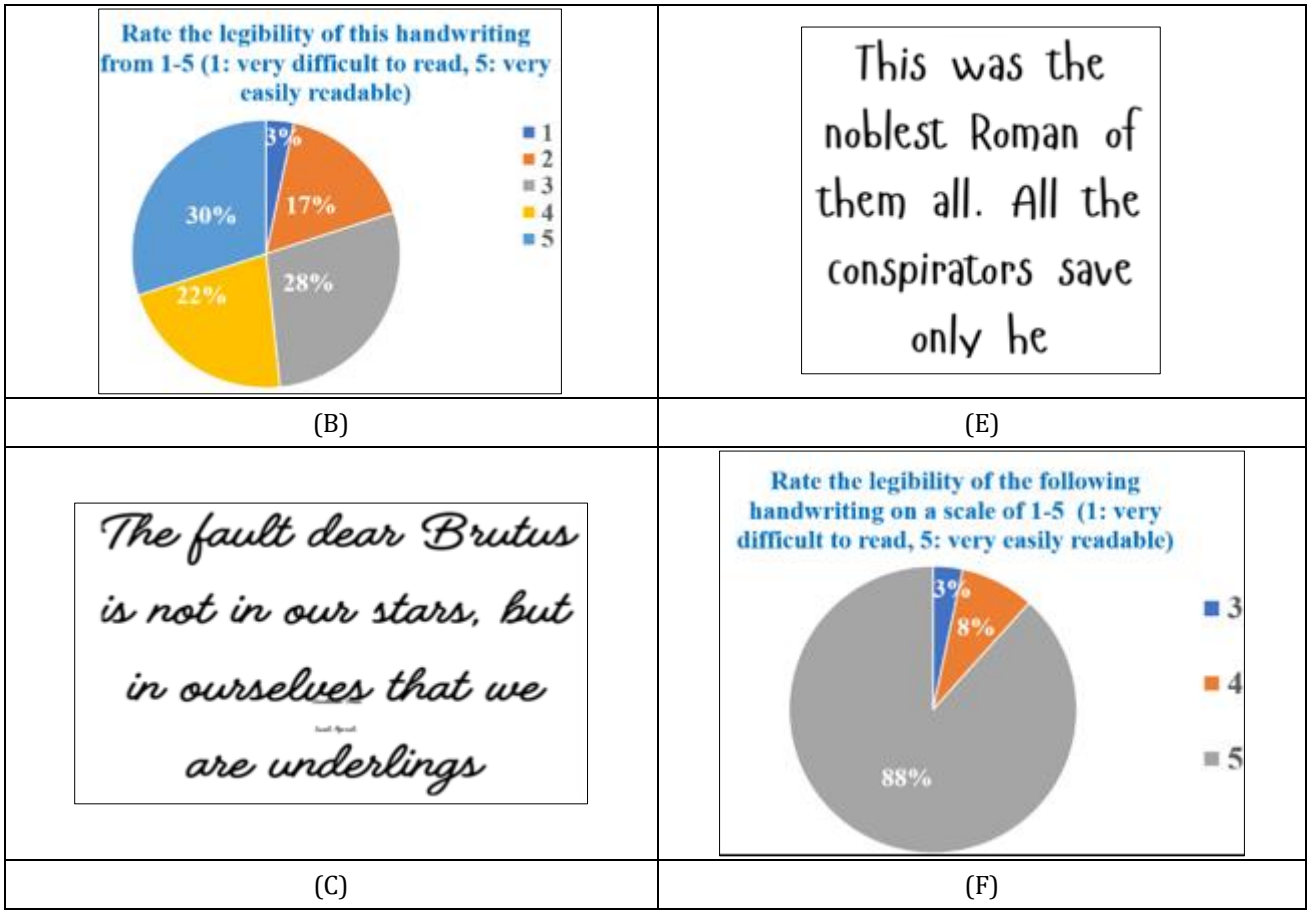


Figure 5 (A), (C), and (E) Samples provided to the participant representing handwritten print, online cursive, and online print font, respectively

(B), (D) and (F) Pie charts characterizing the responses of the legibility rating of the samples A, C, and F, respectively

Figure 5A is of a print handwriting that is relatively illegible as compared to the other examples mentioned above. Here, the distribution is varied (Figure 5B), with 30% saying that it's very easily readable, followed by 28% of the participants rating it a 3, saying that it isn't easily readable. The rest of the participants rated it a 4 (22%), 2 (17%), or 1 (3%). This shows that a comparatively illegible print is easier to read than a comparatively illegible cursive writing.

It can be argued that these are handwritten samples, and hence, variability exists in the writing of each individual, making it easier to read one than the other. To dispute this, a sample of an online text font was also provided, the result of which is as follows. A cursive font was taken from an online platform (Figure 5C). The majority, 75%, says that it's very easily readable, followed by 18% saying that it's easily readable and 7% saying that it's not easily readable. Compared to that, an online print sample (Figure 5E) shows that 88% of the participants found it very easy to read, followed by 8% giving it a 4 (easily readable) and only 3% giving it a 3 indicating that it is not very easy to read.

4. Discussion

This study aimed to determine whether participants find reading print handwriting or font easier than cursive. The results support this hypothesis, as it was found consistently that print was easier to read than cursive. Furthermore, it was found that the legibility of print was robust to noise. Participants were able to decipher the print text as it became increasingly illegible compared while failing to do so in cursive text

4.1. Supporting Literature on Print Superiority and Handwriting Legibility

This result is similar to that of the study conducted by Fortes, Furukawa, Long, Lianza, and Parzick. They found that the recognition of print letters was faster regardless of the handwriting style of their subject. In a study conducted by Boraas, which studied the legibility of cursive or printed letters also suggested that print is more legible for 25 out of the 26 letters. A study conducted by Ziviani and Watson-Will (1998) indicated that students tend to write more quickly

when using print rather than cursive handwriting. Meanwhile, Graham, Berninger, Weintraub, and Schafer (1998) discovered that children in grades 4-9 in the US produce writing more rapidly when using a combination of manuscript and cursive or using purely manuscript handwriting compared to writing completely in cursive. The above research is consistent with the findings of this study.

Additionally, readers must effectively navigate the lack of physical boundaries between letters when they are practiced in chunks (Ramkumar et al., 2016), contend with the uncertainty of basic strokes and loops, and address the significant variability both within and between individuals in the formation of the letters. In 1999, Lorette recognized two challenges in interpreting handwritten words, which were termed polysemy and segmentation. It has been stated that lacking spaces in the stimulus adversely impacts saccade calculation, as it diminishes the likelihood of the eyes arriving at the PVL compared to stimuli that have spaces (Ducrot and Pynte, 2002). Ultimately, in addition to the challenges of segmentation when letters are interconnected entirely, the variability in spacing among the handwritten characters makes it hard for the brain to focus on one letter due to it being "masked" by the other letters (e.g., Gori and Facoetti, 2015). This results in what is known as the crowding effect, which occurs when letters are too close together in the peripheral vision, making it hard to recognize individual letters (it's a type of masking effect), which in turn slows the reading speed. Most of these results are a comparison of printed words and handwritten words (which had cursive and print); these arguments can be used for the cursive handwritten font.

4.2. Limitations and Future Implications

A significant limitation of this study was the lack of imaging techniques or face-to-face interaction with the subjects. The samples were shared through a survey in Google forms, and the participants had to answer accordingly. The absence of face-to-face interaction also did not allow for ensuring that the responses given were true and not influenced by any other factors. Imaging techniques could also have been helpful as it would have aided in understanding which parts of the brain are responsible for the processing of print and cursive writing. Are both processed in the same region or different regions? Lastly, while the age group has been kept diverse, most participants who agreed to the study were from the age group of 14-17 years old. This might have influenced the results.

This study can be used in the future to understand how to make individuals better at reading different types of handwriting. It can also be used to study the regions of the brain involved in the processing of different writing styles. In the growing world of technology, handwriting might soon become a rare phenomenon compared to typing. Hence, this study can further be extended to understand the difference in processing of cursive, print, and typed font styles.

5. Conclusion

In conclusion, the findings of this study supported the hypothesis that print is easier to read than cursive even when it becomes illegible. The results show that cursive handwriting was overall harder to decipher but was especially hard when it became illegible. This was consistent not only in handwritten fonts but also online print and cursive fonts. These results are also supported with literature that talk about the role of the Optimal Viewing Position, phenomena such as polysemy segmentation, masking effect etc. This research can be extended in the future to understand how the human brain processes different types of handwriting and why it finds something 'illegible' or 'unclear with the help of technologies such as fMRI and EEG. The society will benefit from such studies as clarity can be obtained as to why some individuals' handwriting is harder to read and how they can train their minds to processes different types of handwriting.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares that they have no conflicts of interest in the subject matter or materials discussed in this manuscript.

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