The Embodied Saccadic Reader: Synchronized Pedaling for Text Interaction

The Embodied Saccadic Reader

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In recent years, reading has expanded to include digital text alongside traditional print. Despite the interactivity digital text offers, new methods to enhance reader experience and engagement remain underutilized. The Embodied Saccadic Reader introduces an innovative approach by engaging both the body and mind. Readers pedal their arms and legs while focusing on a monitor displaying 3-4 words of text at a time. Four distinct texts are accessible via four pedaling patterns, each linked to a color. Text slides progress based on the pedaling speed, and dynamic shapes surrounding the text window visually correspond to the reader's progress in each section. This method allows readers to navigate texts non-linearly, fostering unique connections and deeper engagement with notes, research, or literature. By integrating physical activity with reading, the Embodied Saccadic Reader offers a novel, immersive experience that enhances interaction with text.

CCS CONCEPTS • Human-centered computing • Interaction design • Interaction design theory, concepts and paradigms

Additional Keywords and Phrases: Embodied Interaction, Reading, Ergodic Literature

1 INTRODUCTION

In 1945 Vannevar Bush wrote, “the summation of human experience is being expanded at a prodigious rate, and the means we use for threading through the consequent maze to the momentarily important item is the same as was used in the days of square-rigged ships” [9]. While Bush addressed the challenges of managing early information overload, his observations are equally relevant to the practice of reading. The first alphabet was entirely consonants and was developed by the Phoenicians in 2000 BC. In 1000 BC, the Greeks added vowels to the alphabet [12]. By 900 AD, punctuation and spaces had been incorporated into text to complete the basic conventions of written language still in use today [15]. Writing material also evolved throughout history making texts more available to the public. These materials ranged from clay tablets, papyrus rolls, wax-covered wooden tablets, animal skin parchment, paper, and others [17]. More recently digital texts have emerged through computers, smartphones, tablets, and e-readers. Although reading practices have developed over time, they have not advanced at the same rate as recent technological innovation. Consequently, this has constrained the potential for experiencing reading in novel, interactive, and immersive ways, despite advancements in technology that facilitate such experiences.

2 ALTERNATIVE READING METHODS

There have been many attempts in the past to reinvent the act of reading. Agostino Ramelli is credited with inventing one of the first reading machines in 1588 [23]. Ramelli’s machine was a book wheel that held 12 books in a Ferris wheel style that allowed the reader to sit in one spot to access all of them. A book would remain open to the precise page where a

reader last left off, enabling them to seamlessly resume reading from that point. In an early nod to accessibility, Ramelli noted his book wheel was convenient for those whose mobility was impaired by gout [24]. While seated, the reader turns the book wheel with their hands to access the desired text always displayed at the perfect reading angle. Since the design was vertical it took up very little space in the reader's home. One limitation of Ramelli's design is the absence of desk space for writing notes as the reader reviews the texts.

Tristan Tzara, a member of the Dada movement, developed the cut-up technique as an alternative approach to reading and writing. Tzara introduced the technique in his 1920 work "To Make a Dadaist Poem" [30]. This technique involved physically cutting up existing texts into fragments and then randomly rearranging those fragments to create new compositions. The result was a non-linear narrative that defied traditional conventions of coherence and meaning. Later, William S. Burroughs and Brion Gysin would expand the cut-up technique for novel-length texts. Burroughs and Gysin collaborated to develop a variation of the cut-up technique called the fold-in technique, where two sheets of linear text are folded together to create new content [8]. Disrupting the linearity of reading forced readers to find their own connections and interpretations, thus requiring more work of the reader as co-creators of the text. The cut-up and fold-in techniques not only expanded the boundaries of literature but also anticipated later experimental literary forms and multimedia approaches to reading.

Bob Brown, an American writer, introduced the concept of a reading machine in his 1930 manifesto "The Readies" [7]. Brown's reading machine was the size of a typewriter and used electricity to move one line of type before the eye. These lines of type were called "Readies", continuous scrolls of abbreviated text that took the hassle of page turning and holding printed text away from the reader allowing the reader to focus only on the moving text on the machine. Though Brown never constructed one himself, he planned to print the type microscopically and run it under a strong magnifying glass like a microfiche reader [26]. The Readies were not meant to offer a new literary style, but to apply the technology of abbreviated dispatches sent by newspapers over the telegraph wire to all types of texts [7]. Brown contributed to and was influenced by his contemporaries in the arts and the literary avant-garde.

Other alternative reading and writing approaches were pioneered by the Oulipo, a group of French writers and mathematicians who in the 1960s began developing constrained writing techniques. OuLiPo is an acronym for Ouvroir de Littérature Potentielle, or Workshop for Potential Literature [6]. Their generative writing algorithms opened new avenues of creativity and new shapes and forms of literature. An example of an Oulipian work is Raymond Queneau's "A Hundred Thousand Billion Poems" [20]. This book is composed of ten sonnets, each presented on a separate strip of paper, allowing the reader to mix and match lines from different sonnets. The structure of the book permits countless combinations, resulting in exactly one hundred thousand billion possible poems. The book invites readers to actively engage with the text by physically manipulating the strips of paper to generate new and unique poems each time. This interactive process transforms the reader into a co-creator, as they must choose and rearrange lines to complete the work.

Another alternative reading area is ergodic literature. The term "ergodic literature" was introduced by Espen Aarseth in his book 1997 book "Cybertext" [1]. Traditional literature, written to be read in a manner requiring trivial movements of the reader's eyes and hands, is considered to be nonergodic and passive. The reader is required to do nothing out of the ordinary to get through the text. In ergodic literature, reading is more active because nontrivial effort is required to allow the reader to interact with the text [1]. In this way the reader actively constructs the text while navigating it. This active effort can range from flipping the book upside down and reading in the opposite direction every eight pages, as required in Only Revolutions by Mark Danielewski, to making the reader choose their own path through 27 unbound sections read in any order in The Unfortunates by B.S. Johnson [13,16].

3 MOVEMENT, READING, AND LEARNING

Many individuals acquire knowledge while remaining stationary. Printed books and e-readers require so much of our attention we can't really engage in much motion. There is much research to support the idea that movement can help understanding and memory. In her book Mind in Motion, Barbara Tversky cites many studies with findings on how action shapes thought [29]. A 2012 study by Cook et al. found that gesturing while reading helps lighten the cognitive load if the reader's gestures are meaningful [11]. With the ESR, a reader is using all four limbs to create different pedaling patterns in a clockwise rotational motion to activate the text. A 2012 study by Topolinski and Sparenberg showed that clockwise movements increase the performer's preference for novelty [27]. Pedaling the ESR clockwise can enhance the reader's experience and foster innovative thinking when making connections between the four available texts.

In her book The Extended Mind, Annie Murphy Paul similarly surveys research related to how cognitive processes can be distributed across the body, physical spaces, and other external elements [22]. One phenomenon Paul discusses is the enactment effect, how when we connect movement with information we activate both procedural and declarative memory. Procedural memory is the memory of how you do something and declarative memory is memory of informational content. When we link movement to the material we create a "memory trace" in the brain and our recall is more accurate than if we had just heard or read the information and not been moving [21]. The ESR facilitates four distinct movement patterns to be associated with specific texts, thereby enabling the occurrence of the enactment effect. Paul also states that novel movements can advance our thinking [22]. Many users of the ESR may not have engaged all their limbs in the four distinct patterns required to activate text at any previous time in their lives, presenting an opportunity to stimulate their cognitive processes while reading in a unique manner.

4 THE EMBODIED SACCADIC READER

The Embodied Saccadic Reader is an interactive reading machine for embodied navigation of text off a screen. The reader uses all four limbs to pedal low resistance exercise machines in different combinations to advance slides of 3-4 words of text on a main computer monitor. There are four different pedaling patterns a reader can perform which make visible four different possible texts in one window in the center of the monitor. The text window is small to mimic the fixation point of an eye saccade, a pause between jumping your eyes across 3-4 words of a line of printed text in a book. Surrounding the text window are four dynamic shapes in the form of a triangle, square, circle, and diamond representing the reader's progress through each text section by how blurry (little progress) or sharp (a lot of progress) the shape appears. Each shape has its own quadrant on the main monitor to help create spatial context for the text to aid in comprehension since it is being read off a screen [18]. The reader can peripherally view feedback from their pedaling pattern on a 2x2 grid displayed on a smaller computer monitor directly below the main monitor. The four different texts are color coded red, blue, green, and yellow and are represented as the background color of the slides of text on the main screen, the four shapes surrounding the text window, and the dots on the pedaling pattern feedback grid on the lower screen.

As the reader is pedaling, they have complete control over when to change their pedaling pattern and view another text. It is not necessary to perform the pedaling at full speed as slower, coordinated efforts of the limbs are required to ensure the reed switches are triggered. Pedaling mimics an embodied saccade, where the motion to trigger the text is jerky rather than smooth. Since all pedals are set to the lowest resistance level, using the ESR is not an exercise for the body, but rather an exercise for the reader's concentration and coordination. The reader can consult the 2x2 feedback grid to see which limb is not in sync with the pattern they are attempting to perform and readjust their pedaling. The shapes surrounding the text and the feedback grid are designed for peripheral interaction as the reader does not need to always be aware of them but can shift focus to them when necessary [5]. Not only can the reader maintain awareness of their progress

through different sections of the text by viewing the clarity of the shape in each section, when the reader reaches the last slide of that section, a tally mark is added in the background of that text section's shape quadrant to indicate how many times the reader has completed that section as the shape returns to its blurry form and the same text content begins again.

The reader can pedal their way through the texts using four different pedaling patterns. The patterns are created using two hand pedal exercise machines and one foot pedal exercise machine. Each pedal machine is outfitted with a magnetic reed switch at the 12 o'clock position of the pedaling arc mounted on each machine's resistance knob. A triggering magnet for the reed switch is attached to the metal rotating arm of the pedal. As the pedal arm passes the switch, a signal is sent to the computer to manipulate the text and other information about the text on two monitors. Each hand pedal machine is standalone, so their rotational movement performed by each hand is free to be synchronized, opposite, or anywhere in-between. Each hand pedal machine has only one reed switch and one magnet attached to the pedal arm closest to the hand pedaling. The foot pedal machine requires balanced pedaling so can only be used to trigger one foot at a time. Because of this, there a two reed switches (one on each side) mounted on a 3D printed custom resistance knob and one magnet on each of the foot pedal's arms. I had originally planned to have two separate foot pedal machines allowing for both feet to pedal in unison, but pedaling with one foot in a stationary position is difficult as you need the other foot to create momentum to return the opposite foot to the top of the pedaling arc.

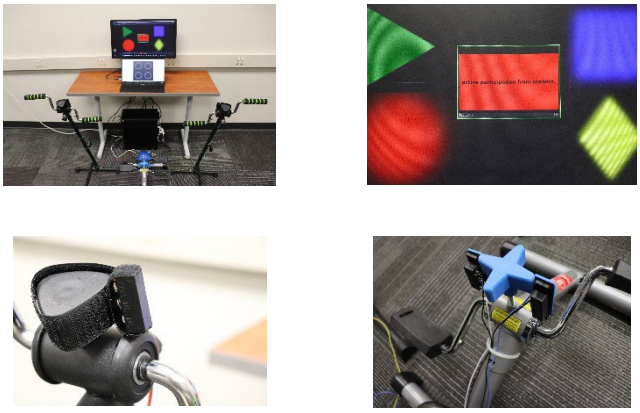

Figure 1: Top left is the full Embodied Saccadic Reader set up. Top right is a close up of the main monitor showing a small window of text and the surrounding shapes that become less blurry as a reader progresses through that color text. Bottom left is a close up of a reed switch mounted on the hand pedal exercisers tension knob with Velcro. Bottom right is the 3D printed reed switch mount for the foot pedal exerciser.

4.1 The Setup

The Embodied Saccadic Reader setup is easily transportable and can be assembled at a low cost. Both monitors can be set up on a shallow desk. The foot pedal exerciser is foldable, portable, and meant to be used under work desks. A 10-15 pound kettlebell weight is placed against the front of the foot pedal exerciser to keep it from moving forward if it is on carpet. The two hand pedal exercisers are easily disassembled and can fit into a medium-size gym bag. The reed switches mounted on the tension knobs of the hand pedal exercisers are covered in Velcro so a reader can adjust them to their target tension and reattach the switch at the triggering position. The 3D printed tension knob on the foot pedal exerciser can be used to

adjust the resistance level of the pedals and then removed and replaced on the tension screw with the reed switches at the ideal triggering zone.

4.2 The Pedaling Patterns

The two hand pedal machines being free and the foot pedal machine being balanced create four possible pedaling patterns. The first pattern is opposite limb as represented by the blue color and the square shape in the upper right quadrant. This pattern is created by the reader crossing the 12 o'clock pedal position with their left hand and right foot or right hand and left foot at the same time. The second pattern is same limb as represented by the green color and the triangle shape (on its side like a "play" button) in the upper left quadrant. This pattern is created by the reader crossing the 12 o'clock pedal position with their left hand and left foot or right hand and right foot at the same time. The third pattern is three limbs at a time using both hands and the right foot and is represented by the yellow color and the diamond shape in the bottom right quadrant. To keep a natural pedaling motion, the left foot alone also advances text progress for the yellow sections. The fourth and final pattern is three limbs at a time using both hands and the left foot and is represented by the red color and the circle shape in the bottom left quadrant. The right foot alone also advances text progress for the red sections to maintain a natural pedaling motion.

4.3 The Software

The two hand pedal machines being free and the foot pedal machine being balanced create four possible pedaling patterns. The *first* pattern is opposite limb as represented by the blue color and the square shape in the upper right quadrant. This pattern is created by the reader crossing the 12 o'clock pedal position with their left hand and right foot or right hand and left foot at the same time. The *second* pattern is same limb as represented by the green color and the triangle shape (on its side like a "play" button) in the upper left quadrant. This pattern is created by the reader crossing the 12 o'clock pedal position with their left hand and left foot or right hand and right foot at the same time. The *third* pattern is three limbs at a time using both hands and the right foot and is represented by the yellow color and the diamond shape in the bottom right quadrant. To keep a natural pedaling motion, the left foot alone also advances text progress for the yellow sections. The *fourth* and final pattern is three limbs at a time using both hands and the left foot and is represented by the red color and the circle shape in the bottom left quadrant. The right foot alone also advances text progress for the red sections to maintain a natural pedaling motion.

5 OPPORTUNITY FOR NEW WRITING, REVIEW, AND NOTETAKING METHODS

There are a multitude of possibilities for the type of texts that can be used for the Embodied Saccadic Reader. 3–4-word slides of text can be created from any document and color coded with the assistance of AI. When testing the ESR, I used four texts related to the research I was conducting to write this paper. This allowed me to jump between sources about Bob Brown, ergodic literature, saccadic eye movements, and embodied learning, creating the opportunity to make connections between ideas that may not have been possible had I been reading each text individually in a traditional way off a screen. Rashomon effect texts, where a single event is told from multiple different perspectives, would also work well with the ESR as a reader could experience the event stereoscopically through their body. I have used the text from the short story "In a Grove" by Ryūnosuke Akutagawa, which was what Akira Kurosawa used to base his 1950 film Rashomon on for which the Rashomon effect is named [3,19]. "In a Grove" is told in seven perspectives which can be incorporated into an expanded input ESR interface by allowing single left hand, right hand, and both hand triggers to act as the fifth, sixth, and seventh pedaling patterns.

Literature and research are not the only available text options for the Embodied Saccadic Reader. Personal notes can be plugged in to review in non-linear and immersive ways. As an artist and researcher, I am constantly writing notes to myself tracking ideas and inspiration. I make handwritten notes on a Kindle Scribe, which are easily digitized and turned into slides of 3-4 words for the ESR. I can sort these notes into categories to review in a cut-up technique inspired way using the ESR myself, or with the assistance of AI I can view new combinations of my notes sorted into different categories. I also keep a dream journal and have used the ESR to play back my dreams sorted into thematic groups in dream-like illogical combinations. Again, this provides novel non-linear combinations of dreams as I shift pedaling patterns that help me uncover new interpretations of myself and my subconscious.

Because my research involves creating new reading and writing methods, I have also created an iteration of the ESR that allows the reader to use the same pedaling patterns to type notes as they are reading. When the reader has an insight based on a new combination of text, they can switch seamlessly to typing by using their chin to click a one-button wearable chin interface [2]. Once the chin interface is clicked, the four pedaling patterns are rerouted to control up, down, left, and right movements of a cursor on an onscreen keyboard. For the typing iteration, the both hands together pedal pattern is incorporated as a fifth pedaling pattern as the select function on the onscreen keyboard. This method requires a third monitor to display the onscreen keyboard and text editing program. The typing method also incorporates a bookmarking method that captures the count of the slide counters of each of the text windows so they can be reviewed later after reviewing the typed note. Once a reader is done typing their note, they click the chin interface again and the four pedal patterns return to controlling the four text sections.

6 FUTURE ITERATIONS

For future developments of the Embodied Saccadic Reader I hope to expand the dynamic capabilities of the shapes. Adding the ability to edit features in addition to the blurriness of the shapes depending on when the reader leaves and returns to a specific section of text may be helpful to the reader like doodling. Doodling while reading and taking notes aids in memory [4]. Mapping the unique journey of the reader through the different sections of texts could also be tracked as a route, e.g. drawing out a labyrinthine pattern unique to that reading journey's shifts between pedaling patterns and texts linking to the non-linear mazes of ergodic literature and Cybertext. Visualizing the narrative across the Ocean of the Streams of Story through graphic scores like those in Cornelius Cardew's Treatise is also desirable [28,10]. Finding ways to represent the structure of novels architecturally and then navigating through them could also enhance comprehension of texts read with the ESR [25]. This might help the reader create more spatial context for the information they are reading, especially if the reader could view the mapping live as it may aid to a method of loci memorization of the text [14]. Readers could then recreate the same routes if they were trying to examine the path of text that led them to a new realization.

I also hope to write and commission texts specifically for the Embodied Saccadic Reader that have one common timeline running through all four pedaling patterns. Instead of each text section and pedaling pattern having its own counter, this method requires a common counter to allow all texts to be at the same point when they are jumped between. Texts would need to be written specifically to have the same word count so there are no lags when jumping between text sections. This would work well for new Rashomon effect style texts mentioned above, but also for comparing different translations of the same text. Imagine jumping seamlessly between different translations of your favorite passages of world literature, gaining new insights with each unique turn through the texts. This may leave the mind with a more comprehensive understanding of the words as your eyes were only fixated on one part of the screen rather than shifting up and down between different lines on the same screen or between different print books. The ESR hopes to inspire more innovative methods of reading and writing that engage the body.

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