Gestural RSVP
(Rapid Serial Visual Presentation)

M.Sc. Dissertation
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Abstract
The traditional page format for presentation of a text has evolved over thousands of years into its current form. This work promotes a relatively new and perhaps unconventional form of text presentation with potential to enable small screen effective reading (speed and comprehension). The need for such a new format might be considered the result of our changing environment: people are increasingly more mobile and using mobile devices which are hard to read from, data is growing rapidly and memory devices are very small and can hold hundreds of thousands of digital pages. The text presentation form is RSVP (Rapid Serial Visual Presentation) which is a reading method in which text is read (in this research) by presenting a word at a time, one after another while keeping the word center static. RSVP has been researched and found to be faster than standard page reading and with the same or higher comprehension. Recent research performed with small screens such as mobile devices, found that in such scenarios RSVP has significant advantage in readability (speed and comprehension) over the standard reading method.

However, while digital reading devices such as Kindle™ from Amazon™ are becoming commercially successful, RSVP reading is not widely adopted although it can easily run on many mobile devices. Using RSVP reading was found to be associated with higher frustration levels which this research assumes is the result of lower perception of control over the reading process. This research hypothesis is that adding Gestural control to RSVP reading will introduce a low cognitive load means of control for RSVP. This should correspond to a lower level of experienced frustration. An experiment was conducted on 6th grade Israeli students. In the experiment iPod touch devices have been programmed with gestural control for RSVP reading, realized by the spatial awareness features of the device. The experiments settings was based on three conditions: standard reading, standard RSVP reading, and Gestural controlled RSVP reading realized by spatial movements of the device. The subjects were tested for speed (words per minute), comprehension (multiple choice comprehension questionnaire), and frustration level.

The results showed significant improvement in reading speed using the RSVP reading methods over standard reading while comprehension was similar. In addition, the frustration level for GRGSP reading was similar to standard reading which was significantly lower than Standard RSVP reading. An additional questionnaire which was administered provided some insights towards habits and tendencies, highlighting that the children who participated in the experiment also showed high tendency towards using mobile devices for reading narrative texts, and indicated having such capable devices will increase their reading frequency.

Possible implications for this research and follow up research in this area can promote the adaptability of a rather new reading methodology which can be used by children in school everywhere. It can promote reading and knowledge for countries with fewer computing and network resources as long as they have some mobile infrastructure such as cellular networks and devices. Future devices might be designed to support more automatic control properties related to pupil behaviour and biofeedback. In addition for ease of use wearability of the device might be promoted as well.
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The Research

This research investigates whether the reading experience using RSVP (Rapid Serial Visual Presentation) can be improved by adding gestural controls. RSVP reading is an alternative method for page reading in which (in this research) reading is performed one word at a time, and one after another, where the word center remains static. RSVP reading is a ‘technological’ method for reading as it requires a device to enable word after word presentation. Compared with conventional reading, RSVP reading seems to proceed considerably faster. RSVP research has shown that readers read and understand RSVP texts presented as fast as 600 wpm (words per minute) – more than twice the speed of page reading rate (Siegel A.C. 1994). Processing and comprehension are probably faster during RSVP reading because serial presentation eliminates the need for time consuming strategies readers ordinarily employ when they decide when and where to move their eye during page reading. Previous research also showed useful properties for RSVP reading on devices with small screens (e.g. mobile devices). However high cognitive load was found as well, putting the reader in a “high alert” state. This state resulted in high frustration level reported by readers. The idea behind this research is adding gestural control, such as exercised in operating a joystick, which uses procedural training with low cognitive load, in order to reduce the cognitive load. Gestural control is associated with procedural attention which has low cognitive load in executing, after it is being learned. Reducing the cognitive load is important because it can lower frustration and thus help promote adoption of RSVP reading in scenarios where it has advantages over the standard method of reading.

This thesis plan is as follows:

- Background – An overview of reading and readability essentials with special emphasis on small screens
- Design – A description of the RSVP method of reading and the gestural RSVP variation.
- Evaluation – The testing method and data obtained.
- Discussion – A discussion of the implications of the test results using the gestural RSVP reading.
- Conclusion and Future Work
- Appendix
  - Prototype implementation:
    - Design considerations
    - User interface
    - Technical specifications
  - Text and questionnaires
Background

When we read, we examine and grasp the meaning of painted, written or printed symbols. As far as we know, pictures were drawn to represent animals and other objects as early as the Stone Age, around 20,000 B.C. The remnants of the oldest systematic reading and writing systems are dated back to North Babylonia, around 8,000 years ago. Alphabet signs, as we now interpret them, were used in Egypt at least 7,000 years ago (Huey 1908; Hill 1999). Reading can essentially be seen as an intricate form of pattern recognition that has evolved over centuries. As with pattern recognition in general, the interpretation is highly dependent on convention. The development of language and writing is very much a result of agreeing on what we choose to associate with certain patterns and how we present them.

The traditional page format for presentation of a text has evolved over thousands of years into its current form. This work promotes a relatively new and perhaps unconventional form of text presentation with potential to enable small screen effective reading (speed and comprehension). The need for such a new format might be considered the result of our changing environment: people are increasingly more mobile and using mobile devices which are still hard to read from, data is growing rapidly and memory devices are very small and can hold hundreds of thousands of digital pages.

The Reading Process—Revelation of Eye Movements

The key to reading and language, in general, lies deeply embedded within our mind (Taylor and Taylor 1983; Hill 1999). There is an abundance of research on how we read. Most agree that we recognize patterns and then mentally process them in some way. The first evidence of what really happens with our eyes while reading was discovered at the end of the nineteenth century.

In 1879, the French oculist Emile Javal found that the eye does not sweep smoothly along the line of text while reading. Instead, it proceeds by making short jumps called saccades. Between saccades, the eye stays put for a brief time in pauses called fixations. At the end of a line, the eye moves to the beginning of the next line in a single movement called a return sweep (reported in Huey 1908, referred to in Paulson and Goodman 2000). The findings of Javal triggered decades of research on eye movements while reading.

In 1891, Landholt, one of Javal’s contemporaries, discovered that “reading of a foreign language required more pauses, as did also the reading of detached words, numbers and lists of proper names” (reported in Huey 1908:19, referred to in Paulson and Goodman 2000). Landholt’s findings are probably the first evidence that the reading process is not regular, but varies depending on the type of text being read. The Landholt study was important since it was the first to imply that eye movement studies might tell us something about the cognitive processing that takes place while reading.

In 1900, Dodge reported that the eye does not retrieve information while moving. The experiment had a simple design, but the proof was convincing. Dodge used a cardboard piece with a slit of 4 mm. In back of the cardboard, he put different colored cards. The subjects were told to fixate on one side of the slit and then move to the other side in one
unbroken eye movement. Dodge found that the subjects could not tell which color had been exposed or even if there had been a slit at all (Dodge 1900, referred to in Paulson and Goodman 2000). The experiment showed that it is during the fixations that the reader actually processes information.

In 1908, Edmund Burke Huey provided the first physical records of eye movements while reading. He made a number of interesting findings. He found that the eye sometimes moves backwards to reread words and phrases in movements called regressions. He also found that only 20-70% of the words in a line are fixated on. Further, the first fixation on a line was not found to be on the first, but rather on the second or third word (Huey 1908, referred to in Paulson and Goodman 2000). These findings provided the first evidence of a reading process where the reader chooses where and when to fixate next. Huey’s results may also have been the first indication that reading is not merely a simple word identification process, but rather a process where words are processed simultaneously in chunks.

In 1922, Judd and Buswell reported results from the first study where the subject’s eye movements were photographed. The detail level was high and provided accurate records of eye movements and fixation durations. In the data, Judd and Buswell found evidence that readers read differently under different circumstances. They also concluded that reading is not simply a matter of bottom-up word identification, but rather a perceptual process that involves interpretations on the reader’s part (Judd and Buswell 1922, referred to in Paulson and Goodman 2000). This conclusion was significant, since it indicated comprehension relies also on top-bottom processes linked to the neural relations in the brain and the effects of priming. Priming is the situation where an early stimulus influences response to a later stimulus.

**Physiology of the Eye**

The receptive part of the eye, called the retina, is essentially a panel of photosensitive receptors located on the back of the eyeball (Ø ~42 mm) (figure 1). The retina has two types of receptors called cones and rods. Cones register luminosity and colors, whereas rods register light changes. Rods are much more sensitive to light but they cannot detect colors and are also slower to respond. Most of the cones are located in a tiny area at the centre of the retina called the fovea (Ø ~0.2 mm). The fovea is surrounded by the parafovea (Ø ~3 mm); in this region there are still many cones, but also an increasing amount of rods. Outside the parafovea there are few cones and a decreasing amount of rods, therefore vision becomes progressively less clear in the periphery of the retina (Procter and Procter 1997).

![Figure 1: Cross-section of the eye](image-url)
When reading text, the image of the text is inversely reflected upon the retina. The retina has a 240-degree field of vision but the maximum resolution is restricted to the fovea. The fixation target (focus of text gaze) must be located in the fovea since a high concentration of cones is required for accurate recognition. The foveal field of vision is only one or two degrees wide and this means that only six to eight characters can be in focus at a time. The parafoveal region further extends the perceptual span to approximately 20 characters, but beyond that acuity is too low for retrieval. The perceptual span is centered to the right of the fixation point, at least for readers of left-to-right languages (Just and Carpenter 1980). Readers pick up information from approximately eight or nine character spaces to the right of a fixation, and four or so to the left (Rayner and Pollatsek 1989; Robeck and Wallace 1990; Rayner and Serano 1994; Rayner 1998).

**Perceptual span**

After information is processed in a fixation, peripheral vision is used to determine the location of the next fixation. A saccade, or a return sweep, are executed to move to the next fixation target, and is not necessarily a forward movement. Regressions are essentially backward saccades used for clarification of incomplete retrieval appearing about 19% of the time (Just and Carpenter 1980). The length of a saccade is usually between 1–20 characters; thus, a saccade is performed very quickly ~40 Ms. Fixations take about ~230 msec, on average, for fast readers and ~330 msec, on average, for average readers (Robeck and Wallace 1990). The duration of the fixations has also been found to vary greatly. In some studies, the duration is between 100–500 ms (Rayner 1998), whereas in others the duration has been found to vary as much as 50–1500 ms (Just and Carpenter 1980).

**Eye and Mind**

In 1980, Just and Carpenter suggested that “a reader can take in information at a pace that matches the internal comprehension process” (Just and Carpenter 1980:329). From this starting point, they developed the most widely known processing model of reading. Just and Carpenter found large variations in the duration of individual fixations, as well as the duration of fixations on individual words. They also found that almost each content word (i.e. words that exclude connecting words) was fixated and that fixation times were longer on words that were infrequent, thematically important or clarifying the interpretation of
previous words. The fixations were also found to be longer at the end of a sentence, suggesting integrative processing.

From these findings, Just and Carpenter developed a reading model based on two assumptions. The first was the immediacy hypothesis, which states that each word is immediately processed when it is fixated (instead of waiting for an accumulation of several words before making an interpretation). The second assumption is the eye-mind hypothesis, which states that the eyes remain fixated on a word as long as it is being processed (Just and Carpenter 1980). Both assumptions have since been criticized, mainly because they don’t account for context and preview effects; i.e. that words other than the fixated ones can be predicted out of the context, or perceived in the parafovea, and, therefore, also affect the processing times (Paulson and Goodman 2000; Reichle et al. 2000).

**Semantic Priming**

Semantic Priming refers to the fact that familiar words quickly activate or “prime” their previously stored semantic associations: subjects identify a target word (such as DOCTOR) more rapidly when its presentation is preceded by a relative word (e.g. NURSE) as opposed to an unrelated “prime” word (e.g. TABLE). Response facilitation of semantically related words (the priming effect) is believed to reflect the organization of concepts in memory: related words prime one another because they are stored closely together in association network. Below 300 msec, between two inputs, priming is automatic, however over 300 msec selective processing incurs a processing penalty and un-attentional priming degrades (Neely 1977; Ratcliff and McKoon 1981). During the reading process, longer fixations (fixations vary between 100-500 msec) will have an impact on the priming effectiveness, and consequently comprehension which is improved through priming.

**Readability**

In order to compare between different reading methods it is important to define a Readability measure. Readability needs to accommodate changes for both the same or different people. The readability estimation used in this work is readability measures which are used to evaluate readability based on actual reader performance.

**Readability Measures**

Reading speed by itself is not a sufficient measure; the same person can read texts in different speeds, based on the reading purpose. In example skimming thorough text is faster than reading for fun which is usually faster than reading for a test. Readability which is evaluated in terms of reading speed and comprehension (Mills and Weldon 1987) enables balanced comparison for the same or different readers.

Reading speed is often calculated as words read per minute (wpm), whereas comprehension is represented as percent of correctly answered multiple-choice questions about the subject matter. Both measures are objective. The reading speed results are more consistent when comparing results from repeated performance of the same subject’s on different texts, whereas comprehension scores are slightly unpredictable since they are highly dependent on the type of questions asked. The product of the reading speed and comprehension scores has been suggested as a composite measure for reading efficiency (Jackson and McClelland...
1979; Rahman and Muter 1999; Castelhano and Muter 1999). The measure is used to avoid problems associated with assumed trade-offs between speed and comprehension (Wickens 1992).

Although a high readability measure is likely to be a good indicator of good readability, it is also common to use additional measures. A comparable, subjective measure used in evaluations is the standardized task load inventory NASA-TLX (Task Load Index) (Hart and Staveland 1988). The inventory measures different cognitive demands that are rated by the subjects after completing a task. The NASA-TLX task load inventory was used in several previous RSVP studies (e.g. Sichesitz 2000; Goldstein et al. 2000).

**Screen Reading**

Many readability studies have focused on comparing reading on screen and reading on paper. Early readability studies were with the first generation Cathode Ray Tube (CRT) screens, commonly referred to as Visual Display Units (VDUs). In the majority of the early experiments on VDUs, readability was found to be poor compared to paper. The average reading speed for an English text on paper is between 220–340 wpm (Kump 1999). Reading speed on VDUs was around 20–30% slower although comprehension was roughly the same (Muter et al. 1982; Kang and Muter 1984). These findings are not too surprising since the first screens were primitive units with poor legibility due to low resolution and mediocre refresh rates.

Later studies using computers with GUIs (Graphical User Interface) for the text reader and with better screen resolution showed that there was in fact little or no differences between screen and paper, provided that attention was paid to such factors as screen resolution, refresh rates, anti-aliasing, text polarity (Gould and Grischkowsky 1984; Osborne and Holton 1988; Muter and Maurutto 1991; Muter 1996). Although reading speed and comprehension do not differ much between high-quality screens and paper, users still seem to prefer paper. This may be partially due to the fact that reading on a large screen requires the reader to view the text from a distance and in a fatiguing posture (Schneiderman 1998). Additional aspects in favor of paper reading are the head and hand gestural control excluded from screen reading. An underestimated aspect is also that most readers are more used to reading on paper. With time however, there may be people that prefer reading on a screen to reading on paper.

Most mobile devices utilize flat Liquid Crystal Display (LCD) screens. Today, LCDs offer a good resolution and color depth. The problem with readability on small screens is however not so much the resolution, but rather the limitation in the screen space. This limitation restricts the amount of information that can be presented at one time. Thus, reading text on a small screen can be frustrating. To complicate matters, users of mobile devices do not always have access to printing facilities. Studies have been done on the effect of display size on reading in order to determine how small a screen can be before problems occur.

Duchnicky and Kolers (1983) performed an experiment with varying text window widths and heights and found that, readability with window heights that are four lines and smaller with width of 1/3 of whole page, were significantly less efficient (highly corresponds to mobile
devices). As compared to 2/3 width (and up) with more than 4 lines height which varied non-significantly.

Devices with small screens, such as mobile phones, have become very popular; people carry the devices with them wherever they go. However, while the devices are used for many purposes, reading is not yet one of them with the exception of short messages (e.g. SMS). One reason may be that reading is not natural and convenient given the screen size and its effect on readability.

**Text Presentation on Small Screens**

There are several methods to present text on small screens. The methods can be divided into static and dynamic text presentation formats. The major difference between the formats is that traditional text presentation refers to a multi-line user-controlled scroll ('pull' method), while dynamic refers to push methods where text (paragraph, line, word etc.) is sequenced to the user. The text presentation formats presented here are not applicable for small screens alone. Often a lot of information must be squeezed into a small window on a large screen.

Leading (text moves from right-to-left) and RSVP (Rapid Serial Visual Presentation) are the two most common forms of dynamic text presentation. Both formats require little interaction from the reader since the text proceeds automatically. These techniques use limited screen space, leaving the rest of the space for other information. In Leading, or horizontal scrolling (also known as the “Times Square Format”), the text moves from right-to-left. Sekey and Tietz (1982) and Granaas et al. (1984) found that Leading had lower readability than traditional text presentation in the page format. However, in these studies the text moved forward letter-for-letter. Kang and Muter (1989) evaluated Leading that moved forward pixel-for-pixel (one pixel shift each instance) and found it to be more effective.

RSVP originated as a tool for studying reading behavior (Forster 1970) but has lately received more attention as a presentation technique with a promise of optimizing readability (Joula et al. 1982; Masson 1983; Potter 1984; Joula et al. 1995; Muter 1996; Rahman and Muter 1999, Sicheritz 2000; Goldstein et al. 2001). When RSVP is used, the text is successively displayed as small chunks within a small area. Each chunk typically contains one or a few words depending on the width of the text presentation window. When reading in this fashion, the text proceeds by itself, making the saccadic eye movements and the return sweeps unnecessary. This reading fashion also means that regressions, or the rereading of words and phrases, may be effectively prevented (Rahman and Muter 1999).

**Rapid Serial Visual Presentation**

The term RSVP was first introduced by Forster (1970) as a name for a technique used for studying text processing and comprehension. Later RSVP was introduced as a presentation technique for computer screens with the assumption that the reduced need for eye movements could reduce cognitive load and improve readability (Joula et al. 1982; Masson 1983; Potter 1984). However, the term RSVP has come to label a wide variety of approaches for text presentation where chunks of text have been displayed successively. The designs of
most RSVP evaluations and implementations have differed so much that the findings from one evaluation are not necessarily applicable to another. Some present single words at a time, whereas others present several words. Some present long-text tasks, whereas most present only short paragraphs as tasks. Differences in reading speed have also been large; some use high presentation speed, whereas others allow readers to choose their own.

Following are several previous RSVP reading evaluations:

Joula et al. (1982) presented text paragraphs on a CRT screen, in a standard format and in the RSVP format with text chunks of 5, 10 or 15 characters. Each text chunk was exposed for 200–300 msec, which is equal to a reading speed of approximately 300 wpm. The results showed no significant differences in comprehension (as demonstrated with multiple choice questions on the domain matter) between the reading conditions.

Masson (1983) evaluated how the insertion of blank windows at sentence breaks affected the RSVP format. Masson experimented with durations of 500 and 1000 msec and found that performance increased with blank windows regardless of duration.

Muter et al. (1988) performed experiments with self-paced RSVP and RSVP that permitted regressions. The results showed that larger regressions yielded slower reading; regressions back to the beginning of the sentence were found to be more frequent than regressions two words back. Overall, the results indicated that permitting reader control was feasible, but permitting regressions resulted in lower performance.

Siegel A.C (1994) performed experiments about automatic processing during rapid reading. The results showed that readers read and understand RSVP texts presented as fast as 600 WPM – more than twice the page reading rate. Processing and comprehension are probably faster during RSVP reading because serial presentation eliminates the need for time consuming strategies readers ordinarily employ when they decide when and where to move their eye during page reading.

Fine and Peli (1995) evaluated how visually-impaired and elderly subjects read using RSVP and scrolled text. They found that visually-impaired subjects read at a similar speed using both formats, whereas elderly subjects read faster using RSVP.

Castelhano and Muter (2001) evaluated the effects of using RSVP with or without punctuation pauses (i.e. a pause after periods, commas, semi-colons, and colons) and variable word durations (based on word length or dictionary complexity). Several RSVP formats were compared to traditional text presentation and sentence-by-sentence presentation. The results showed that pauses and variations improved the RSVP format significantly.

Karin Sicheritz implemented an RSVP reader in order to evaluate how to read using RSVP on a PDA compared to using paper-based text (Sicheritz 2000; Goldstein et al. 2001). The application was implemented on a Casio Cassiopeia E-105 PDA and offered a graphical user interface. In a repeated-measurement, within-subject experiment, using ten subjects, the RSVP reader was benchmarked against the paper-based text. Different window widths for the RSVP reader, 11 and 25 characters, were compared to a paper-based text condition. The
texts used in the experiment were the first six chapters from the novel “Röda Rummet” (in Swedish by August Strindberg), the chapters were between ~2700–6300 words long. The subjects read the first chapter in the paper-based text and the following chapters using the RSVP reader prototype. The subjects were instructed to read as fast as possible. Readability was measured by reading speed, comprehension inventories consisting of ten multiple-choice questions, the NASA-TLX (Task Load Index) (Hart and Staveland 1988) task load inventory, and an attitude inventory consisting of five questions about difficulty, efficiency, comprehension, stimulation and facilitation of the presentation (Sicheritz 2000; Goldstein et al. 2001). Though a text presentation width of 25 characters resulted in the highest reading efficiency, the differences were not significant. However, the task load inventory did reveal significantly higher task load ratings for all RSVP conditions for all factors but Physical demand. The attitude inventory showed a significant advantage for difficulty, comprehension, and stimulation (Sicheritz 2000; Goldstein et al. 2001).

The results obtained from the RSVP reader evaluation were quite encouraging. As a minimum, they showed that reading a book using RSVP on a PDA is just as efficient as using a paper-based book, even though the subjects may not agree. The high task load rating and the lower attitude ratings for the RSVP format were disappointing. Many issues may have affected the discrepancy between the subjects’ objective and subjective results.

A problem with the RSVP reader evaluation is that reading a screen is compared to reading a paper-based book; these are two very different things. An assumption (which was rejected) for the high task load for the RSVP reader prototype have been that the exposure time for each text chunk was fixed, since The latter does not seem to adhere very well to the reading process (Sicheritz 2000; Goldstein et al. 2001).

A later experiment was performed using a Compaq iPAQ 3630. The initial speed of the text presentation was set to 250 wpm, but the subjects were allowed to alter the speed at any time. A commercial program was chosen for the traditional text presentation - Microsoft Reader version 1.0. The results showed that the use of RSVP resulted in significantly higher task loads when compared to traditional text presentation with Microsoft Reader. In addition, regardless of the RSVP condition, in the test the perceived ease, comprehension, immersion, and naturalness were rated significantly lower compared to Microsoft Reader (Gustav Öquist 2001)

However, the last result is exactly what triggered this work.

Gestural Control
For over 40 years, almost every possible form of human gesturing can be seen in the literature as a means of providing natural and intuitive ways to interact with computers across most, if not all, computer application domains. In addition, many input and output technologies have been used to enable gesture-based interactions.

Quek et al. (2002) have proposed a framework for classifying gestures for human-computer interactions into three categories: manipulation, semaphores and gesture-speech approaches. The relevant gesture category for this work is semaphoric: "systems of signaling
using flags, lights or arms” (Brittanica.com). By extension, we define semaphoric gestures to be any gesturing system that employs a dictionary of hand or arm gestures.

Semaphoric gestures are linked with the move towards more ubiquitous computing paradigms and are a means of reducing distraction to a primary task when performing secondary task interactions (e.g. locating region on satellite image – primary task, while monitoring an error terminal – secondary task) (Karam and M. C. Schraefel 2005).

In the work presented by Bolt (1980), electronic sensors were one of the first methods for recognizing hand and arm movements in gesture-based interfaces. We do not discuss the technical details of these sensing devices, but refer to them in terms of the gesture-based interactions that they enable.

Ubiquitous, mobile and wearable computing shows the benefits from gesture interactions, primarily through touch-screen stroke gestures. These gestures enable users to control their PDA through touch and audio, freeing up the visual channel for other tasks involving mobility (Lumsden and Brewster 2003; Pirhonen et al. 2002; Brewster et al. 2003; Pastel and Skalsky 2004).

In this work, the new spatial control added to mobile devices is used as a semaphoric gestural control. Learning to operate a device by means of gestural control constitutes a procedural learning, leading to procedural memory. Procedural memory reflects stimulus-response pairing or more extensive patterns learned over time, and has low cognitive load. In contrast, declarative memory generally can be put into words and performing declarative tasks has high cognitive load. Examples of procedural learning are learning to ride a bike or learning to play a musical instrument. Low cognitive load enables gesture based computing interaction paradigms to enable lower distraction on the primary task.
Design

Standard RSVP
The standard RSVP used in this research refers to the presentation of word after word while the center of the words stays static (RSVP). The standard term refers to the control exercised over the speed and play / pause of the text.

![Figure 2: Standard RSVP](image)

The text is being parsed and presented based or predefined parameters, the default speed between two words, pause defined for punctuation marks in the text. Standard RSVP includes manual buttons which operates word presentation speed and pause/play control.

Gestural RSVP
The Gestural RSVP used in this research refers to the presentation of word after word while the center of the words stays static (RSVP). The Gestural term refers to the control exercised over speed and play / pause, which is spatial movement (tilt) of the device in predefined ways.

![Figure 3: Motion is used for gestural control](image)
The text is being parsed and presented based or predefined parameters, the default speed between two words, pause defined for punctuation marks in the text. Gestural RSVP is operated by spatial movements of the reading device which control the speed of the word presentation and the pause/play control.

**Motivation**

Reading involves top-bottom processes such as priming; however we lose a big part of the advantages of priming due to the eye fixations performed during standard reading (which takes on average 230-330 msec per word). Readability is significantly reduced when screen height is 4 lines and lower and 1/3 in width (from a standard page) and lower, such is the case for small screens devices. RSVP reading provides useful method to deal with these issues; however a frustration factor has been found in previous research. The frustration might be caused at least partially by the perceived lack of control over the reading process as compared to the standard reading method, and the high cognitive load in operating it. The Gestural control for RSVP reading was introduced to provide a low cognitive load means of controlling RSVP and to test if it will reduce frustration.

**Evaluation**

**Usability Evaluation**

The same device was used for all groups to ensure that the hardware does not bias the assessment.

**Method**

Sixty subjects were split into three groups. The task presented to each subject was identical and differed only in the reading software used and included:

- **Introduction** – An explanation of the procedure and the questionnaires.
- **Familiarization Text Reading** – familiarization text was read on the device by each subject. This was done to adjust to the device and reduce initial anxiety.
- **Test Text Reading** – Each subject was asked to read identical test text. The WPM (words per minute) rate was calculated according to the total amount of words in the text divided by the end time minus the start time (as measured by the device).
- **Unseen Comprehension** – Each subject answered an unseen comprehension test consisting of 12 multiple choice questions.
- **Task Load (derived from NASA-TLX)** – Each subject answered a task load questionnaire and a frustration measuring question as part of it.
- **‘follow up’ Questionnaire** – the subject completed a set of multiple choice questions on the possible use of the reading technique they have experienced in their everyday life and education in the future.

**Reading the Text** – Reading the text as described in the procedure above was conducted on identical devices (iPod touch 8GB second generation).
**Reading Variant** – The variant in the experiment was the method and software used for reading the text as follows:

- **Group I** – ‘Standard reading’: texts presented using a standard text reader for iPod touch (mail reader)
- **Group II** – ‘Standard RSVP’: text presented using standard RSVP with button control as presented in relevant previous research (Sicheritz 2000; Goldstein et al. 2001, Gustav Öquist, 2001).
- **Group III** – ‘Gestural RSVP’: text presented using RSVP and controlled by gestural control (see Appendix A for implementation details)

**Design**

The null hypotheses were as follows:

- No difference in reading speed across the three reading methods
- No difference in text comprehension across the three reading methods
- No difference in task load across the three reading methods
- No difference in frustration level across the three reading methods

The hypotheses were tested via the repeated-measurement General Linear Model (GLM). The significance level was set to 5%.

The number of subjects per group was calculated according to the power of the experiment for a one-way ANOVA. Seventeen subjects are the minimum in order to get the experiment in the desired power range of 80–90% probability to find significance (if significance exists). Twenty subjects provide a power of almost 87% probability to find significance and allow for redundancy.

**Figure 4: One way ANOVA power calculation for groups of 20**

The data was collected between groups; the hypotheses were tested based on the following measures:

- Reading Speed – based on the wpm (word per minute) rate in reading the test text.
- Comprehension – percent of correctly answered success multiple choice domain matter questions.
Task Load – The measure of the task load was based on the answers to the Task Load inventory which was administered to check mental, temporal demands, as well as performance level for reading the text.

Frustration question – this measure was taken to check the frustration level during reading the text.

The ‘follow up’ test was used for additional perspective and future research; however it was not used for the null hypothesis testing.

Subjects
A balance-group design was employed. Three experimental conditions (I, II and III) were formed where each subject was tested with one of the conditions only - 20 subjects for each experimental condition, 60 subjects in total. The subjects were assigned to one of the three groups at random.

Apparatus
All experiments were performed on five iPod touch second generation 8GB devices. They were all running version 2.2.1 of the iPod/iPhone OS. The prototype software was installed on the devices and was used for all RSVP conditions. The initial speed of the text presentation was always set to 92 wpm (assuming no punctuation), but the subjects were encouraged to set a suitable speed (by adjusting the speed multiple times until they felt it was right for them) in the training session. Altering text speed for the Standard RSVP as well as Gestural RSVP conditions was allowed at any time, also after training in the test session. The built in Apple mail reader was used for the regular text reading. The mail reader allows easy scrolling with hand stroke and zoom in and out.

Texts
The texts used were taken from the “Meitzav study” (see example in Appendix I) which is a country-wide test for Israeli students in early seventh grade testing reading comprehension.

Setting
The experiment took place in the subjects’ school in a vacant classroom. Each test session consisted of an experimenter, technical help, and five subjects from a specific group. To minimize any distractions, the test was planned so that it would not take place during school breaks. The classroom door was closed and the subjects were seated close to the experimenter with enough space between them.
Instructions
Before the experiment, each subject received instructions that pointed out that it was the reading method and not the individual performance that was being tested. All were encouraged to ask questions whenever they wanted and were told that they could terminate the experiment at any time if they felt uncomfortable. The instructions described the principal features of the employed reading method and user interface, what kind of text they were going to read, and how long it was likely to take.

Training
Each subject participated in a reading training session relative to the reading method group he was assigned to. The training, which was announced as training with no comprehension questions afterwards, included a text about the size of the test text. The experimenter and technical help answered any questions and helped the subjects with any issues related to operating and setting the prototype. There were no time constraints set and the subjects were encouraged to feel comfortable with reading and the reading speed, and reading control.

Procedure
The experiment was executed for all the subjects within normal school day hours 08:00–13:30. The children were called from their classes in a manner designed to try and avoid influence and discussions between subjects who had already done the experiment and subjects who had not yet done the experiment. The subjects received instructions from the experimenter and then performed the familiarization part which included the training. After all the subjects finished the familiarization part - no questions were left unanswered - the test experiment took place where the text and the questionnaires were performed consecutively and independently by each subject. A subject’s pace was not dependent on any other subject; each subject moved from start to finish without waiting for the other subjects.
**Questionnaires**

At the end of each experimental session, there were three questionnaires to fill in. The first was a comprehension test with twelve questions, all with four alternative multiple-choice answers. The second questionnaire was the Task Load Index (based on NASA-TLX Hart and Staveland 1988). This was administered in order to check *mental and temporal* demands, as well as *performance* level, in addition to a frustration measure question. The third questionnaire was a short multiple-choice questionnaire regarding the future viability of the reading technique the subjects experienced for reading, in general, and for learning, in particular.
**Results**

All subjects completed the experiment. There were only a few problems with understanding what had to be done or how to do it. Although RSVP was a new way of reading for all the subjects, no one had any problems using the RSVP program. In addition, although iPod Touch gestural control was new for all the subjects, understanding the mechanism and operating it was easily learned. During the familiarization, some subjects pressed the Program button which closed the application. However, after explaining and emphasizing this principal during the familiarization – no such incidents occurred with the actual test text.

In the remainder of this section, the presentation of the results is divided into five subsections: Reading Speed, Comprehension, Task Load, Frustration, and ‘Follow up’. Under each section, except the ‘follow up’, the null hypotheses were tested.

**Reading Speed**

Reading speed was calculated based on the total amount of words read in the text divided by the end time minus start time, including all interruptions (pauses, regressions, speed changes, etc.). Based on the calculation: \( \frac{262}{\text{totalTime} \div 60} \)

The reading was significantly faster for both RSVP methods as compared to the standard reading method. However, there was little difference between the two RSVP methods. The null hypothesis was not kept, but the direction of the change favors the RSVP methods.

<table>
<thead>
<tr>
<th>Reading speed</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading</td>
<td>81.83</td>
<td>15.25</td>
</tr>
<tr>
<td>RSVP</td>
<td>112.39</td>
<td>39.18</td>
</tr>
<tr>
<td>GRSVP</td>
<td>114.00</td>
<td>37.90</td>
</tr>
</tbody>
</table>

To test the null hypothesis, a differential analysis was performed between the three groups using the WPM data. A significant difference was found between the RSVP groups and the regular reading group (f=6.15 p<0.01).

<table>
<thead>
<tr>
<th>WPM</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>13136.399</td>
<td>2</td>
<td>6568.200</td>
<td>6.150</td>
<td>.004</td>
</tr>
<tr>
<td>Within Groups</td>
<td>60877.534</td>
<td>57</td>
<td>1068.027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>74013.933</td>
<td>59</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Comprehension**

Comprehension was calculated by the percentage of correctly answered multiple-choice questions in the multiple choice comprehension tests.

The null hypothesis concerning no difference in comprehension between the conditions when reading texts was kept. Both RSVP methods showed a somewhat higher level of comprehension (10%) as compared to the standard reading method. There was no
difference between the two RSVP methods. However this change is not significant enough to reject the null hypothesis (F=2.135, P=0.128).

<table>
<thead>
<tr>
<th>Comprehension</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading</td>
<td>72%</td>
<td>15%</td>
</tr>
<tr>
<td>RSVP</td>
<td>80%</td>
<td>13%</td>
</tr>
<tr>
<td>GRSVP</td>
<td>80%</td>
<td>14%</td>
</tr>
</tbody>
</table>

**Task Load**

Task load was produced by combining three task load questions (mental effort, time pressure, and performance measure). Each one was assigned a value on the scale of 1 to 9 (Likert scale). The null hypothesis concerning the task load was kept, although the standard reading method showed a somewhat lower task load with no significance (F=1.048, P=0.357). A lower standard deviation for the standard reading method shows stable results around the average while the RSVP reading methods had higher standard deviations, indicating higher fluctuations.

<table>
<thead>
<tr>
<th>Task load</th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>2.60</td>
<td>1.244</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>3.05</td>
<td>1.643</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>3.03</td>
<td>1.678</td>
</tr>
</tbody>
</table>

Graphical representation of the task load average results per groups
Frustration
The null hypothesis concerning no difference in frustration between the conditions was rejected since it became significant ($F=23.407, p\leq0.01$). Comparisons of pairs revealed that the use of the standard RSVP reading method resulted in significantly higher ($p\leq0.05$) frustration compared to using regular reading. Comparison of pairs also revealed that the use of Gestural RSVP reading had no significant difference from the standard reading method and had a significant difference from the standard RSVP reading method. The frustration level can be generalized as:

"Regular Reading" $\sim$ GRSVP $<<$ RSVP.

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>1.85</td>
<td>1.137</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>4.25</td>
<td>1.552</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>1.8</td>
<td>1.152</td>
</tr>
</tbody>
</table>

Graphical representation of the task load average – compared to Frustration results per groups

Follow up Questionnaire
This research included questions for qualitative analysis, as well as directions for future use and future research. Most of the studies on RSVP reading have been done on university students, while this study was performed by sixth grade students. This questionnaire might provide a 'peek' into the future of the device usage.
Question 3
If you had the opportunity to read text like you did today in the experiment:

1. I would read more than I read today
2. I would read the same as I read today
3. I would read less than I read today

<table>
<thead>
<tr>
<th>Group/ reply</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>50%</td>
<td>35%</td>
<td>15%</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>65%</td>
<td>30%</td>
<td>5%</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>50%</td>
<td>30%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Questions 4 and 5
How would you prefer reading books in the future (for educational purpose / for ‘fun’)

1. Like you read in standard book
2. Like you read on your personal PC
3. Like you read today in the experiment

<table>
<thead>
<tr>
<th>Group/ reply (fun)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>30%</td>
<td>15%</td>
<td>55%</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>30%</td>
<td>15%</td>
<td>55%</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>25%</td>
<td>15%</td>
<td>60%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group/ reply (educational)</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>15%</td>
<td>20%</td>
<td>65%</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>30%</td>
<td>20%</td>
<td>50%</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>25%</td>
<td>25%</td>
<td>50%</td>
</tr>
</tbody>
</table>
Questions 6 and 7

If you could choose to read texts on your PC / Mobile Phone how would it affect your reading?

1. Read much less
2. Read a little less
3. Read the same
4. Read a little more
5. Read much more

<table>
<thead>
<tr>
<th>Group / condition</th>
<th>Average Personal Computer</th>
<th>Average Mobile Phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular reading (A)</td>
<td>3.2</td>
<td>3.65</td>
</tr>
<tr>
<td>RSVP (B)</td>
<td>3.6</td>
<td>3.45</td>
</tr>
<tr>
<td>GRSVP (C)</td>
<td>3.45</td>
<td>3.7</td>
</tr>
</tbody>
</table>
Discussion

The results show a significant decrease in frustration level between the GRSVP reading and RSVP reading methods and a 50% faster reading speed for the GRSVP reading method over the standard reading method. The results also show no significance in comprehension and task load index. These results are in line with the basic assumptions for this research. The discussion is based on these findings.

Reading Speed

The reading speed for Hebrew readers (the same as English readers) is 100–200 wpm for learning and 200–300 wpm for comprehension. This corresponds to the average reading speeds in English. The lower reading speeds obtained for children in this research can be attributed to two combined reasons. The first is that the reading skills of sixth graders are still not as mature as adults. The second is the context of this research to the subjects was learning, which implies that the relevant range is 100–200. The significant differences between using the RSVP reading method and the standard reading method indicate that the RSVP reading method can improve reading speed on a mobile device; this is similar to the results reported for the RSVP reading method on desktops by Bailey, R.W. and Bailey, L.M. (1999).

In our view, the RSVP reading method is primarily a way of facilitating reading on small screens and not a way of optimizing reading in itself. However, reading in the near future may become more mobile and more prone to small screens. Children will be more exposed to small screen devices due to their lifestyle. The obtained reading speed, 50% faster is quite encouraging in view of future needs.

Comprehension

The result that no significant differences in comprehension were found is consistent with findings from previous evaluations (Joula et al. 1982; Masson 1983; Rahman and Muter 1999; Sicheritz 2000; Goldstein et al. 2001). The lack of differences shows that the GRSVP reading method at least does not affect comprehension in a negative way. Comprehension rating at the levels reported in the results (72-80%) establishes that the nature of reading have not been degraded to a high-speed low comprehension method, such as skimming (skimming in reading standard texts is faster however reports on average 50% comprehension).

Task Load

The task-load parameters (not including frustration) did not show any significant difference between the standard reading method, the RSVP reading method, and the GRSVP reading method. This is consistent with previous findings (Gustav Öquist 2001). There was, however, a non-significant lower task load average for the standard reading method as compared to the RSVP reading based methods. This may be because the standard reading method is more familiar to the subjects than the RSVP reading method. Additional training and usage with the RSVP reading method may eliminate this non-significant difference. The results on the Likert 1–9 scale (increase indicates task load growth) are on average around 3, which...
indicates a low-mid task load. These results are encouraging for general readability on small screens and mobile devices for longer texts SMS.

**Frustration**

Although research results show a significant speed increase and although there are obvious advantages in small screens (e.g. mobile phones), in our opinion, one of the key issues for the low commercial usage of the RSVP method is due, in large part, to the frustration factor. The frustration factor may be caused by the perceived lack of control over the reading process as compared to the standard reading method. The significant change in frustration was reported for small screen mobile devices in previous research (Sicheritz 2000; Goldstein et al. 2001; Gustav Öquist 2001). For the frustration factor, the significant change between the RSVP reading and GRSVP reading methods and the similarity between the GRSVP reading and standard reading methods are very important. The results indicate that the standard reading and GRSVP reading methods received low average level while the RSVP reading method reached a medium level (and significantly higher). The gestural control and training are assumed to have been formed as procedural learning, such that the executing it has low cognitive load and hence low frustration level.

**Future Use**

The common findings were that the excitement attributed to reading as done in the research, namely with a mobile device like the iPod touch was high. Fifty percent and above rated the experiment experience (with no significance between groups) better than reading texts in books or desktops. They also noted they would read more for fun and for education than they read today with the new reading methods. This result may be due to temporary enthusiasm attributed to the iPod touch device used. On the other hand, the subjects are frequent users of mobile phones and gadgets and the lack of significant differences between the groups may be a result of each subject participates only in one test condition and could not compare. In any case, this fact may suggest that mobile-device reading is very attractive to the young, dynamic generation; for young people the availability of a mobile device and its ease of use make it very attractive.

This research sets to investigate the ability of Gestural RSVP reading to make RSVP reading method widely used for small screen device.Changing life-long habit like reading might prove difficult, the ‘follow up’ questionnaire might outline that school children can adopt it willingly.
Conclusion and Future Work

The major drawback of the RSVP reading method appears to be the high frustration felt by the subjects using it. An increase in frustration is attributed to the perception that control is lost as compared to the page-like reading process. Therefore, the most important finding in this research is that frustration with the RSVP reading method can be reduced to the level of the standard reading method by using the Gestural RSVP reading method and through training.

The initial training and habit change is likely to be a nuisance for the new user, a factor which increases with age due to life habits. There might not be any reason to use the RSVP reading method when traditional text presentation can be used efficiently. In this research the GRSVP reading method was found to be just as effective as the standard reading method but GRSVP reading enabled a significantly faster reading speed. As part of the modern lifestyle, society is adopting small screen mobile devices for extensive usage. RSVP reading with the Gestural control can provide a viable method for enabling reading high volume texts and not only reading short messages (e.g. SMS).

The life-style technology is moving ahead in giant steps. However, reading failed until fairly recently to use the “new” technology effectively; there were a few unsuccessful reading appliances. Yet, now, reading devices are attracting attention and recent effective ones, such as Amazon™ Kindle™, are succeeding commercially. The combination of mobile device proliferation and the ability for reading devices to take advantage of technology (presentation, storage etc.) may become the setting for educating a new generation to read in a more efficient and economical way.

In this research a simple form of Gestural RSVP reading improved readability and decreased frustration. Future work can improve the Gestural control and the client-side can be further improved with more features such as: present images, full text mode, handling hyperlinks and more. Server-side analysis, such as adaptive text analysis, pre-parsing and lexical analysis, can be combined to create a powerful, real-life, all-types-of-texts reading device. Such an integrated approach can bring together all the recent research to enable reading for long texts (such as novels). Research of mobile adoption patterns for children, reading habits, etc. can also be extended.

The next level of gestural control can be extended to use more sophisticated mechanisms, such as eye and pupil control and automated bio-feedback mechanisms for RSVP reading control. In addition the reading device can collect reading pattern information, which can be used to improve the reading device experience for future users, and also use specific information to improve the user’s future experience.
References


Web Resources


Glossary

**RSVP (Rapid Serial Visual Presentation)** – Wide variety of approaches for text presentation where chunks of text are displayed successively.

**Saccades** – Quick, simultaneous movements of both eyes in the same direction. Initiated by eye fields in the frontal and parietal lobes of the brain, saccades serve as a mechanism for fixation, rapid eye movement.

**Reading comprehension** – Quantitative measurement of text comprehension using multiple-choice unseen questions, rated as percentage of correct answers.

**Fixations or Visual Fixation** – Maintaining the visual gaze on a particular location.

**Return sweep** – When reading text, the action of advancing to the next line of text.

**Regressions** – When reading texts, the action of going back one word or more to an already visited (fixated) text area.

**WPM (words per minute)** – Calculation based on the total amount of words read in the text divided by the end time minus start time.
Appendix

A - Implementation

The gestural RSVP prototype reader was designed for an iPhone/iPod touch type device because of the special properties this device introduces for spatial information (accelerometer).

![Figure 6: One of the Prototypes](image)

The main gestural control principles are:

**Horizontal Tilt**

Horizontal tilt is used to increase and decreases the word presentation speed. The tilt formula is: each noticeable tilt (tilt passed the ignore angle increases/decreases by the setup amount (0.5 Msec. per word was setup for this experiment)

**Vertical Tilt**

Vertical tilt based is used to “play” and “pause” the text.

![Figure 7: The iPod Touch accelerometer features used for gesture control](image)
Deployment

The iPod touch second-generation 8GB is Apple OS based. The available programming language was primarily objective C using Apple XCODE and Visual builder environments; these are currently available only for Mac OS computers. The timing in the application must be reliable due to the differences in exposure time when using gestures.

Program Design

The software design is client-based only. However, the design allows for the content to be delivered locally or remotely via a URL, thus enabling server-side processing as well.

The software design is straightforward. The main concepts are:

- Extensive Setup – Most of the gestures and variables relevant for RSVP (pause period, punctuation, letter size etc.) were not hard-coded but were set as setup parameters enabling easy change and tuning.
- Text Processing – Text-retrieval was based on the text location. Once retrieved, the text was analyzed by the client for structure, punctuation etc. At this stage, a simple full-text scan was used. However, a JIT (Just In Time) with read-ahead was part of the supported design for future additions.
- RSVP Pace Control – The RSVP pace control is central to the design. The same mechanism is re-used both for buttons on the screen and gestural control.

Graphical User Interface

The user interface is clean and simple. The words appear in the center of the screen; the pace buttons and the pause-play button are set at the bottom. Pace indication is placed in the bottom as well.

Prototype Walkthrough

General Setup

To enable quick modification, the prototype had been made so many of the relevant attributes such as the speed decrease and increase, the tilt angle effect as well as other parameters have been put in setup. This enabled rapid tuning through iterations with no code changes, as well as personal customization for the different subjects.
Choosing Text Source
The prototype software includes three possible sources for the text: embedded (used in this prototype), database and URL, after choosing a source the list of options is presented of available texts to be selected.

The Reader
A text reader with three control buttons is presented. The reader is operated horizontally to maximize width. It provides indication for the current word pace (in green below the play button) to enable some control feedback. Timer monitors the reading time and logging it on the top of the screen in red.
Figure 10: Using the reader and taking the reading time

RSVP Characteristics

The window width of the RSVP display is one word plus punctuation. The presented text is centered so no saccades are required. Font-size has been found to have a minor effect on RSVP (Russel et al. 2001). The prototype supports the two forms of RSVP that have been described in this paper. In standard RSVP and gestural RSVP modes, text chunks containing punctuation marks receive an addition of 0.3-0.4ms based on the specific setup. The following table offers a summary of the RSVP variables used by the prototype:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word pace</td>
<td>6.5MS</td>
<td>Determines the default pause between two words</td>
</tr>
<tr>
<td>Comma pause</td>
<td>0.3MS</td>
<td>On top of the word pause</td>
</tr>
<tr>
<td>Semicolon pause</td>
<td>0.4MS</td>
<td>On top of the word pause</td>
</tr>
<tr>
<td>Period pause</td>
<td>0.4MS</td>
<td>On top of the word pause</td>
</tr>
<tr>
<td>Speed rate</td>
<td>0.5MS</td>
<td>Speed change (+/-) to word pause after user increase / decrease speed</td>
</tr>
</tbody>
</table>
Gestural Characteristics

The gestural control was implemented using the iPOD touch accelerometer capabilities to detect its spatial position. The relevant gestural setup attributes are:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON/OFF</td>
<td>OFF</td>
<td>On enables gestural speed and pause/play control, Off enables only the buttons for speed and pause/play</td>
</tr>
<tr>
<td>threshold</td>
<td>0.15</td>
<td>iPod spatial movement threshold for triggering an event (translated to the proper speed pr pause/play control)</td>
</tr>
<tr>
<td>Sample rate</td>
<td>40</td>
<td>The rate at which the spatial position of the device is sampled in ms.</td>
</tr>
</tbody>
</table>
מדוע חשוב לשחק בצעצועים?

מרבית בניי האדם נוהגים בצעירותם לעסוק בפעילויות פיזיות המלוות במגננים בצעצועים. אולם: קופים צעירים רודפים זה אחר זה, גדיים נוגחים זה את זה בקרניהם, קופים צעירים רודפים זה אחר זה, גדיים נוגחים זה את זה בקרניהם, קופים צעירים רודפים זה אחר זה, גדיים נוגחים זה את זה בקרניהם, קופים צעירים רודפים זה אחר זה, גדיים נוגחים זה את זה בקרניהם.

מזהו שהילד י mudança את התנהגותו המבוקשת ויחד עם זאת י‿לך ויפהו של כל זמן ויחר אחור. זה יחד בצעצועים ישращל צעירה, ש布拉ָי מושחת על מצה לאומן על ענין ולחונך הביצועים, לעזם על היותו והרוחות של חיות שונות, שארקתיות השערת ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה השעון, והכדים את תרבות הילידים וביה ובראשה الش
A training text

Amenities and rare species of plants and animals are in danger of extinction. These species could disappear within a short time if they do not get special protection.

The International Union for Conservation of Nature monitors the number of animals from different species. The Union also publishes "Red Books" containing detailed information on rare species and endangered plants and animals, according to different levels of risk: threat of extinction, threat of extinction and threat of damage.

The number of species of plants and animals found today is much larger than ever before, because the number of people has increased. The World Conservation Society compiled a list of species that are likely to become extinct in the near future.

Many of these species are being destroyed by man. People can live in different environments. Against this, most animals can only live in a specific environment. When people change the environment in an area, plants and animals there cannot survive, and many of them die.

For example, the forests of Madagascar were cleared for agriculture, endangered the lemur and the giant forest elephant.

Sometimes people transport plants and animals to other areas without thinking about the consequences. These species could cause serious damage to plants and animals in the area. For example, New Zealanders remained only as hundreds of dried plants because they were eaten by sheep and brought to Europe.

Sometimes people's desire to get rich can lead to the destruction of all animals of a specific species. For example, the African elephant's horn, which is used to make ivory, is destroyed by the elephants. Even love for plants and animals can be harmful. For example, tortoises of the species Kakoa are sold as a delicacy, and this species is almost extinct in Indonesia. Also, rare species of snakes and carnivorous plants are disappearing from nature, due to the collection of plants.

There is a reason for concern about the species found in danger, because some of them, especially plants, contain substances that can help humans, such as new medicines. It is possible that there are still many species of plants and animals that will disappear without us knowing about it, and this could be a great loss for our world.
ל囷ך שאלון הבנה海鲜ו על התוזם הקצר שקרה.

החק ביעה את החששו היהcosa לכל החזנים הביאה.

לא ניתן לחזור למאמר.

איןębeltaב תוחור השאלון.

1. הקופים מזכרים במאמר כו: 
   א. הם חיים ליבותתחת
   ב. הם משקיקים ככר צעירות
   ג. הם חיות אלומות
   ד. הם חיות בעלות אנרגיה

2. הגדיים מזכרים במאמר כו: 
   א. הם חיות אלומות
   ב. הם דומים להתנהגותם לקופים
   ג. הם מחקים בהתנהגותם את המבוגרים
   ד. הם יונקים

3. לפי המאמר משקיקים שוכבים כו: 
   א. הם מרביעים זמני
   ב. הם מעמידים עד לטרום בועית
   ג. הם מלקחים ידניות כיתות
   ד. אף תשובה אינה נכונה

4. השערת החוקריה найוה: 
   א. שבטי ליימ משקיקים כדי להירגע
   ב. שבטי ליימ משקיקים כדי להרגים חופשיים
   ג. שבטי ליימ משקיקים כדי להתקין למתקים בועית
   ד. אף תשובה אינה נכונה

5. התשובה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגמה המגма

6. על מי난יעה הגוזים? 
   א. קר על קופים
   ב. קר על ליימ
   ג. קר על בולע חיות
   ד. גז על בולע חיות עב על ליימ

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הבעיה שהוצגה לילדים היא: 
א. לבנות מקל
ב. למיצר מקל ארוך
ג. לה.TODO
ד. להביש שני מקלות קצרים ולקבל מקל ארוך

8. הבנה המילונית של הLineStyle קבוצת כ.
א. היי הרובsolid
ב. חלוקתサイト לפני بنין בנות לבנות מעורבות
ג. לכל קבוצה מלי אתחום אראים לינו
ד. אם תשובות איננה נכוניות

9. הבנה המילונית של השיטה על הילידים הפתרון היא: 
א. חלוקת שני מקלות קצרים בין קבל מקל ארוך
ב. למיצר מקל ארוך
ג. חפש מקלות באורכים שונים
ד. ליי הנחה מצגת מוזיקה שינה

01. הקבוצת הילידים ששיקקה לפני בין קבלות הוכיחה את: 
א. בגדה המשתק מצ gratuitement הבין
ב. המשתק שימו אוסף
ג. בגדה המשתק רצ פתרון את הבעיה
ד. המשתק את האון פתרון את

11. התוכנת הילידים השארה להז את שדר הפתרון היה: 
א. האצלות מיך
ב. רציו אוד להצלות
ג. האצלות שיקפיו את ריב
ד. נס פתרון ביד שנייה שארית להז

21. המסקנה שנבעה מהמיסה היא: 
א. לא שמשתוק הרבד משטחנעמ
ב. לא שמשתוק הרבד מיתיש
ג. לא שמשתוק הרבד למד מששטוק ולא להז
ד. לא שמשתוק הרבד למד והזנה
C2 – Task Load

قبل הגעת לשאלות vocêخطر בכל השעון המڊorda, בכל השעון הבא יישלים

קריאת המאמר דרשה ממני מאמץ Başkan

[Diagram]

מאמץ גבוה
מאמץ בינוני
מאמץ בול

مبחרת לחום, בדחלק קריאת המאמר

[Diagram]

לחות כלכל
לחות
לא היה
גייס
גיאז
מואז

איך אתה מעורר עינית על השאלות?

[Diagram]

כל השעון
לא נמצוא

짜ר את רמת התוכן של בדחלק קריאת המאמר

[Diagram]

לא היו
מואז
גייס
גיאז
לחות כלכל
לחות
C3 – Follow up

הף בוגלו את התשובה ואתה מת德拉/תה בוחר ביחס לשאלת

דע כמה אתה Kıאır ספרי 'בשכלי חכמ'?
1. אני Kıאır כל שבוע.
2. אני Kıאır פעמיים בשבוע.
3. אני Kıאır פעמיים בשבועיות.
4. אני לא Kıאır ספרי.

דע כמה אתה Kıאır ספרי 'عبر הלימודים'?
1. אני Kıאır כל שבוע.
2. אני Kıאır פעמיים בשבוע.
3. אני Kıאır פעמיים בשבועיות.
4. אני לא Kıאır ספרי.

אלו היהتك לאפישואת קיאır ספרי באוק ובקראת קיאר'הית קיאר:
1. יחרמת שתאני Kıאır hoje.
2. באחרא מידיה הב אפי Kıאır hoje.
3. פוחתת מתמה שתאני Kıאır hoje.

בדאיה אופו' קיאר' מעדיח קיאır בפדי ספרי 'בשכלי חכמ'?
1. כממי קיאארים בפxEE ראלי.
2. כממי קיאארים במחשש איסי.
3. כממי קיאארים'ים בין נימי.

בדאיה אופו' קיאר' מעדיח קיאır בפדי ספרי 'عبر הלימודים'?
1. כממי קיאארים בפxEE ראלי.
2. כממי קיאארים'ים במחשש איסי.
3. כממי קיאארים'ים בין נימי.

נניה שטיאית יול Kıאır חומר על ביב המסק של המחשבעיתשות שולק. זה היה גורם לקיאר:
1. ערב Hạתחת מתמה שתאני Kıאır hoje.
2. פוחתת מתמה שתאני Kıאır hoje.
3. באחרא מידיה הב אפי Kıאır hoje.
4. יחרמת שתאני Kıאır hoje.
5. ערב יחרמת שתאני Kıאır hoje.
נניח שהיית יכול לקרוא חומר כתוב על גבי המסך של הטלפון הנייד שלך, כפי שניטע בה Maverick של Apple.

והיה זה הגורם ש Jaguars קורא יותר מה שאני קורא היום.

1. הוכחה שה_nf למד שணי קורא היה
2. פחיתו הממדים של קורא היה
3. אקווהughtים מידי הבני קורא היה
4. יצור הממדים של קורא היה
5. הוכחה מצידה של קורא היה
The layout of reading on pages is a collection of lines in which words are arranged. This layout has developed over thousands of years.

The study aims to promote a new and non-standard method of reading, which has an advantage when used in mobile devices such as cell phones.

The advantage of reading is measured by "a pair of meters": reading speed and comprehension - in order to measure reading effectiveness accurately.

The need for a new format and additional exists due to the change in the reader's pace, it becomes more and more mobile and thanks to mobile devices, it is also connected and calculable, but mobile devices with small screens are not convenient for reading full texts (like SMS).

In addition, digital data volumes are growing and require people to deal with more texts in a more efficient and accessible manner.

The reading format examined in the study is RSVP - Rapid Serial Visual Presentation, a method of reading where a word is replaced by a new one on the screen each time, with the center of the words always fixed.

Studies in RSVP showed that it is possible to achieve a higher reading speed while maintaining a similar level of understanding.

Studies conducted on mobile devices have shown that RSVP has a significant advantage over RSVP on smaller screens, so that 'reading effectiveness' was better.

However, while digital books are already standard on the market (such as Kindle™ of Amazon™), the use of RSVP is not becoming popular or significant, although it is easy to use on devices that are now available and popular.

The use of RSVP was found in previous studies to be associated with high levels of stress, which suggests that they are the result of a low sense of control in the reader in the process.

The hypothesis of the research is that the addition of control through movement sensations will add a control method that does not require high cognitive levels.

Reducing cognitive difficulty will return a sense of control and reduce stress levels.

A study was conducted on students in elementary school in Israel. The program was supported on iPod™ Touch of Apple™ for reading via RSVP, and control was exercised through buttons or movement sensations.

Movement sensations could be programmed due to the device's motion-sensitive component. The tests were divided into three parts: normal reading on the screen of the device, reading in the middle of RSVP in a standard way through buttons, and reading via RSVP with movement control.

The results showed a significant improvement in reading speed compared to normal reading, while the understanding was similar.

In addition, the significant finding is that control via movement sensations lowers stress levels to levels similar to normal reading, which are much lower than control via RSVP.

An additional finding that parents who used this method were more likely to use mobile devices for reading, especially in schools without a library, as they are cheaper and easier to use.

Furthermore, teachers espoused the benefits of this method in mobile devices, especially for children in remote areas with sparse mobile networks.

These studies and others in this field can promote the use of RSVP for at least mobile devices, to promote the use of this method in schools, especially in those with limited financial resources and limited access to digital books due to high costs and lack of availability.

In addition, the effectiveness of the method was found to increase with age and experience, making it a valuable tool for teachers and students alike.
שליטה בقراءת מוסוג
(Rapid Serial Visual Presentation)
בעזרת תנועה

מרחכי הבינתחומי בהרצליה
בית ספר אחרון ארז למדעי המחשב

שליסר שגיא

העבודה בוצעה בהנחיית פרופסור שמעון שוקן

אוקטובר 2009