Examining Memory Retention Through Rapid Serial Visual Presentation Reading

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This study investigates the efficacy of Rapid Serial Visual Presentation (RSVP) compared to static text methods in enhancing reading comprehension. Utilizing story prompts, four participants were exposed to both RSVP and static text formats, followed by comprehension assessments. Findings suggest a significant difference in comprehension between the two methods, with static text yielding superior retention, however further study is needed due to methodological concerns. Participant feedback highlighted minor issues with screen brightness, underscoring the need for methodological refinement. This research contributes to understanding RSVP's role in education and suggests avenues for future investigation.

CCS Concepts: • **Human-centered computing** → **Displays and imagers**; **HCI theory, concepts and models**; **Empirical studies in HCI**; User interface programming; Graphical user interfaces; **User studies**.

Additional Key Words and Phrases: reading, rapid-serial visual presentation, studying, speed reading, memory

ACM Reference Format:
Micah Eisele. 2024. Examining Memory Retention Through Rapid Serial Visual Presentation Reading. 1, 1 (May 2024), 10 pages. https://doi.org/XXXXXXX.XXXXXXX

1 INTRODUCTION

A very large aspect (especially when you get higher up) in education are readings. Typically, at least for colleges, each week a reading is assigned with the intent to supplement the lectures. However, for many, this is a rather daunting task as the process of reading itself takes a long time – with many opting to skip reading entirely leading to lower quiz scores and understanding of the material.

With this in mind, Rapid Serial Visual Presentation (RSVP) reading may be the answer many are looking for. A technique that involves flashing text on a screen, RSVP has been shown to effect reading speed in works like "Crowding and eccentricity determine reading rate" by Pelli et al. [1] where participants were asked to react to letters on a screen with their corresponding button. And it also has been shown to be an effective tool for rifling through long lists of things, like in Spence's article "Rapid, Serial and Visual: a presentation technique with potential" [2].

This study aims to explore this reading technique, but through a different avenue. Being able to read faster is nice, but retaining that information is crucial. What we attempted to find is whether or not utilizing a form of RSVP that flashes the words individually from a reading significantly affects the reader's understanding of the text in their working memory. Our experiment, which was carried out via four participants, found that the trade-off did indeed exist but the small sample size combined with the small question pool leads room for further inquiry.

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2 RELATED WORKS

2.1 Reading Rate Improvement Quantified

There have already been other experiments that have explored RSVP reading. Rubin and Turano's article, "Reading Without Saccadic Eye Movements" [3], measured the reading rates of people using RSVP versus not using RSVP and found that their reading rates improved on average between 2 and 4-fold.

2.2 Trade-off Using Sentence-based RSVP

Of course, there have been studies that explored whether there is a significant trade-off between speed and accuracy using RSVP. "So Much to Read, So Little Time: How Do We Read, and Can Speed Reading Help?" by Rayner et al. [4] provides a comprehensive overview of a multitude of studies that have tested whether or not this trade-off exists in speed reading methods in general (with a particular focus in RSVP reading), theorizing that this trade-off does indeed exist based on the information gleaned from the studies analyzed. However, in the sections where they analyzed RSVP, they examined RSVP methods that flashed either one or more sentences as opposed to singular letters.

Table 1. Prior studies that have analyzed RSVP reading versus traditional methods.

Paper	Participant Type	Modalities	Delivery Method	Software Tested	Focus/Conclusion
This paper	Naive users	Desktop Screen	Single Words	Custom	Focused on whether or not an advantage to memory retention is presented when comparing static and RSVP text reading methods. Found that static text presents an advantage.

3 METHODOLOGY

3.1 Prompts.

Story prompts were generated using ChatGPT to ensure impartiality and eliminate bias in prompt creation. Each prompt was specifically designed to be comprehensible to the majority of English-speaking adults, requiring no prior knowledge or experience. The prompts were presented in both RSVP and static text formats to compare comprehension and reading speed between the two conditions.

3.2 Participants.

Four native English-speaking individuals, aged between 21 to 59, were recruited for this experiment. Participants had familiarity with desktop computers. However, in order to prevent any possible legacy bias from occurring, none of the participants chosen had familiarity with RSVP reading methods.

3.3 Apparatus.

A computer program created for this experiment was utilized to present the story prompts and record participant responses. The program automatically centered the text on the screen, which was displayed on a high-resolution monitor with a resolution of 2560×1440 pixels. Participants used a mouse for input. Before each section, participants received a welcome message shown in Figure 1 and Figure 2 explaining the task (reading a prompt with RSVP or a static method and being quizzed on it after) and underwent a three-second countdown after confirming their readiness. Text was displayed using a white background and black sans-serif font. This is to keep in line with recommendations for a high-contrast background and font for readability from the study, "The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention," by Hall and Hanna [5] and recommendations for sans-serif

font to improve readability from the study, "Letter and symbol misrecognition in highly legible typefaces for general, children, dyslexic, visually impaired and ageing readers," by Thomas Bohm [6]. Scores were recorded in a text document automatically indicating participant number and their responses and were not provided to participants to prevent potential bias in their feedback.

Fig. 1. The welcome screen for the RSVP text prompt.

Fig. 2. The welcome screen for the static text prompt.

3.4 Procedure.

Volunteer participants were first briefed on the experiment's procedures. They were then presented with two story prompts of similar difficulty, each assigned to one presentation format: RSVP or static text. For the RSVP section, the text was presented at a speed of 400 words per minute (WPM), maintaining consistency with the low-end of average reading speed increases observed in previous studies (2-fold). For the static text section, participants were given the same prompt but were allotted double the time it would take to assuming a reading rate of 200 WPM chosen on the low-side of the range using the meta-analysis written by Marc Brysbaert, "How many words do we read per minute? A review and meta-analysis of reading rate" [7].

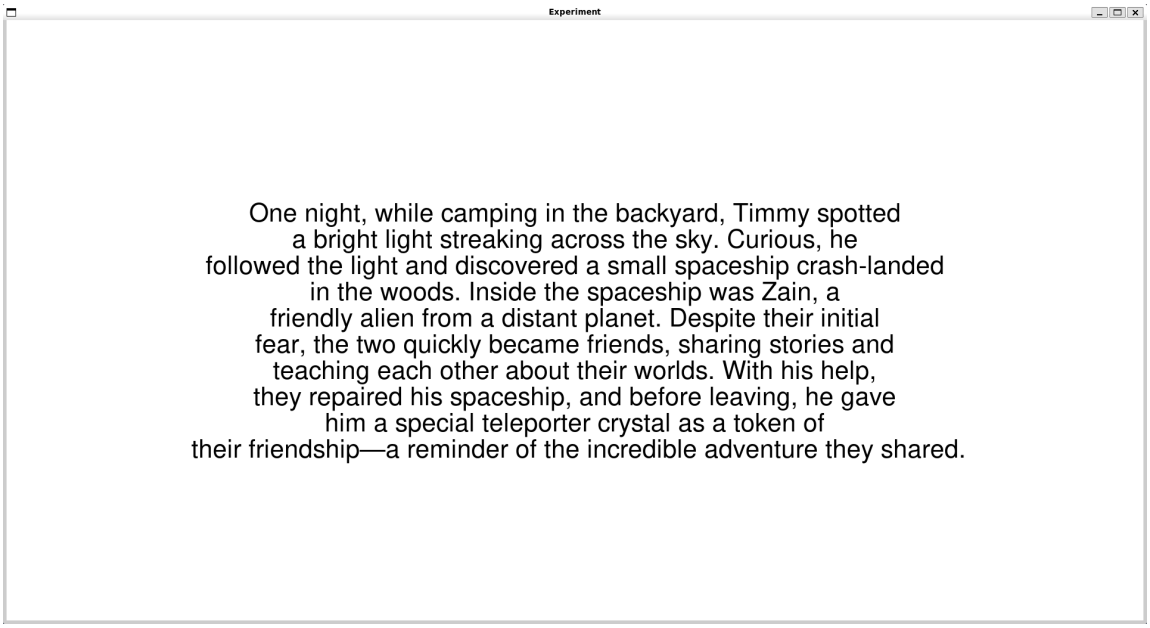

Fig. 3. The static prompt displayed.

After each section, participants completed a three-question multiple-choice quiz assessing their comprehension of the prompt. Participant responses were recorded electronically by the computer program. Feedback was obtained from participants regarding any difficulties encountered during the task.

Fig. 4. An example of a question asked.

3.5 Design.

The experiment followed a 1×2 within-subjects design. Participants were scored on a scale of 0 to 3 depending on the number of correct responses for each presentation method. Data collected from participant responses was analyzed to compare comprehension between the RSVP and static text conditions. The total number of trials was 4 participants $\times$ 1 story prompt $\times$ 2 presentation methods = 8.

4 RESULTS

4.1 Test Scores.

The mean combined score for both sections is a score of 4.5 out of 6 or 75%. The mean score for the RSVP quiz section was 1.75 out of 3 with a standard deviation of 0.75. The static reading method presented an increase of about 33.33% with a mean score of 2.75 out of 3 and a standard deviation of 0.25.

Using these numbers, we can perform a t-test to determine statistical significance. The formula for a t-test is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \tag{1}$$

where:

t : The calculated t-statistic

$\bar{x}_1, \bar{x}_2$: The means of the two groups

s_1, s_2 : The standard deviations of the two groups

n_1, n_2 : The sample sizes of the two groups

From this, we can calculate that the t-statistic is -2.53. Using the standard alpha value of 0.05, the critical t-value for a degrees of freedom equaling 6 is about 2.447 according to the table in Figure 6. Since the absolute value of -2.53 is greater-than 2.447, we reject the null and conclude there is indeed a statistically significant difference between the two methods.

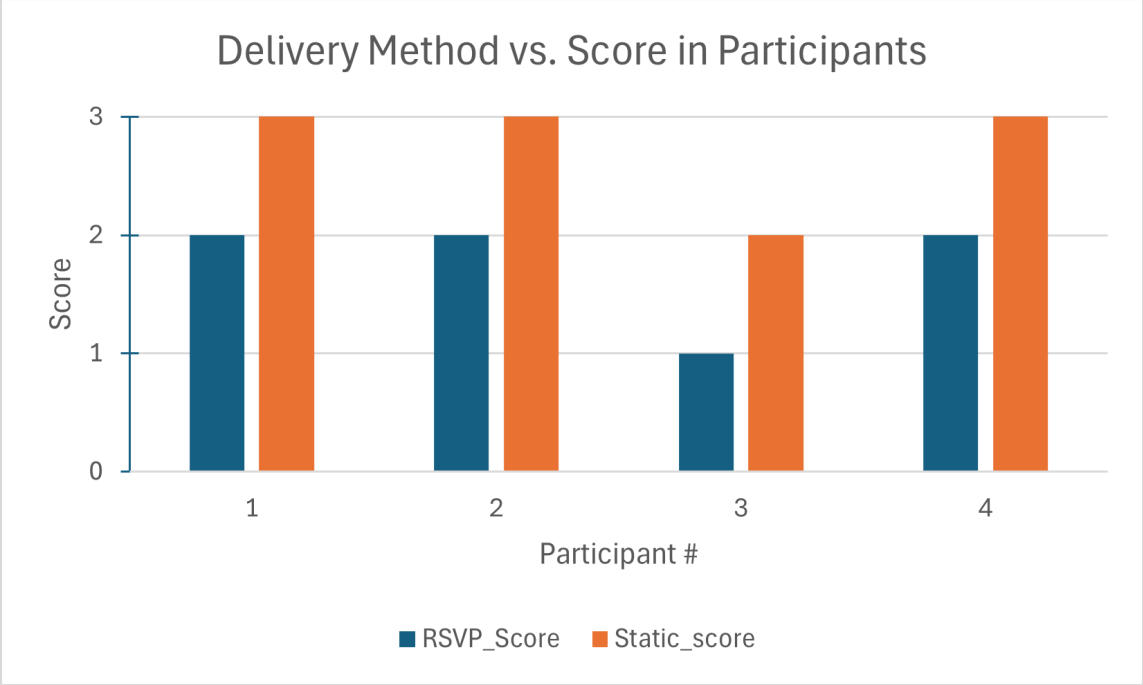

Fig. 5. Delivery method versus score.

t Table

cum. prob	$t_{.50}$	$t_{.75}$	$t_{.80}$	$t_{.85}$	$t_{.90}$	$t_{.95}$	$t_{.975}$	$t_{.99}$	$t_{.995}$	$t_{.999}$	$t_{.9995}$
one-tail	0.50	0.25	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.001	0.0005
two-tails	1.00	0.50	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.002	0.001
df											
1	0.000	1.000	1.376	1.963	3.078	6.314	12.71	31.82	63.66	318.31	636.62
2	0.000	0.816	1.061	1.386	1.886	2.920	4.303	6.965	9.925	22.327	31.599
3	0.000	0.765	0.978	1.250	1.638	2.353	3.182	4.541	5.841	10.215	12.924
4	0.000	0.741	0.941	1.190	1.533	2.132	2.776	3.747	4.604	7.173	8.610
5	0.000	0.727	0.920	1.156	1.476	2.015	2.571	3.365	4.032	5.893	6.869
6	0.000	0.718	0.906	1.134	1.440	1.943	2.447	3.143	3.707	5.208	5.959
7	0.000	0.711	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.785	5.408
8	0.000	0.706	0.889	1.108	1.397	1.860	2.306	2.896	3.355	4.501	5.041
9	0.000	0.703	0.883	1.100	1.383	1.833	2.262	2.821	3.250	4.297	4.781
10	0.000	0.700	0.879	1.093	1.372	1.812	2.228	2.764	3.169	4.144	4.587
11	0.000	0.697	0.876	1.088	1.363	1.796	2.201	2.718	3.106	4.025	4.437
12	0.000	0.695	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.930	4.318
13	0.000	0.694	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.852	4.221
14	0.000	0.692	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.787	4.140
15	0.000	0.691	0.866	1.074	1.341	1.753	2.131	2.602	2.947	3.733	4.073
16	0.000	0.690	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.686	4.015
17	0.000	0.689	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.646	3.965
18	0.000	0.688	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.610	3.922
19	0.000	0.688	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.579	3.883
20	0.000	0.687	0.860	1.064	1.325	1.725	2.086	2.528	2.845	3.552	3.850
21	0.000	0.686	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.527	3.819
22	0.000	0.686	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.505	3.792
23	0.000	0.685	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.485	3.768
24	0.000	0.685	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.467	3.745
25	0.000	0.684	0.856	1.058	1.316	1.708	2.060	2.485	2.787	3.450	3.725
26	0.000	0.684	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.435	3.707
27	0.000	0.684	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.421	3.690
28	0.000	0.683	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.408	3.674
29	0.000	0.683	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.396	3.659
30	0.000	0.683	0.854	1.055	1.310	1.697	2.042	2.457	2.750	3.385	3.646
40	0.000	0.681	0.851	1.050	1.303	1.684	2.021	2.423	2.704	3.307	3.551
60	0.000	0.679	0.848	1.045	1.296	1.671	2.000	2.390	2.660	3.232	3.460
80	0.000	0.678	0.846	1.043	1.292	1.664	1.990	2.374	2.639	3.195	3.416
100	0.000	0.677	0.845	1.042	1.290	1.660	1.984	2.364	2.626	3.174	3.390
1000	0.000	0.675	0.842	1.037	1.282	1.646	1.962	2.330	2.581	3.098	3.300
z	0.000	0.674	0.842	1.036	1.282	1.645	1.960	2.326	2.576	3.090	3.291
	0%	50%	60%	70%	80%	90%	95%	98%	99%	99.8%	99.9%
	Confidence Level										

Fig. 6. T-table used. Table taken from San Jose State University, via web. (https://www.sjsu.edu/faculty/gerstman/StatPrimer/t-table.pdf).

4.2 Participant Feedback.

All participants reported no issues aside from one participant who reported that the white background caused some mild discomfort due to the brightness. Considering that both prompts were presented on the same background, it is safe to assume that this most likely had little-to-no bearing on the results.

4.3 Discussion and Limitations.

From the results gathered, there was indeed a difference found between the memory retention of participants when contrasting RSVP and static text delivery methods. Reader's memory retention tended to suffer when attempting to retrieve from a prompt read using RSVP. However, the sample size of four participants combined with the small question pool poses problems in terms of scalability.

5 CONCLUSION AND FUTURE WORK

This study aimed to determine whether or not there posed a significant difference in memory retention for RSVP and static reading methods. What was found was that there was indeed a significant difference and that the static-based reading method was superior to the RSVP-based reading method, which falls in line with other similar studies conducted. However, due to the limitations of the methodology (see §4.3), more study is needed. That being said, the results can provide a good basis for future investigations. And the feedback provided (see §4.2) can allow for improvements on the methodology used by providing an option to lower screen brightness.

Interestingly enough, in terms of score, the question that had the most true responses for the RSVP section was the question asking what the main character's name was despite it only appearing once at the beginning of the prompt — with three participants guessing it correctly as shown in Figure 7. Now, for the static section, the only question that got a wrong response was the one asking, "What were their initial emotions upon meeting?" Despite this question appearing at the beginning much like the previous question as well, it presented itself as the worst score-wise for the opposite section as shown in Figure 8, putting them on equal footing in terms of location. So, perhaps individuals have an easier time retaining names as opposed to other forms of information? A further study into this could be conducted by examining this phenomenon.

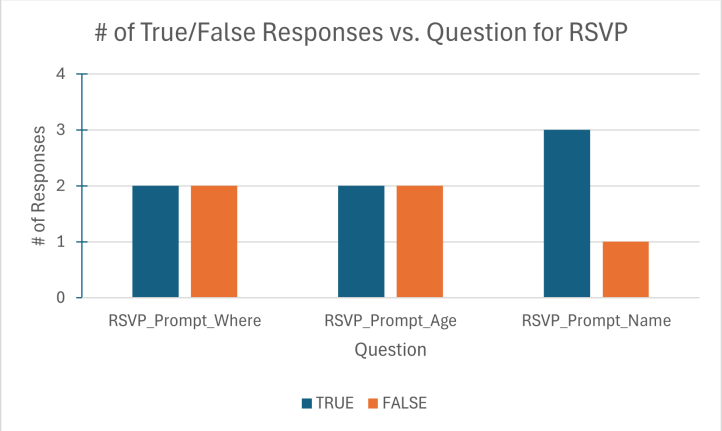

Fig. 7. Responses versus score for the RSVP section.

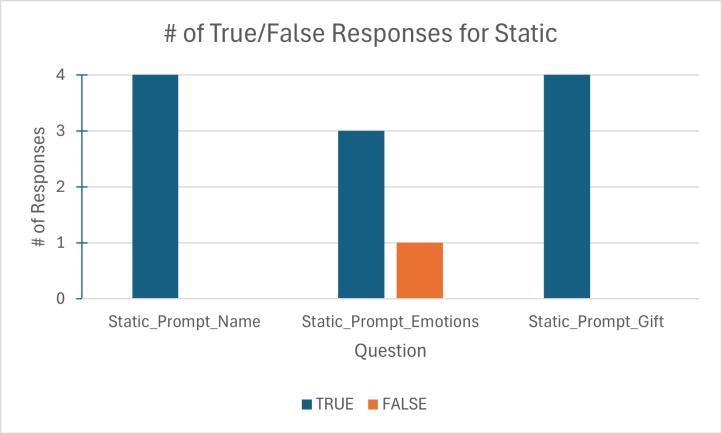

Fig. 8. Responses versus score for the static section.

6 REFERENCES

(1) Denis G. Pelli, Katharine A. Tillman, Jeremy Freeman, Michael Su, Tracey D. Berger, and Najib J. Majaj. "Crowding and eccentricity determine reading rate." Journal of Vision, 7(2):Oct, 2007. DOI: 10.1167/7.2.20. URL: https://doi.org/10.1167/7.2.20.

(2) Robert Spence. "Rapid, Serial and Visual: A Presentation Technique with Potential." Information Visualization, 1(1):Mar, 2002. DOI: 10.1057/palgrave.ivs.9500008. URL: https://doi.org/10.1057/palgrave.ivs.9500008.

(3) Gary S. Rubin and Kathleen Turano. "Reading without saccadic eye movements." Vision Research, 32(5):May, 1991, pages 895-902. DOI: 10.1016/0042-6989(92)90032-E. URL: https://doi.org/10.1016/0042-6989(92)90032-E.

(4) Rayner, K., Schotter, E. R., Masson, M. E. J., Potter, M. C., and Treiman, R. "So Much to Read, So Little Time: How Do We Read, and Can Speed Reading Help?" Psychological Science in the Public Interest, 17(1):Jan, 2016, pages 4-34. DOI: 10.1177/1529100615623267. URL: https://doi.org/10.1177/1529100615623267.

(5) Marc Brysbaert. "How many words do we read per minute? A review and meta-analysis of reading rate." Journal of Memory and Language, 109:Dec, 2019. DOI: 10.1016/j.jml.2019.104047. URL: https://doi.org/10.1016/j.jml.2019.104047.

(6) Richard Hall and Patrick Hanna. "The impact of web page text-background colour combinations on readability, retention, aesthetics and behavioural intention." Behaviour & Information Technology, 23(3):Jun, 2004, pages 183-195. DOI: 10.1080/01449290410001669932. URL: https://doi.org/10.1080/01449290410001669932.

(7) Thomas Bohm. "Letter and symbol misrecognition in highly legible typefaces for general, children, dyslexic, visually impaired and ageing readers." Information Design Journal, Dec 2014. DOI: 10.1075/idj.21.1.05boh. URL: https://doi.org/10.1075/idj.21.1.05boh.

(8) Acklin D and Papesh MH. "Modern Speed-Reading Apps Do Not Foster Reading Comprehension." Am J Psychol, 2017, pages 183-199. DOI: 10.5406/amerjpsyc.130.2.0183. URL: https://doi.org/10.5406/amerjpsyc.130.2.0183.

(9) Chung STL and Bernard JB. "Bolder print does not increase reading speed in people with central vision loss." Vision Res, Dec 2018, pages 98-104. DOI: 10.1016/j.visres.2018.10.012. URL: http://doi.acm.org/10.1016/j.visres.2018.10.012.

(10) Fine EM and Peli E. "Benefits of rapid serial visual presentation (RSVP) over scrolled text vary with letter size." Optom Vis Sci, 75(3):Mar, 1998. DOI: 10.1097/00006324-199803000-00024. URL: https://doi.org/10.1097/00006324-199803000-00024.