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RAPID SERIAL VISUAL PRESENTATION (RSVP) TECHNIQUE ANALYSIS FOR YOUNG ADULT'S STRENGTH MEMORY

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ABSTRACT

This study examines the impact of various process parameters of Rapid Serial Visual Presentation (RSVP) on the memory capacity of young adults. It employs a thorough experimental methodology and statistical analysis to identify the ideal interval time and word count that result in the highest memory retention. The study employs rigorous experimental design and analysis techniques, such as factorial plots, contour plots, and response surface regression, to identify meaningful connections between interval times, word counts, and memory performance. These findings underscore the significance of optimizing these parameters to improve cognitive processing and memory retention. The results indicate that achieving an optimal balance between the speed at which information is presented and the amount of information provided is essential for enhancing memory effectiveness. These findings offer significant guidance for designing memory training programs and educational technologies that are specifically customized to the cognitive characteristics of young adults. This study enhances our comprehension of memory processes in young individuals and provides practical suggestions for implementing RSVP techniques in strategies to enhance memory. It emphasizes the importance of future research concentrating on personalized RSVP protocols and their practical applications in enhancing memory.

1.0 Introduction

Memory serves as a fundamental aspect of daily life, crucial for tasks ranging from remembering one's name to making plans and recalling appointments, particularly for young adults aged 20-29 [1]. This age group primarily relies on short-term memory to navigate the dynamic and exploratory nature of their cognitive processes, amidst a stable population of 15 to 64-year-olds at 94% from 2024 to 2030. The significance of memory extends to cognitive development and health, with early engagement in activities like reading linked to enhanced cognitive performance [2]. Moreover, memory plays a pivotal role in quality of life, influencing education, career opportunities, and social interactions [3].

Advancements in technology have introduced methods such as fMRI, PET, EEG, and MEG for brain and memory studies, though challenges like cost and complexity remain [4]. Rapid Serial Visual Presentation (RSVP) emerges as a promising technique for memory analysis, yet its optimization for young adults presents challenges due to variable reading speeds and technological literacy [5]. Despite these hurdles, RSVP's potential for simpler and more accessible memory analysis is underexplored.

This research aims to harness RSVP for analyzing young adults' memory strength, focusing on designing experiments with varying parameters, investigating memory capabilities, and determining optimal parameters through statistical analysis. Targeting individuals aged 18 to 25, the study explores the impact of variables like word count and interval timing on memory strength, measured through accuracy and reaction times. By addressing these aims, the research seeks to enhance understanding and application of RSVP in memory studies, contributing to the broader field of cognitive science and quality of life enhancement [5](Xu et al., 2018; Lees et al., 2020).

2.0 Research Methodology

This chapter details the methodology used to explore the effects of Rapid Serial Visual Presentation (RSVP) on memory capacity, particularly focusing on young individuals. Through a structured simulation, we aim to identify optimal RSVP parameters, utilizing a flowchart to guide the experiment's steps for clarity and efficiency. The PsychoPy software is instrumental in designing and executing the experiment, allowing for precise control over variables and the collection of meaningful data on memory performance.

The RSVP experiment methodology involves a series of steps, beginning with selecting appropriate parameters for memory assessment, followed by the creation and execution of the experiment using PsychoPy. Participant recruitment is conducted with criteria ensuring suitability for the study's objectives. The experiment tests RSVP's effectiveness on a group of young adults, analysing the data to find the best RSVP settings for enhancing memory. The final stage involves developing a model based on the Response Surface Methodology (RSM), a sophisticated approach for analysing the effects of various variables on outcomes, aimed at Improving memory capacity in young adult memory.

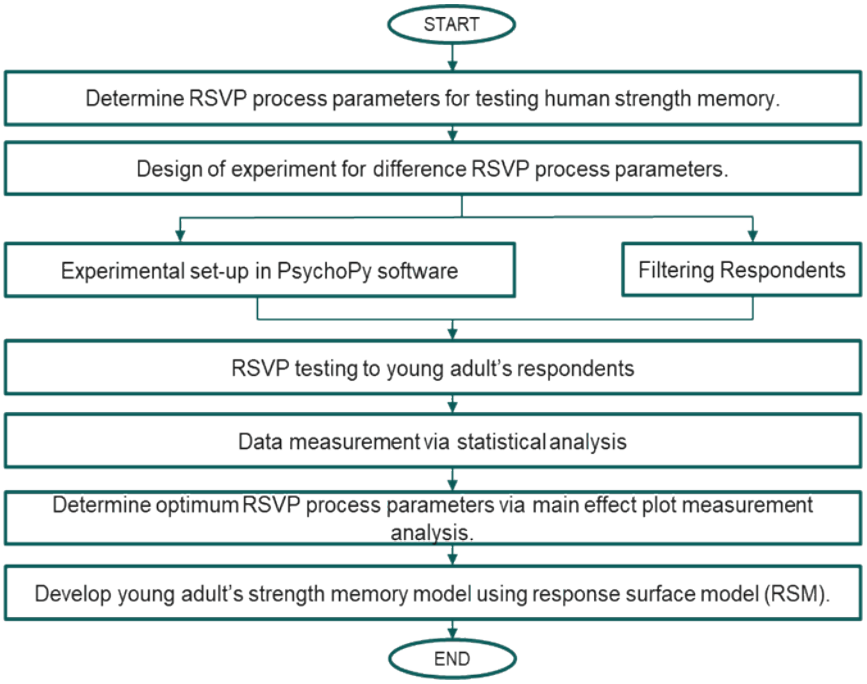

Figure 1: Flow Chart of Project

2.1 Experimental Setup

The experiment will use a laptop, and participants will be briefed beforehand and seated comfortably. According to Burgess–Limerick et al. (1999), to prevent neck discomfort, it's important for users to view the screen easily without straining. An ergonomic setup is shown in Figure 3.3, emphasizing proper posture and monitor placement to lessen physical stress. The chair height can adjust from 43 to 57 cm, allowing users to rest their feet flat on the floor with their thighs parallel to it, ensuring a stable and comfortable position. The monitor should be around 70 cm away from the eyes, with the top tilted at a 30-degree angle and positioned 18 degrees below eye level. This arrangement aims to reduce eye and neck strain, maintaining focus and reducing fatigue during extended computer use.

Such an ergonomic setup is particularly beneficial for Rapid Serial Visual Presentation (RSVP) studies, where participants quickly read and understand screen-displayed information. By reducing the need for eye readjustments and minimizing neck and back discomfort, it helps participants focus better on the RSVP task. Adjusting the display to avoid glare and reflections is key to improving visual clarity for the fast reading and cognitive processing RSVP tests require. Thus, an ergonomic environment can significantly enhance performance in tasks demanding sustained eye concentration and quick information processing.

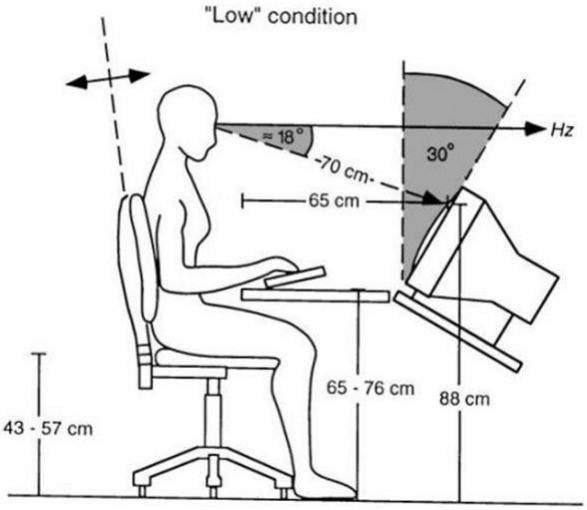

Figure 2: Low monitor condition [6]

2.2 Filtering Respondents

In the study, 15 young adults aged 18 to 25 with good physical health and fluency in Bahasa Malaysia were selected to focus on their short-term memory capabilities. The criteria aimed to minimize variables like age-related cognitive changes and health issues that could affect cognitive performance. Additionally, participants needed normal colour vision for the experiment's colour-based tasks, ensuring consistent sensory perception among all subjects.

2.3 Design of Experiments

This study uses a full factorial design to explore how the number of words (2, 4, 6) and interval times (0.1, 0.2, 0.3 seconds) affect participants' answer accuracy and response times. By combining each word count with every interval, the experiment creates 9 different scenarios, resulting in a detailed analysis of how these variables interact and impact performance. To ensure reliability, each scenario will be repeated ten times per participant, leading to a total of 1350 trials across 15 participants. This approach allows for a thorough examination of the effects and interactions between word count and interval time on the participants' cognitive responses.

Table 1. Design of Experiments Variables.

No	Factor	Level			Output
1	Number of Words	2	4	6	Accuracy of the answer
2	Interval Time (s)	0.1	0.2	0.3	Respond Time(s)

In this memory experiment using the Rapid Serial Visual Presentation (RSVP) method, a list of words will be prepared in Microsoft Excel and then imported into PsychoPy-2022.2.5 for randomization to minimize biases. Participants will be exposed to word sets of 2, 4, or 6 words, with each set size being tested 10 times to assess memory abilities in young people effectively. All words used have exactly four letters, ensuring consistency across trials.

Table 2: List of Words.

List of Words		
RAYA	UBAT	LADA
JIWA	BUKU	IKAN
NAMA	BAPA	HAJI
KUDA	ASAM	DURI
SUSU	TALI	GIGI
KUKU	BATU	HARI
KAKI	AWAN	SUDU
MATA	RATU	CITA
JARI	HATI	AYAM
MUKA	BOLA	LAUT

In this memory experiment, participants will see words flash quickly one after the other, with each word appearing for the same brief duration. They will then be tested on their ability to remember or recognize these words. Varying the number of words and using randomization helps examine memory retention under time constraints. For accurate results, clear instructions, precise data recording, and consistent use of PsychoPy for randomization are essential. The experiment's design also considers the display duration of words and intervals between them, as these factors are key to understanding the RSVP memory test outcomes.

2.4 PsychoPy Simulation

In this experiment, the routine is divided into two parts, which is target and respond. Target which words the respondent needs to remember and the response part is for the answer that will collect data accuracy and reaction time.

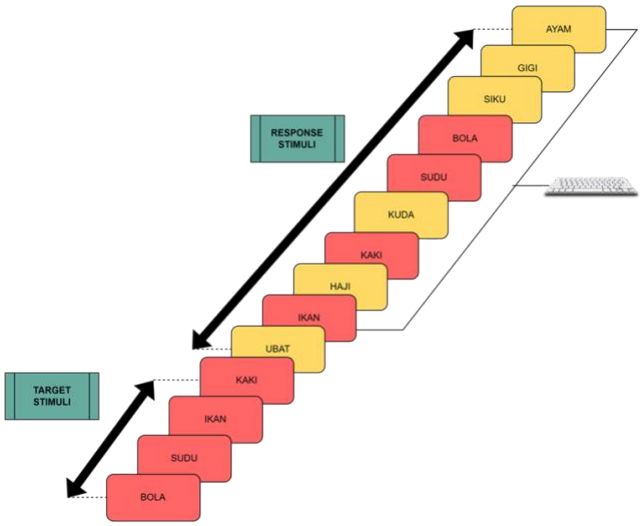

Figure 3: Illustration of preview in respondent screen.

This experiment tests the immediate memory and cognitive abilities of young people by quickly presenting them with information. It aims to understand how accurately and quickly participants can identify words and how such rapid presentation affects their cognitive load. The study could lead to insights into young adults' memory capacity and cognitive processing, with further exploration possible into the effects of word traits or distractions. The experiment uses a simple response setup with three keyboard keys: the number 1 key for correct matches, the number 0 key for incorrect matches, and the space bar to indicate readiness for the next word. This setup ensures easy participation and straightforward data analysis, making it a valuable tool for investigating cognitive functions related to rapid stimulus presentation.

The RSVP memory test for young people uses distractors during the test phase to challenge their memory retrieval by shifting their focus from the main stimuli. For instance, if two words are the targets, eight unrelated distractors are also shown, increasing the cognitive load. The number of distractors varies to maintain a total of 10 samples per condition, ensuring a consistent evaluation framework. This method helps researchers understand how memory works under different levels of distraction and cognitive load, providing valuable insights into young adults' information processing abilities in complex environments.

Table 3: Set of Distractor

No	Number of words	Interval Time (s)	Distractors
1	2	0.1	8
2	4	0.2	6
3	6	0.3	4

3.0 Result and Discussions

The results and discussion part of the study using the RSVP method to test memory in young people provides important insights into the outcomes. It looks at how factors like the number of words shown and the time between them affect memory, focusing on accuracy and how quickly people respond.

3.1 Factorial Plot

The findings in figure 4 show that increasing the time between words or the number of words can slow down response times. This suggests that more words or longer intervals make the task harder, as seen in the increased time it takes for participants to respond. The study uses graphs to illustrate how each factor (time between words and number of words) independently affects reaction time, indicating that both a faster pace of word presentation and a higher volume of information lead to challenges in processing, which is important for understanding how to improve information processing in fast-paced or information-rich environments.

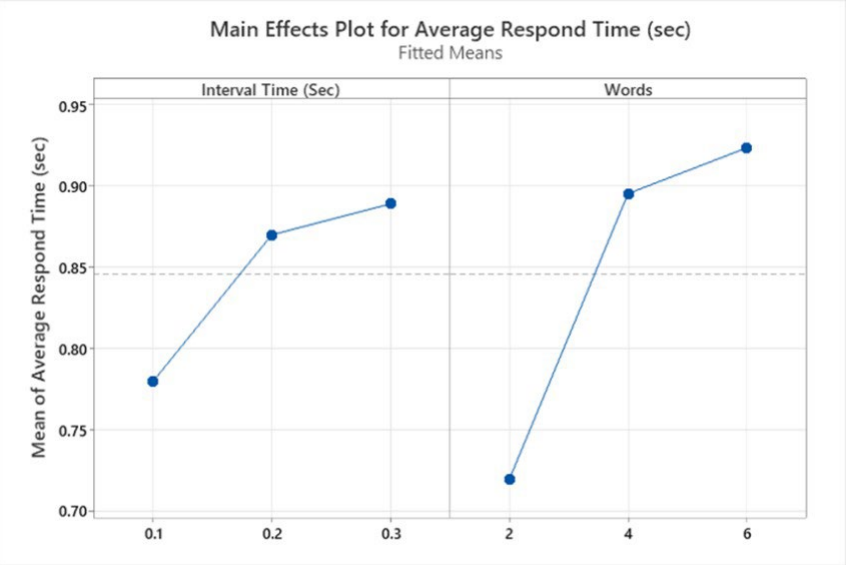

Figure 4: Main effects plot for average respond time

Figure 5 in the study on RSVP and memory strength in young people shows that the best speed for presenting words varies with the amount of information (word count). It highlights that with 4 words, reaction times don't change much with different intervals, suggesting there's an optimal rate for showing words that helps memory retention. This means presenting a moderate number of words at a steady pace could improve young people's memory by avoiding overwhelming them or not engaging them enough.

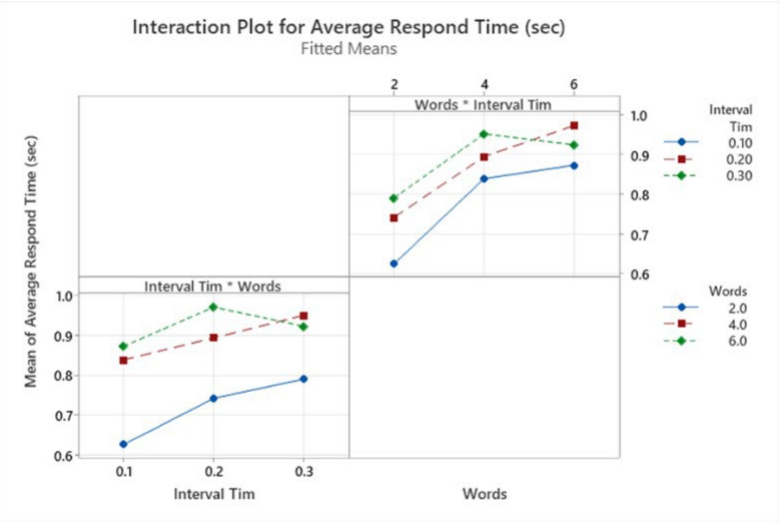

Figure 5: Interaction plot for average respond time(sec)

Figure 6 shows how different interval times and word counts affect response accuracy in an RSVP test. Accuracy improves significantly when interval time is increased from 0.1 to 0.2 seconds, then stabilizes. The best accuracy is achieved with 4 words, while using 2 or 6 words leads to lower accuracy. This suggests that a 0.2-second interval and presenting 4 words is optimal for memory recall in young people. Shorter intervals may not allow enough time for processing, and too few or too many words could cause cognitive overload or underuse of memory capacity. These insights can help design RSVP-based tools to enhance memory by adjusting presentation speed and information amount.

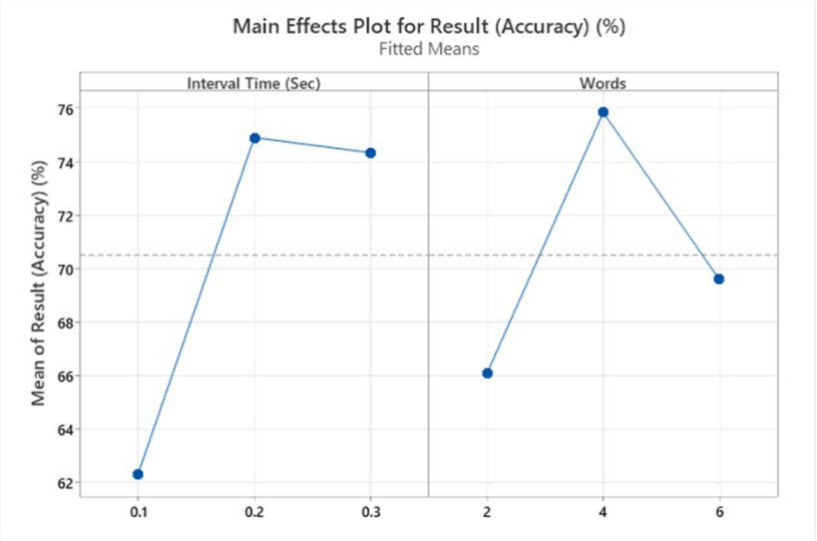

Figure 6: Main effects plot for results accuracy (%)

Figure 7 shows how different combinations of word counts and interval times affect memory accuracy in young adults using the RSVP method. The highest memory accuracy is achieved with a 0.2-second interval and 4 words, suggesting this combination is best for efficient cognitive processing. The results vary with different interval times and word counts, indicating that the optimal memory performance depends on finding the right balance between how fast

information is presented and how much information is given. This balance is key to maximizing memory retention in RSVP tasks.

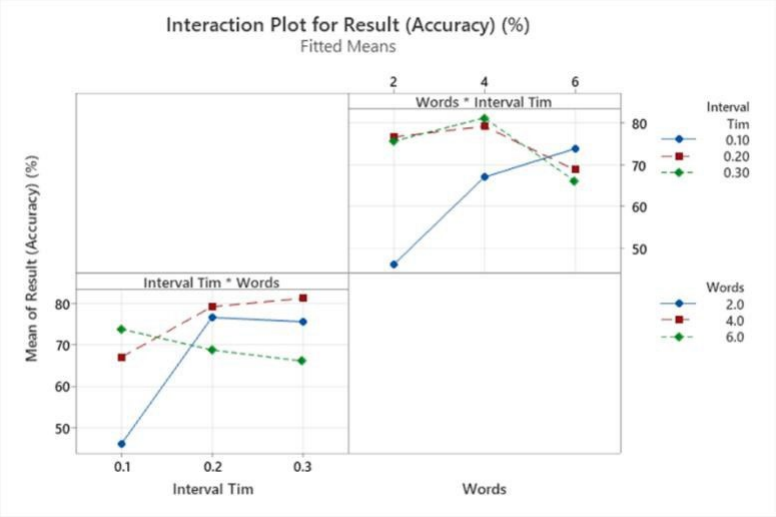

Figure 7: Interaction plot for results accuracy (%)

3.2 General Factorial Regression

The ANOVA summary in figure 8 shows that both the interval time between words and the number of words significantly influence memory strength in young people during an RSVP experiment, with very low p-values (0.000) and high F-values (13.77 for Interval Time and 90.01 for Words), highlighting the strong effect of each on memory retention. However, the interaction between these two factors doesn't significantly affect memory strength, as shown by a p-value of 0.093, indicating that adjusting them individually can improve memory without needing to find a specific combination of the two. This suggests focusing on separately tuning the time between words and the number of words for better memory performance in RSVP tasks.

Analysis of Variance for Transformed Response

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	7.4935	0.93669	26.78	0.000
Linear	4	7.2738	1.81845	52.00	0.000
Interval Time (Sec)	2	0.9631	0.48155	13.77	0.000
Words	2	6.2952	3.14759	90.01	0.000
2-Way Interactions	4	0.2795	0.06987	2.00	0.093
Interval Time (Sec)*Words	4	0.2795	0.06987	2.00	0.093
Error	1317	46.0569	0.03497		
Total	1325	53.5504			

Figure 8: General factorial regression (Average respond time(s) vs Interval time(s), words)

Figure 9 presents an ANOVA summary showing the significant impact of various factors on memory capacity in young people using the RSVP method. The model, including linear components, interval time, words, and their interactions, is highly significant with p-values of 0.000, indicating their relevance in explaining memory variability. Both interval time (F-value: 73.75) and words (F-value: 35.95) significantly influence memory performance, emphasizing the importance of stimulus frequency and information quantity. Additionally, the interaction between interval time and words (F-value: 54.65) is also significant, highlighting the combined effect of these factors on memory strength.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	132230	16528.8	55.13	0.000
Linear	4	65432	16357.9	54.56	0.000
Interval Time (Sec)	2	44218	22108.9	73.75	0.000
Words	2	21552	10776.1	35.95	0.000
2-Way Interactions	4	65534	16383.4	54.65	0.000
Interval Time (Sec)*Words	4	65534	16383.4	54.65	0.000
Error	1317	394821	299.8		
Total	1325	527051			

Figure 9: General factorial regression (result accuracy % vs Interval time(s), words)

3.3 Respond Surface

Figure 10 presents an ANOVA summary for a response surface regression analysis in a study using the RSVP technique to evaluate memory strength in young adults. The model is highly significant, with interval time showing a particularly strong impact on memory performance. This underscores the importance of the duration between word presentations in memory recall. While words also influence memory, their impact is slightly less pronounced compared to interval time. The significant interaction between interval time and words highlights the combined effect of presentation speed and quantity on memory function. This emphasizes the need to carefully adjust both factors to enhance memory retention effectively, crucial for designing successful RSVP-based training or learning programs.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	14.173	2.83460	16.95	0.000
Linear	2	11.856	5.92789	35.44	0.000
Interval Time (Sec)	1	2.651	2.65051	15.84	0.000
Words	1	9.091	9.09100	54.35	0.000
Square	2	1.984	0.99220	5.93	0.003
Interval Time (Sec)*Interval Time (Sec)	1	0.366	0.36605	2.19	0.139
Words*Words	1	1.619	1.61870	9.68	0.002
2-Way Interaction	1	0.497	0.49670	2.97	0.085
Interval Time (Sec)*Words	1	0.497	0.49670	2.97	0.085
Error	1320	220.807	0.16728		
Lack-of-Fit	3	0.269	0.08979	0.54	0.658
Pure Error	1317	220.537	0.16745		
Total	1325	234.979			

Figure 10: Response surface regression (Result Accuracy % vs Interval time(s), words.

Figure 11 presents an ANOVA summary for a response surface regression analysis conducted as part of a study utilizing the Rapid Serial Visual Presentation (RSVP) approach to examine memory strength in young adults. The ANOVA table assesses the significance of the different components of the model, excluding the squared terms.

The model's relevance is clearly demonstrated by a p-value of 0.000, suggesting a robust correlation between the parameters examined and the memory strength. Both Interval Time and Words are highly influential predictors of memory performance, as indicated by their respective F-values of 15.84 and 54.35. This suggests that the timing of word presentations and the quantity of words presented play a critical role in determining the effectiveness of memory recall. The p-value for the interaction between Interval Time and Words is 0.085, indicating a slight trend towards significance. This suggests that the effect of one factor may vary depending on the level of the other factor. However, it is important to note that this interaction is not statistically significant at the conventional 0.05 level.

Regarding RSVP approaches for improving memory capacity in young people, these results emphasize the significance of optimizing both the duration between word presentations and the quantity of words. Although the relationship between these two parameters is not definitively significant, the p-value that is near to being significant indicates that the exact combination of interval time and word count may still have an impact on memory performance. Therefore, in order to optimize memory training by RSVP, it would be advantageous to modify the rate of information delivery and the quantity of information in order to determine the most efficient approach for enhancing memory retention.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	14.173	2.83460	16.95	0.000
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Pure Error	1317	220.537	0.16745		
Total	1325	234.979			

Figure 11: Response surface regression (Average respond time vs Interval time(s), words

3.4 Contour Plot

Figure 12 shows a contour plot illustrating the relationship between average response time (in seconds), the number of words displayed, and the interval time between presentations in an RSVP experiment. The x-axis represents interval times ranging from 0.12 to 0.28 seconds, while the y-axis represents word count ranging from 2 to 6. Darker shades of blue indicate shorter response times, while darker shades of green indicate longer response times.

The data suggests that shorter response times are associated with longer interval times and fewer words, while longer response times are linked to shorter intervals and more words. This

implies that a fast pace and high information load can slow reaction times, likely due to cognitive overload. For optimizing memory function in young people using RSVP, finding a balance between presentation speed and information quantity is crucial. Reducing the number of words and increasing interval duration can improve memory retention by allowing sufficient cognitive processing time and reducing the risk of overload.

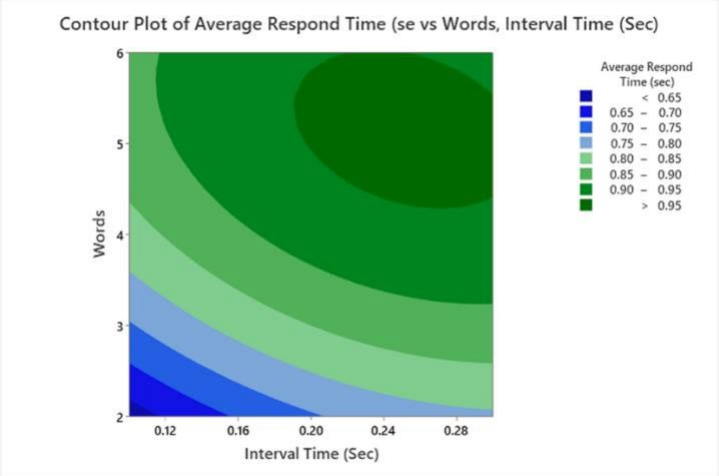

Figure 12: Contour Plot of Average Response Time (se vs Words, Interval time)

Figure 13 is a contour plot showing the relationship between accuracy percentage, word count, and interval time in an RSVP scenario. The x-axis represents interval time (0.12 to 0.28 seconds), and the y-axis represents word count (2 to 6). Darker shades of blue indicate lower accuracy, while darker shades of green indicate higher accuracy.The plot reveals that higher accuracy levels are typically achieved within specific ranges of word counts and interval times. For example, accuracy levels above 80% are concentrated within a certain interval period and around a word count of 4. Lower accuracy percentages are observed with shorter interval times and larger word counts. This suggests that both the amount of information (word count) and the time allotted for processing (interval time) are crucial for optimal memory recall in young adults. Insufficient spacing or excessive word density can lead to reduced memory accuracy, emphasizing the need for balance to maximize memory potency using the RSVP approach.

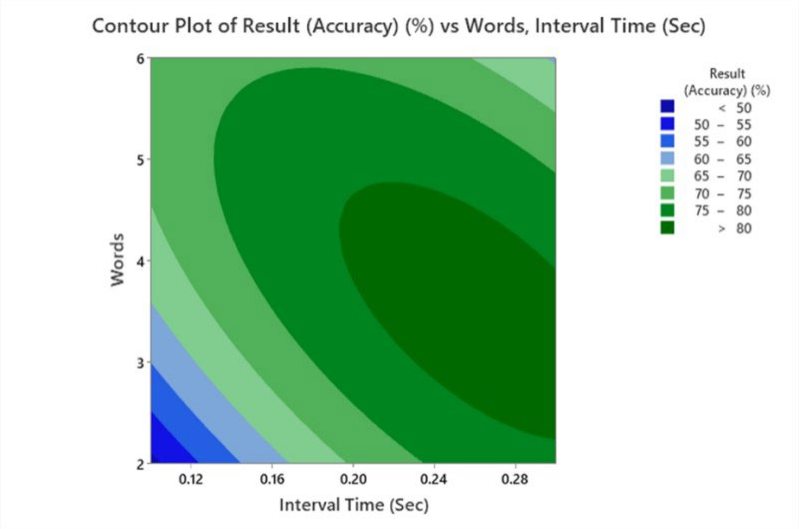

Figure 13: Contour Plot of Result Accuracy% vs Words, Interval time)

3.5 Discussions

The main effects plot shows an optimal 0.2-second interval for short-term memory encoding, with diminishing returns beyond. Decreased accuracy with six words highlights short-term memory constraints. Longer processing times do not always improve accuracy, indicating a threshold. Contour plots reveal increased cognitive burden with more words, emphasizing the need to manage cognitive load. Optimal memory performance involves a balance between interval time and word count. Shorter intervals and excessive word count challenge processing capabilities, emphasizing balanced task design.

4.0 Conclusion

The trials systematically analysed how RSVP process parameters like interval time and word count impact young people's memory capacity. Through statistical methods such as contour plots and main effects plots, we uncovered the intricate relationship between these factors and memory performance. This empirical approach provided valuable insights into the cognitive challenges young people face when processing rapidly presented information, contributing significantly to our understanding of memory processes in this population. The statistical analyses identified optimal RSVP parameters for evaluating memory strength and offer practical guidance for developing memory training programs aimed at improving memory effectiveness in young individuals.

5.0 Acknowledgement

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