SERIAL POSITION EFFECT: A CASE STUDY AMONG PRIMARY SCHOOL STUDENTS

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Abstract. The serial position effect is an important phenomenon in student learning whereby learners tend to remember information at the beginning and end of a list than those at the middle. More empirical studies are needed to ascertain whether this phenomenon is applicable and true for all learners. This case study aims to examine whether Primary 1 students at a Primary school experience the serial position effect phenomenon when recalling lists of English words. For this purpose, five Primary 1 students from a primary school in Ipoh, Perak, Malaysia were selected for this case study. In the experiment, three sets of English word lists (with 14 words for each list) were used as the main instrument for the data collection in the memory recalling process. The experiment was conducted following five steps as determined by the researcher. The findings revealed that the participants demonstrated the primary and middle effects, partially in contrast with the standard serial position effect theory. The present study has ascertained that the serial position effect theory is not fully true and applicable for the subjects of this study. This case study has some pedagogical implications to teachers, and recommendations for future research were proposed.
Keywords: *Serial Position Effect, short term memory, long term memory, primary, recency*

Introduction

Information processing model compares human memory to computers. This is because our mind works like a thinking device where raw of information is converted into ideas, memories, and cognitions (McLeod, 2024). Human working memory is crucial as it recalls information while improving our intelligence. Hence, a curiosity existed among psychologists about how cognitive abilities work, especially in remembering information. Herman Ebbinghaus discovered a cognitive phenomenon called the Serial Position Effect (SPE) in the late 19th century that enables us to understand how information in a sequence affects memory patterns. This effect manifests through two distinct patterns: the primacy effect, where items at the beginning of a list are more frequently remembered, and the recency effect, where items at the end are also better recalled than those in the middle (Azizian and Polich, 2007). Observed in both explicit and implicit memory tasks, this pattern highlights the fundamental role of the SPE in our memory processes and information retrieval (Raanaas and Magnussen, 2006).

Several studies indicate that the SPEs are well known for examining memory in tasks such as free recall, serial recall, recognition memory, and implicit memory (Mack et al., 2017). Therefore, this theory offers a fundamental understanding of the cognitive process involved whereby information received by the sensory register is retrieved by short-term memory before ending up in long-term memory. Understanding the SPE has important practical implications in various aspects of our everyday life, from learning

and education to marketing and advertising. For instance, educators can use this knowledge to structure their lessons, prepare suitable teaching and learning materials, and placing crucial information at the beginning or end of a session to enhance learners' retention. Although numerous studies have been conducted on SPE, most of the studies involved young adults (Hoffmann and Hosch,, 2023; Giovannelli et al., 2022; Lee et al., 2019; Azizian and Polich, 2007). Limited studies have been conducted to ascertain the consistency of this theory among young learners. In view of this, this case study aims to examine whether Primary 1 students experience the Serial Position effect phenomenon when recalling lists of selected English words.

Literature review

Serial Position Effect, a fundamental phenomenon in psychology, refers to the impact of an item's position within a list on an individual's recall ability (Glanzer and Cunitz, 1966; Waugh and Norman, 1965; Murdock Jr, 1962). Ebbinghaus (1913) found that the accuracy of recall tends to vary dependant on the position of the word on the list. Murdock Jr (1962) validates this through an experiment on free recall of a list of words. He let his subjects learn a list of 10 to 40 words and immediate free recall of those words. The result showed that his participants tended to remember the words in the early list (primacy effect) and the end of the list (recency effect occurs when given 40 words), and they mostly forgot the words in the middle parts. Murdock points out that the early list is usually stored information in long-term memory (LTM) because people have time to rehearse the words while the end list is stored in short-term memory (STM) as the information will be removed in a short time. However, the words in the middle are neither stored in LTM nor STM because these words are held too long in STM but too short for LTM which ends up being forgotten by the brain. In recent years, numerous research has been conducted on the effects and relationships of varied independent variables or factors such as memory strategies, literacy and schooling, cognitive ability, the order information is retrieved, neurological diseases, environment, tasks demand, information retrieval sequence, learning strategies, time, etc. with the SPE. Van Dijck et al. (2020) contends that memory strategies are developed early and refined through literacy in preliterate children. Supporting this, Kolinsky et al. (2020) found that literacy and schooling profoundly influence the progression and sophistication of verbal serial-order short-term memory, reflecting a direct correlation between educational attainment and memory development. Additionally, Roe et al. (2024) who investigate memory strategies in young and older adults revealed that older adults faced challenges in certain memory tasks, and they employed effective prioritisation strategies for more valuable information. This adaptability suggests compensatory mechanisms in response to age-related memory changes, showing the dynamic nature of memory across the human lifespan.

Past studies have also revealed the direct influence of participants' cognitive ability on serial position effect. Logan (2021) claims that serial order phenomena in various cognitive domains might be governed by a single underlying mechanism. Hence, Bai et al. (2021) specifically examine how divergent thinking intersects with memory's serial order effect in children. They ascertain that children's originality in thinking not only draws upon their divergent thinking skills but also taps into executive functions, which orchestrate the retrieval and mental manipulation of memories. On a different note, Kowialiewski et al. (2021) employ a computational model to explore if the sequence in which participants remember words stems from the way words are activated in their

brains. The model confirms that connections between related words enhance memory, but it is less successful in predicting the specific order in which people recall information. Besides, word production effect is also impacting the serial position effect. Evidently, words we say out loud are not uniformly recalled better than those read in silence; rather, their memorability varies depending on their position in a list, with spoken words recalled more effectively from the end (Gionet et al., 2022). Recently, Shafaghat Ardebili et al. (2024) confirm that the all-or-none retrieval phenomenon is rare when encountering words just once but is more likely when recalling familiar word chunks. This indicates that this kind of retrieval depends on how information is initially learned and organized. SPE can also be affected by neurological diseases which can lead to individuals' cognitive decline. Weitzner and Calamia (2020) review reveals that both subjects with mild cognitive impairments (MCI) and Alzheimer's disease (AD) demonstrate similar patterns of reduced primacy and intact recency effects. Additionally, tasks demand, information retrieval sequence, and learning strategies also affect SPE. Bireta et al. (2018) verify the presence of both primacy and recency effects in implicit memory tasks, as well as underlying principles of memory retrieval. This concludes that serial positions are not specified to one memory system but have also been found in all systems. This is supported by Roe et al. (2024) who demonstrate that prioritisation within working memory can extend to the tactile domain, proving that learners' attention can be strategically directed within memory sequences based on task demands. However, Liu and Caplan (2020) reveal that recall is more influenced by the order in which information is retrieved rather than its initial sequence. Furthermore, Murphy et al. (2022) prove that learners adjust their learning strategies based on the serial position when studying under fixed conditions, and this can be optimised for better recall.

The physical environment is another important influencing factor of the serial position effect. Santoro et al. (2023) discover that spatial contexts disrupt the typical U-shaped curve of recall, suggesting that the physical environment can significantly affect memory. Besides, dim lighting significantly affects the primacy effect and diminishes the retrieval of middle items, but the recency effect is more noticeable in bright conditions, but less so in slightly bright light (Lee et al., 2019). Subsequently, Koo et al. (2021) studied the effect of noise from the environment and working memory capacity effects on the SPE. They found that the subjects with high working memory capacity in a quiet environment performed the least SPE while the subjects with low working memory capacity in a noisy environment performed the most significant SPE. Nevertheless, Koo et al. (2021) found that noise inference negatively affects recall performance, with poorer recall percentages for four-talker babbling noise compared to silent conditions. These changes were not statistically significant. Evidently, time is also an influencing factor. Murphy et al. (2022) study showed a reduction of the SPE when the students recalled the information within the time list planned by themselves than set by their researchers. Therefore, they believed that the SPE can be controlled if time is planned wisely. However, Lewandowsky et al. (2004) disagreed with the statement of time as they claimed actions that occurred during recall determine the memory. Their study showed no significant differences in results between the short-term memory in time-based and event-based models for recalling words, and this proves that time does not affect short-term memory when there is a specific event or action that happens during the recall. This is supported by Brown et al. (1981) experiments that examine the children's primacy and recency effects in probe-type pictorial memory tasks. They

found that older children including preschoolers were able to code temporal order along with the correct picture and position. This research proves the spatial effect reduced the SPE because children can link the pictorial items with the corresponding temporal order. This supports that a specific event or action affects memory more than time because the visual items used act as stimuli that stimulate the children's senses in memorising. In relation to this, Sahan et al. (2022) explore the role of eye movements and spatial attention in serial position effects, especially in the retrieval of items in working memory. They discovered that beginning items are recalled with leftward eye movements and ending items with rightward eye movements.

The past studies above revealed that there are numerous factors or variables that can affect the serial position effect phenomenon which range from literacy to environment factors. The findings on the occurrence of SPE also varies depending on the magnitude of influence of the variables employed in these studies. Evidently, many past findings on SPE have not been conclusive and consistent with Murdock (1962) and Ebbinghaus (1913). In view of this, more empirical studies are required to ascertain the consistency of this SPE theory across different contexts, participants, and variables.

Materials and Methods

This study employs a one-shot case study design whereby data is collected from a single group at a specific point in time. This is employed based on its suitability for gathering information about a particular phenomenon (Dawidowicz, 2011). In the present study's context, the SPE is the phenomenon being studied and five subjects were experimented by undergoing three sets of word recalls. Five Primary 1 students were involved in the memory recall experiment. They were two males and three females of 7 years old. These students were randomly chosen from one of the primary schools in Ipoh, the capital city of Perak, Malaysia. To maintain the confidentiality of the participants, a pseudonym was assigned to each of them, and the name of the primary school is kept anonymous. The participants were designated as Subject K, Subject L, and Subject M, Subject N, and Subject O correspondingly. One trained English teacher at the school volunteered as a research assistant to conduct the experiment following the steps given by the researchers. The teacher has a qualification in Bachelor of Education (TESL) with more than five years of teaching experience. The research instruments for this case study include three sets of word lists which consist of 14 words per list (*Table 1*). Besides that, an answer sheet and a scoresheet for the memory recall are also provided for the data collection process.

Table 1. *Word list.*

No.	Word list 1	No.	Word list 2	No.	Word list 3
1	bat	1	cup	1	thunder
2	umbrella	2	king	2	cat
3	telephone	3	paper	3	mug
4	dog	4	snow	4	shirt
5	chair	5	table	5	fork
6	ruler	6	cow	6	pipe
7	fire	7	baseball	7	pen
8	pencil	8	shoe	8	rug
9	ashtray	9	book	9	piano
10	horse	10	clock	10	tree

11	queen	11	daisy	11	goat
12	spoon	12	fence	12	rain
13	flower	13	eraser	13	barn
14	scissors	14	vase	14	bowl
	(Go!)		(Go!)		(Go!)

All five Primary 1 students took part in this psychological experiment that tested their ability to remember lists of English words. There are three sets of English word list as shown in *Table 1* (each consists of 14 words) for this experiment. The teacher began by reading the instructions. Next, the students listened to the teacher reading a list of 14 English words. The students should write down as many words in the answer sheet that they could recall when the teacher said, "Go." They must write down the words in the right sequence: the first word must be written in the space next to number 1 and the last word must be written in the blank next to number 14. The order in which they wrote the words down was up to them, for instance, they might start with the first or final word in the list. There are five steps in this process as listed below: (1) Request the first student to take a seat at a desk in a relaxed writing position; (2) Respond to any queries the student may have before the experiment begin. If necessary, the teacher may provide the instruction again; (3) When the student is prepared, read the words from word list 1, then tell him to "Go" and write down as many words as he/she can recall; (4) The steps 1-3 will be repeated for word lists 2 and 3; (5) Steps 1-4 should be repeated with the other four students.

Since the subjects of the experiment are young children, their headmaster and parents were briefed about the purpose of the experiment and signed a consent form to allow them to participate in the experiment. Besides, the participants' particulars were kept confidential and anonymous. The English teacher was also briefed about the purpose and details of the research procedures and required to sign a consent form of participation in the research. The data analysis was conducted immediately after the experiment was completed. There are five steps for this data analysis as listed: (1) Checking Responses. The answer sheet is utilised for this purpose. Each subject's responses will be analysed by checking them with the original English word lists. A response is considered correct if the subject recalls the words correctly as provided in the lists. If a respondent misspells a word or leaves a blank, it will be marked with "X" to indicate an error. (2) Recording Correct Responses. Designate at the right-hand column on each subject's answer sheet the total number of accurate responses for each of the fourteen serial locations in the word lists. For example, if a subject correctly recalls the first word on Lists 1 and 2 but misses the first word on List 3, enter "2" in the space corresponding to that subject's serial position 1. (3) Inserting the Data. The scoresheet is used to record the students' scores. This scoresheet table is created to organise the data systematically, with columns denoting serial positions (1 through 14) and rows for each subject. Insert the number of correct responses obtained by each participant for each serial position. (4) Totalling up the Correct Responses. In the same scoresheet table, total up the number of correct answers for each serial position by adding the values from all three subjects. The maximum number of accurate responses for each word is 15 (5 subjects x 3 lists). Then, SPSS version 27.0 was used to compute the raw data, and the statistical analysis was generated in the form of a line graph. (5) Analysis of the Serial Position Curve. Compare the generated curve with the idealised serial position curve and determine whether the present data resembles the expected

curve. Analyse whether there are any similarities and differences between the observed and standard curves and report the analysis results.

Results and Discussion

The experiment was conducted following the data collection procedures as explained above. All five students took their turns to participate in the experiment. *Table 2* shows the students' overall scores. The data obtained was computed into SPSS version 27.0 for the data analysis results and the line graph (*Figure 1*) was generated. Finally, the current curve as depicted in *Figure 1* was compared with *Figure 2* that shows the idealised SPE curve. *Figure 1* shows the serial position curve of the present study that was obtained from the subjects' words recalled scores. The total number of correct responses was measured based on the correct answers obtained by each of the participants. The graph reveals that there were two effects of the present study which were the primacy effect and the middle effect. In the primacy effect, the scores were high for list of words between 1 and 4 with scores between 10 and 5 showing that they tended to remember the information at the beginning of the list. Besides, the participants also tended to remember better the middle words as the scores increased again at the middle between word lists 5 and 9 with scores between 3 and 6. However, the recency effect between word lists 10 and 14 was very weak as the highest score was for word list 14 with 4 total correct answers only while other scores remained at 3, and item 12 with only 1 correct answer. The current curve (*Figure 1*) is partially different from the idealised serial position curve in *Figure 2*. This case study reveals that the participants showed the primary and middle effects while there was almost no recency effect.

Table 2. *The students' scores*.

Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14
SK	1	1	0	0	0	1	2	2	0	1	0	0	0	0
SL	3	2	0	0	0	1	1	0	0	0	0	0	1	0
SM	2	1	2	3	1	2	2	1	1	1	3	0	0	1
SN	2	1	0	1	1	0	1	0	2	1	0	0	0	2
SO	2	3	3	2	0	0	0	1	0	0	0	1	2	1
Total	10	8	5	6	2	4	6	4	3	3	3	1	3	4

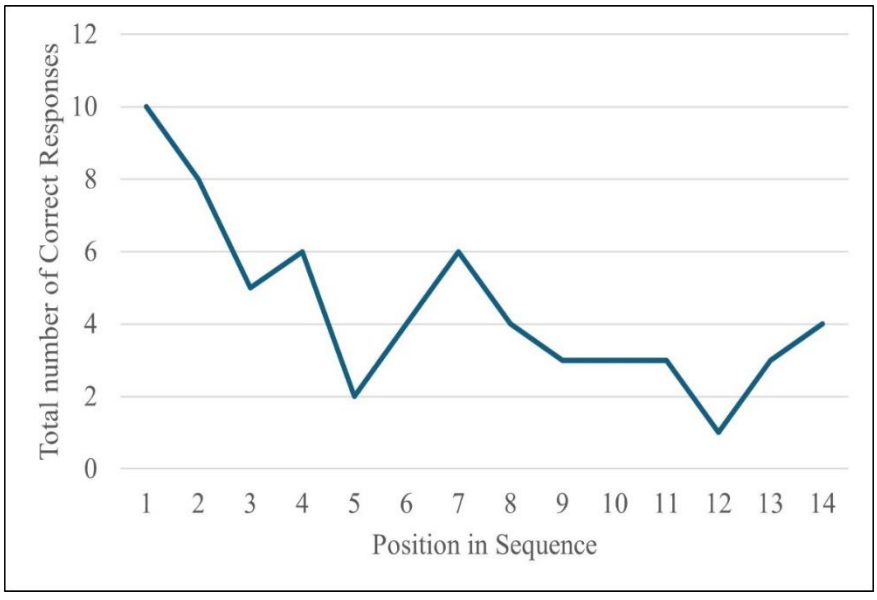

Figure 1. *The serial position curve of the present study.*

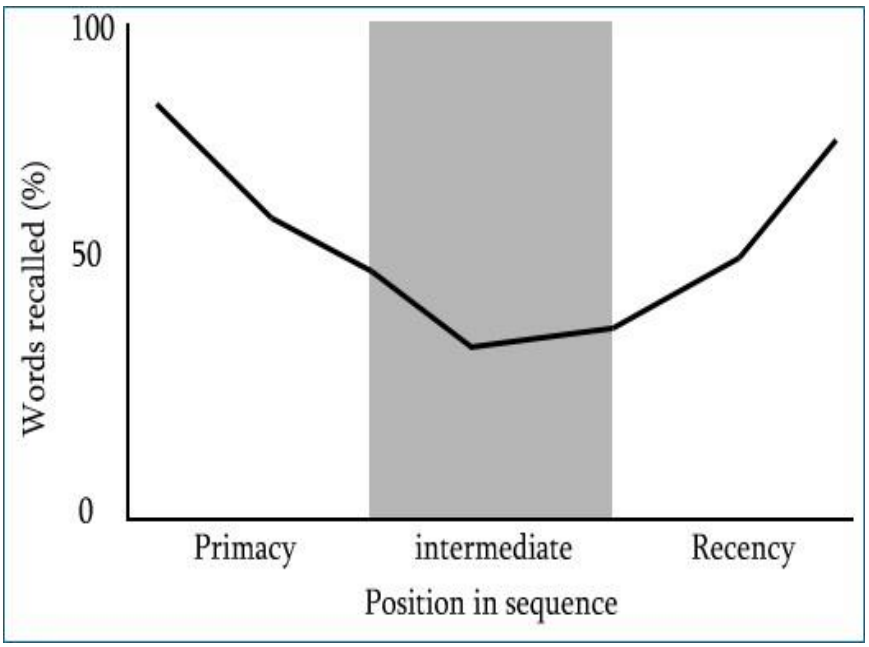

Figure 2. *Serial position effect curve.*
Source: Murdock (1962).

This case study aims to examine whether the Primary 1 students at a primary school in Ipoh, Perak, experience the SPE phenomenon when recalling lists of selected English words. The result of the experiment revealed that the standard SPE by Ebbinghaus (1913) does not truly and fully applicable to these young learners. They were more likely to remember the words at the beginning and the middle of the lists than words at the end of the lists. This is a new finding which is partly conflicting with the normal belief based on the SPE theory by Ebbinghaus (1913). This finding is also partially in contrast with many past findings (Koo et al., 2021; Lee et al., 2019; Bireta et al., 2018; Murdock, 1962) that support the SPE theory. Evidently, the present finding is partially conflicting with Murdock (1962) study of SPE which stated that children mostly remembered words at the beginning and end of word lists. Nevertheless, the present finding does replicate part of Murdock's SPE as it still shows the same primacy effect whereby the participants tend to remember words at the beginning of the lists than after them. In contrast, the present finding reveals that the participants also tend to remember the middle words in the lists better than words at the end of the lists. Thus, this opposes Murdock's finding that words in the middle tend to be forgotten as this information is neither stored in short-term nor long-term memory. Besides, the present finding is also partially in conflict with the finding by Bireta et al. (2018) who found the presence of both primacy and recency effects in implicit memory tasks. Like the finding by Murdock (1962), the results of this present study cannot be generalised across different age groups or learners of different levels of education.

The present finding revealed that children remembered the first and middle items but not the last. This shows that all the children faced short-term memory problems as they tend to forget the last items at the end of the lists. This occurs most probably due to cognitive overload whereby the learners' working memory is overwhelmed with too much information (Gerjets et al., 2009), unable to store and retrieve it. Teachers do

often introduce children to a large amount of new information as they engage in a new lesson and try to squeeze this information to children and ask them to absorb it. However, too much information is overwhelming for their brains to encode, which causes them to choose only to remember, for instance some keywords rather than lengthy information. When the short-term memory is overloaded, learners will not be able to understand, get confused, unable to encode the content taught effectively in the long-term memory, and this slowed down the learning process (Martin, 2016). Thus, it can be concluded that the SPE is not a foolproof predictor to determine what will be recalled and forgotten by students in a lesson. However, the findings of the present study cannot be generalised to a larger population as it involved only a small sample. Furthermore, past studies revealed that there are many other factors that can affect learners' memory recall. It can be influenced by literacy and schooling Kolinsky et al. (2020), the order in which information is retrieved rather than its initial sequence (Liu and Caplan, 2020), word production effect (Gionet et al., 2022), how information is initially learned and organised (Shafaghat Ardebili et al., 2024), learners' study techniques (Murphy et al., 2022), the physical environment (Santoro et al., 2023; Koo et al., 2021), the lighting conditions (Lee et al., 2019), time (Murphy et al., 2022), actions that occurred during recall (Lewandowsky et al., 2004), etc.

Based on the above discussion, it can be inferred that the SPE is not a stereotype phenomenon. The present finding has proven that the SPE phenomenon is not fully applicable to the young learners who were involved in this study. This showcases the complexity and versatility of human memory, entwining cognitive development, cognition, environment, and numerous other factors. This finding also shows that our memory is not static but has a dynamic ability that adapts to different demands which determine how we retain and retrieve information.

Pedagogical implications

The present study leaves some important pedagogical implications especially for teachers. First, in view of the important of the short-term and long-term memory, educators should carefully plan the arrangement of information by limiting the amount of information to be presented to students per lesson. According to the SPE, information delivered in the middle of a series interferes with learners' memory. However, this is not always true for all learners as evidence in the present finding. To arrange information in a way that will be most effective for recall, educators must be aware of the serial positioning effects on children to ensure that only essential ideas, concepts, or significant information are covered at the beginning, middle, and end of their lessons. Second, educators must play their essential roles in planning and implementing effective teaching strategies for their lesson in the classroom. Thus, it is beneficial for teachers to understand the child's preferred learning style, which may be visual, auditory, or kinesthetics, etc, and tailor teaching methods accordingly. Some students may benefit more from visual aids, while others may need hands on activities. They may employ powerful tools such as mnemonic devices to help children associate new information with familiar cues, making abstract concepts more tangible and memorable (Pressley et al., 1982). Besides, visual aids, such as diagrams, charts, and illustrations are powerful tools for promoting memory retention as they "help children process abstract information, organise concepts spatially, and create mental frameworks for understanding complex topics" (Tversky, 2013). Research also suggests using storytelling to enhance children's memory retention because narratives provide a

coherent framework for processing and encoding new knowledge making information becomes more relatable and easier to remember (Mar and Oatley, 2008). Other effective strategies include employing kinesthetics activities, visual aids, and auditory cues which can cater to various learning preferences and foster a holistic understanding of new material (Sousa, 2014). An essential component of educational planning and instruction is good content organisation. Students understand, retain, and apply knowledge more effectively when it is organised efficiently by teachers. Encouraging students to examine their learning experiences, identifying their strengths and growth, and doing self-reflection can encourage metacognition and give students a better understanding of how they learn.

Third, educators also need to have a solid understanding of how memory works. This includes knowledge of different types of memory like short-term memory, long-term memory, and factors that influence memory retention. Teachers can overcome the limitation of the working memory by utilising schema construction and automation. According to the cognitive load theory (Sweller, 1999; 1988), knowledge is stored in the long-term memory in the form of 'schemas.' A schema organises parts of information based on how they will be used. An important process in schema construction is called automation, whereby information can be processed spontaneously with minimum conscious effort. Automaticity occurs after extensive practice (Sweller et al., 1998). Schemas are beneficial to learning based on several important functions. First, they provide a system for organising and storing knowledge. Next, they reduce working memory load because a schema constitutes only a single element in the working memory. Through continuous practice learners can develop their simple schemas into higher order schemas. This process of more complex schema construction eventually allows learners to engage in more challenging task and deduce meaning from it. In this way, a high-level schema can effectively bypass the limits of working memory (Sweller et al., 1998). The major limitation of this case study is the small number of subjects which does not permit the findings to be generalisable to students in other schools. Besides, there may be interference of other external variables that might have influenced students' performance during the experiment. For instance, the environment which could also affect their concentration ability to listen and memorise the word such as distraction caused by noises in the environment, or they might have experienced some anxiety when recalling the words.

Conclusion

In conclusion, the present study has proven that the SPE theory is not fully true and applicable for the young Primary 1 learners who participated in the study. Nevertheless, this finding has contributed some important pedagogical implications to teachers, and added to the current body of knowledge relating to this phenomenon as research in this field is still scarce. Moreover, through the exploration of the SPE phenomenon, we have gained valuable insights about the complexity of human memory and cognition. This phenomenon, which encompasses both the primacy and recency effects, is a meaningful theory and knowledge about the ways in which the order of information presentation can profoundly impact learners' ability to remember and retrieve information. In essence, the SPE effect underscores the malleability and limitations of human memory, offering valuable insights that can be applied to various aspects of our daily lives. The present study has its limitations and cannot be generalised to a larger population and

students of different levels of education. As recommendations, future research may conduct a similar study on other levels of learners with more suitable word lists for their proficiency levels, and conduct more rigorous experiment by taking into accounts the influence of other important external variables such as their demographic factors, environment, etc. Additionally, mixed methods research design can be employed to obtain qualitative data by interviewing the participants regarding their recalling process to support the findings obtained from the quantitative data analysis.

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Conflict of interest

The authors declare that they have no conflict of interest with any parties in this research.

REFERENCES

[1] Azizian, A., Polich, J. (2007): Evidence for attentional gradient in the serial position memory curve from event-related potentials. – Journal of Cognitive Neuroscience 19(12): 2071-2081.

[2] Bai, H., Leseman, P.P., Moerbeek, M., Kroesbergen, E.H., Mulder, H. (2021): Serial order effect in divergent thinking in five-to six-year-olds: Individual differences as related to executive functions. – Journal of Intelligence 9(2): 26.

[3] Bireta, T.J., Gabel, A.J., Lamkin, R.M., Neath, I., Surprenant, A.M. (2018): Distinctiveness and serial position functions in implicit memory. – Journal of Cognitive Psychology 30(2): 222-229.

[4] Brown, R.M., Brown, N.L., Caci, M. (1981): Serial position effects in young children: temporal or spatial? – Child Development 52(4): 1191-1201.

[5] Dawidowicz, P. (2011): With scholarship & practice in mind: The case study as research method. – The Hournal of Applied Instructional Design 1(2): 5-12.

[6] Ebbinghaus, H. (1913): Memory: A contribution to experimental psychology. – Teachers College, Columbia University 142p.

[7] Gerjets, P., Scheiter, K., Cierniak, G. (2009): The scientific value of cognitive load theory: A research agenda based on the structuralist view of theories. – Educational Psychology Review 21: 43-54.

[8] Gionet, S., Guitard, D., Saint-Aubin, J. (2022): The Production Effect Interacts With Serial Positions. – Experimental Psychology 69(1): 12-22.

[9] Giovannelli, F., Innocenti, I., Santarnecchi, E., Tatti, E., Cappa, S.F., Rossi, S. (2022): Emotional context shapes the serial position curve. – Brain Sciences 12(5): 581.

[10] Glanzer, M., Cunitz, A.R. (1966): Two storage mechanisms in free recall. – Journal of Verbal Learning and Verbal Behavior 5(4): 351-360.

[11] Hoffmann, J.A., Hosch, A.K. (2023): Predicting serial position effects and judgment errors in retrospective evaluations from memory recall. – Journal of Economic Psychology 96: 14p.

[12] Kolinsky, R., Gabriel, R., Demoulin, C., Gregory, M.M., de Carvalho, K.S., Morais, J. (2020): The influence of age, schooling, literacy, and socioeconomic status on serial-order memory. – Journal of Cultural Cognitive Science 4(3): 343-365.
[13] Koo, M., Jeon, J., Moon, H., Suh, M., Lee, J., Oh, S., Park, M. (2021): Effects of noise and serial position on free recall of spoken words and pupil dilation during encoding in normal-hearing adults. – Brain Sciences 11(2): 14p.
[14] Kowialiewski, B., Lemaire, B., Majerus, S., Portrat, S. (2021): Can activated long-term memory maintain serial order information? – Psychonomic Bulletin & Review 28: 1301-1312.
[15] Lee, C.W., Kim, J.H., Hwang, I.K. (2019): A Study on the Serial Position Effect of Memory according to Illumination of LED Light. – In E3S Web of Conferences, EDP Sciences 120: 4p.
[16] Lewandowsky, S., Duncan, M., Brown, G.D. (2004): Time does not cause forgetting in short-term serial recall. – Psychonomic Bulletin & Review 11(5): 771-790.
[17] Liu, Y.S., Caplan, J.B. (2020): Temporal grouping and direction of serial recall. – Memory & Cognition 48: 1295-1315.
[18] Logan, G.D. (2021): Serial order in perception, memory, and action. – Psychological Review 128(1): 44p.
[19] Mack, C.C., Cinel, C., Davies, N., Harding, M., Ward, G. (2017): Serial position, output order, and list length effects for words presented on smartphones over very long intervals. – Journal of Memory and Language 97: 61-80.
[20] Mar, R.A., Oatley, K. (2008): The function of fiction is the abstraction and simulation of social experience. – Perspectives on Psychological Science 3(3): 173-192.
[21] Martin, A.J. (2016): Using Load Reduction Instruction (LRI) to boost motivation and engagement. – Leicester: British Psychological Society 65p.
[22] McLeod, S. (2024): Information processing theory in psychology. – Simply Psychology 9p.
[23] Murdock Jr, B.B. (1962): The serial position effect of free recall. – Journal of Experimental Psychology 64(5): 482-488.
[24] Murphy, D.H., Friedman, M.C., Castel, A.D. (2022): Metacognitive control, serial position effects, and effective transfer to self-paced study. – Memory & Cognition 50(1): 144-159.
[25] Pressley, M., Levin, J.R., Delaney, H.D. (1982): The mnemonic keyword method. – Review of Educational Research 52(1): 61-91.
[26] Raanaas, R.K., Magnussen, S. (2006): Serial position effects in implicit memory. – European Journal of Cognitive Psychology 18(03): 398-414.
[27] Roe, D., Allen, R.J., Elsley, J., Miles, C., Johnson, A.J. (2024): Working memory prioritisation effects in tactile immediate serial recall. – Quarterly Journal of Experimental Psychology 77(11): 2354-2363.
[28] Sahan, M.I., van Dijck, J.P., Fias, W. (2022): Eye-movements reveal the serial position of the attended item in verbal working memory. – Psychonomic Bulletin & Review 29(2): 530-540.
[29] Santoro, I., Sors, F., Mingolo, S., Prpic, V., Agostini, T., Murgia, M. (2023): Spatial Descriptions Eliminate the Serial Position Effect. – The Open Psychology Journal 16: 1-7.
[30] Shafaghat Ardebili, A., Liu, Y.S., Caplan, J.B. (2024): The emergence of all-or-none retrieval of chunks in verbal serial recall. – Memory & Cognition 52(2): 352-372.
[31] Sousa, D.A. (2014): How the brain learns to read. – Corwin Press 272p.
[32] Sweller, J. (1999): Instructional design in technical areas. – ACER Press 168p.
[33] Sweller, J. (1988): Cognitive load during problem solving: Effects on learning. – Cognitive Science 12(2): 257-285.
[34] Sweller, J., Van Merrienboer, J.J., Paas, F.G. (1998): Cognitive architecture and instructional design. – Educational Psychology Review 10: 251-296.

[35] Tversky, B. (2013): Visualizing thought. – In Handbook of human centric visualization. – New York, NY: Springer New York 37p.
[36] Van Dijck, J.P., Abrahamse, E., Fias, W. (2020): Do preliterate children spontaneously employ spatial coding for serial order in working memory? – Annals of the New York Academy of Sciences 1477(1): 91-99.
[37] Waugh, N.C., Norman, D.A. (1965): Primary memory. – Psychological Review 72(2): 89-104.
[38] Weitzner, D.S., Calamia, M. (2020): Serial position effects on list learning tasks in mild cognitive impairment and Alzheimer's disease. – Neuropsychology 34(4): 467-478.