



(RESEARCH ARTICLE)



Factors affecting the short-term memory: A pilot study

Wings Tjing Yung Loo^{1,2}, Preston Corliss Loo¹ and Mary Ngan Bing Cheung^{1,2,*}

¹ P and P Dental and Medical Sciences Ltd and Essence Medical Laboratory, Hong Kong.

² Hong Kong College of Technology.

World Journal of Advanced Research and Reviews, 2025, 27(01), 366-377

Publication history: Received on 26 May 2025; revised on 30 June 2025; accepted on 03 July 2025

Article DOI: <https://doi.org/10.30574/wjarr.2025.27.1.2550>

Abstract

Short-term memory (STM) refers to the immediate memory in holding information in consciousness. It allows retention of limited amounts of materials over brief intervals. Simple span task has been a dominating experiment to investigate STM processes and individual differences. It elaborates the ability of an individual in immediate recall of a series of discrete stimuli in the correct serial position.

Total 39 healthy subjects were invited to participate in this pilot study. All participants were determined to be free from the presence of systemic or chronic disease. Consents were obtained from every participant after elaboration of the experimental procedures. The blood pressure and pulse were monitored for subjects throughout whole procedures. Their test items included comparing the length of the words, numbers, similar and different sound of the words.

The correct rate for Numbers was 2.7-fold with a 95% confidence interval ranging from 1.74 to 4.05, which was significantly higher than that for Letters that sound different ($p = 0.0005$). The correct rate for Numbers was 2.4-fold with a 95% confidence interval ranging from 1.60 to 3.73 which was higher than that for Letters that sound alike ($p = 0.0003$). The other two tested items of short and long words when compared with Numbers also showed a significant difference ($p = 0.05$). However, their odds ratios were not higher than the Number. The Pearson Chi-squared test for the rest of groups yielded no statistically significant difference among them. This result showed that Numbers were easiest to be remembered.

Regarding the individual differences, age, sex and educational level were unable to acquire statistical significance. To a certain extent, this study failed to obtain the ageing effect on span performance documented. Increasing sample size and recruitment of older participants (>65 years old) were considered in the future study.

Keywords: Pilot Study; Short-Term Memory; Memory Span; Short Words; Long Words; Letter That Sounds Different; Letter That Sounds Alike; Ageing Memory

1. Introduction

1.1. Short-term memory

Short-term memory (STM), introduced in the information-processing models (Atkinson & Shiffrin, 1968; Mihalko, *et al.*, 2025), refers to the immediate memory in holding information in consciousness. It allows retention of limited amounts of materials over brief intervals. Advocates of recently developed working memory (WM) model (Baddeley & Hitch, 1974; Hughes, 2025) regard the old concept of STM as a unitary store which merely and passively hold onto limited pieces of information for a few seconds.

* Corresponding author: Mary Ngan Bing Cheung

1.2. Relationship between STM and Simple span tasks

Simple span task (e.g. forward digit span, word span) has been a dominating experiment to investigate short-term memory processes (mainly STM capacity and serial recall performance) and individual differences therein over the century. It elaborates the ability of an individual in immediate recall of a series of discrete stimuli in the correct serial position. Contrasting to the complex memory task (e.g. reading span, counting span, operation span) which measures WM capacity, simple span task merely requires storage of information (Daneman and Carpenter, 1980; Teng, 2025). Reading in a Foreign Language Special Issue: Conceptualizing individual differences in reading.), it involves neither concurrent monitoring nor re-organization of information.

In a typical test of STM span, participants are presented with a sequence of items (e.g. digits, consonants, words). Starting from a short list length (the number of items presented) of 2 or 3 items, it usually gradually increases the list length in subsequent trials. The common rate of presentation is 1 second per item (ranging from 0.5 to 2 seconds/item). Probable risk of errors due to failure to perceive may be resulted from faster rates while slower rates allow sufficient time for participants to engage in complex and perhaps highly variable rehearsal strategies (Miller, 1956; Kankam, 2025; Vásquez Duque, 2025). Recognizable patterns (e.g. 1-2-3-4-5, 2-4-6-8) are avoided. Participants are required to recall the items in the sequential order of presentation. Various ways are described to calculate the span, for instance the total number of words recalled, proportion of words per set, numbers of words in correct trials or maximum series correctly achieved. The magic number seven plus or minus two is speculated as the average digit span (Miller, 1956; Kankam, 2025; Vásquez Duque, 2025). Memory span, nevertheless, can possibly be expanded by aggregating several items into a chunk of information (Miller, 1956; Kankam, 2025; Vásquez Duque, 2025). Recalling a short string of items in serial order appears to be a simple task, nonetheless, recent research findings, however, discloses its complexity. Few speech-based variables such as word length effect (Baddeley, 1986; Hughes, 2025) and phonological similarity effect (Conrad and Hull, 1964; Cheng, *et al.*, 2025) are found influential in span performance.

1.3. Speech-based variables affecting memory span

Rehearsal, affected by word length (Baddeley, Thomson and Buchanan, 1975; Hughes, 2025; Baddeley, Chincotta, Stafford and Turk, 2002; Ghosh, Sharma and Sinha, 2021), and phonological similarity (Conrad and Hull, 1964; Baddeley, 1966; Cheng, *et al.*, 2025; Kintsch and Buschke, 1969; Aitim and Satybaldiyeva, 2025), plays a pivotal role in span performance (Atkinson and Shiffrin, 1968; Mijalkov, *et al.*, 2025). Baddeley and Cheng have put forward a two-component structure to explain the interactive effects of these variables on memory span (Baddeley, 1966; Cheng, *et al.*, 2025). On one hand, a dual-functional verbal rehearsal process has been suggested to translate visual input into acoustic codes (phonemic representations) and maintain the acoustic codes in a readily retrievable state. A rapidly decaying phonological store, on the other hand, has been also proposed to temporarily hold the acoustic code of the to-be remembered information (Baddeley, 1966; Cheng, *et al.*, 2025).

1.3.1. Word length effect on memory span

Given the time-dependent trace decay, lengthy and multi-syllabic words presumably require longer time to articulate and rehearse, resulting in a lower level of recall. This assertion is advocated by a positive linear relationship ascertained between the number of recalled items and the rehearsal rate (Baddeley, Thomson and Buchanan, 1975; Hitch, Allen and Baddeley, 2025). The scholars have further clarified with a constant memory span (in unit of time) because the temporally-limited capacity. Hence, the more words that can be articulated within the temporal limitation, the more words that can be rehearsed and eventually greater the span. A regression equation of span-rehearsal rate has been formulated to predict the span (the number of items that a subject could read or pronounce in approximately 2 seconds). Correspondence with the span-rehearsal rate, span performance of structural differences in materials [e.g. digits, words, colors, shapes, consonants] (Schweickert and Boruff, 1986; Claxton, 2025), developmental (Hulme, Thomson, Muir and Lawrence, 1984; Nuha and Suharso, 2025; Machinskaya, *et al.*, 2025) and cross-cultural in various languages (Elliott, 1992; Ellis and Hennesly, 1980) discrepancies are determined by the rehearsal speed. Word length is conceivable as a mediator influencing the efficiency of rehearsal (Cowan, Keller, Hulme, Roodenrys, McDougall and Rack, 1994; Nuha and Suharso, 2025; Machinskaya, *et al.*, 2025).

The temporal limits do not, however, entirely explain the detrimental effect of word length. A counter-interpretation based on interference hypothesis, degree of interference directly relates to word length or associated complexity, gives essentially equivalent predictions for the bottleneck of span performance (Coltheart and Langdon, 1998; Service, 1998). Longer words are thus assumed to take more time to articulate, which being more liable to a greater degree of forgetting from trace decay and/or interference.

1.3.2. Phonological similarity effect on memory span

Phonological similarity, proposed by Conrad and Hull, is a well-explored phenomenon in STM research. Participants presented with a list of phonologically similar items [words e.g. cat, hat, bat, or letters e.g. B, D, V], causing acoustic confusion generally perform worse when compared to list of items that sound differently (Conrad and Hull, 1964; Cheng, *et al.*, 2025). Due to the dominant use of acoustic coding in STM (Baddeley, 1966), phonological similarity decrement in memory performance is observed.

Scholars have documented a typical error pattern when manipulating word phonological similarity in memory span (Lian, Karlsen and Eriksen, 2004; Misra and Goh, 2006; Lin, *et al.*, 2015). More order errors are observed in the sound-alike condition while dissimilar lists elicit more omissions and item errors. The similarity features may confer retrieval cue advantages in recalling specific words, yet it may also result in positional confusion (order errors) and thus more transpositions. In contrast, omission errors or extra-list intrusions may happen in the sound-dissimilar circumstances.

1.4. Ageing memory

It is a common believe that memory declines with age. However, the types of memory can determine the extent of memory devastation by age. Earlier literature converged that STM memory span was largely unaffected by increased age. Though still relatively less age-sensitive than WM capacity, recent studies have detected a small to moderate age-related declines in memory span (Maylor, Vousden and Brown, 1999; Salthouse, 1991; Murphy and Castel, 2025). Younger groups outperform the elderly in terms of serial position (Maylor, Vousden and Brown, 1999; Murphy and Castel, 2025), speech rate and memory capacity (Multhaup, Balota and Cowin, 1996; Murphy and Castel, 2025) for both auditory and visual presented information.

To date, ageing memory have been interpreted by 3 major theoretical frameworks, namely (i) limited processing resources, (ii) reduced processing speed and (iii) impaired inhibitory functioning.

1.4.1. Processing resource theory

The limited processing resources approach (Belleville, Rouleau and Caza, 1998; Craik, Morris and Gick, 1990; Foos, 1998; Shahid, *et al.*, 2025) supposes ageing uses up the cognitive resources available for information processing (i.e. encoding information into memory and then for retrieving information from memory). Empirical support concurring with this general view comes from the significant age deficits in memory tasks which drilling for more processing resources, such as recalling an item rather than simply recognizing it as having been encountered earlier (Craik and Mc Dowd, 1987; Shahid, *et al.*, 2025).

1.4.2. Processing speed theory

Mental slowing is typically seen in old age. Ageing is thought to decelerate the operational executions, in turn degrading the cognitive performance (limited time mechanism). The simultaneity mechanism proposes that the earlier-processed information may no longer be available when later processing is complete. Compiling the two mechanisms, given unlimited time, Salthouse and Murphy conclude that the elderly is comparable to the younger adults in memory tasks (Salthouse, 1991; Murphy and Castel, 2025).

1.4.3. Inhibition functioning hypothesis

An alternative explanation for ageing memory is the reduced inhibitory control on irrelevant contextual and temporal information among the elderly (Hasher and Zacks, 1988; Horn, Fandakova and Shing, 2025). As a consequence of impaired inhibition function, cluttering with distracting information occurs during both encoding and retrieval of goal-relevant memory and the elderly are more likely to be distracted by environment events and internal thoughts than younger adults.

2. Materials and methods

2.1. Source of memory test, content and requirement of the test

A STM Test, including foreword digit span and word span, was obtained from a set of classic experiments and concepts from cognitive psychology (Francis, Neath, MacKewn and Goldthwaite, 2003; Argyriou, Benamar and Nikolajeva, 2022). In this memory span experiment, participants were given a list of items and asked to recall the list in order. In order to examine the word length and phonological similarity effects on span performance, five types of stimuli, namely Numbers (No.), Letters that sound different (LSD), Letters that sound alike (LSA), Short words (SW), and Long words (LW), were included.

After thorough explanation on the procedure of the memory test, all participants began a trial by pressing the *Next Trial* button. On the left of the window a sequence of items appeared at presentation rate of 1 item/second. After the whole sequence presented, participants were required to recall the presented items by clicking on the buttons among a list at the right side. The participants were then allowed to start next sequence by clicking on *Next Trial*.

The five stimuli were visually presented five times with varying list lengths. It was regarded as Correct if the items were recalled in the presented order. Any mistakes (recalling too many items, recalling too few items, or recalling items in the wrong order) were counted as Incorrect. No amendments of the inputted answers were allowed (Francis, Neath, Mac Kewn and Goldthwaite, 2003; Argyriou, Benamar and Nikolajeva, 2022).

2.2. Selection of subjects and the condition of test

From July to September 2011, 39 healthy subjects (29 females and 10 males age from 25 to 65 years) were invited to participate in the current experiment. All participants were determined to be free from the presence of systemic or chronic disease. Consents were obtained from every participant after elaboration of the experimental procedures. As shown in Table 1, 46% of the participants are degree holders. Their occupations include scientist, pharmacy, clinical researchers, clinic nurses, students and office assistants.

The current experiment was conducted in an 18m² consultation room at a medical centre of Hong Kong. The room was sound-proof so that the subjects could quietly perform the test. The participants were asked to settle down for about 10 minutes prior to the test. Their blood pressure and pulse were monitored by an electronic sphygmomanometer (Welch-Allyn, USA) throughout whole procedures (Figure 1a-e). Their test items included comparing the length of the words, numbers, similar and different sound of the words (STM).

Table 1 Demographic data (Mean \pm SD) of the participants

Parameters	Subjects (n=39)
Male/female	10/29
Age range (years)	25 - 65
Age (years)	32.69 \pm 8.42
Education Level	
Secondary school	20 (51.3%)
Bachelor or above	18 (46.2%)
Primary school	1 (2.6%)



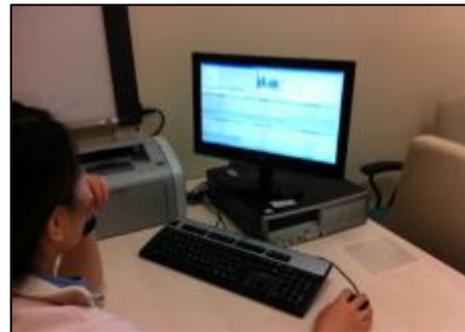
A



B



C



D



E



F

Figure 1a The electronic sphygmomanometer with pulse monitor used to record the participant's blood pressure and pulse throughout the test; 1b-f The participants were conducting the memory test

2.3. Statistical analysis

The responses (STM) were tested against with sex, age, educational level and the degree of anxiety (pulse rate and blood pressure before and during the test) for any correlation.

Pearson correlation was applied to find out the relationship of responses (STM) to sex, age, education level and different test items (short, long number etc.).

The mean pulse and blood pressure before and during the test were compared to responses (STM) by independent T test.

Chi-squared test was applied to examine the differences in testing items and the responses, the pulse (heart rate) and blood pressure before and during the test were evaluated with an independent t-test. A p-value of <0.05 was considered statistically significant. Statistical analysis was conducted using SPSS 17.0 for windows (SPSS Inc., U.S.A.).

3. Results

3.1. Relationship of STM and age, sex or educational level

As refer to Table 2, the nonparametric correlations of Spearman test showed no statistical significance ($p > 0.05$) between responses (correct/incorrect) and age, sex or educational level. The older participants did not show difference in memory tests, the results also showed that the participants with higher education level (bachelor and master degree holders) did not get a higher rate of correct answers in the memory test. It might be due to the insufficient sample size.

Table 2 The association of age, sex and educational level in selecting correct or incorrect answers with the application of nonparametric correlations of Spearman test in 39 participants

Subjects' parameters	Spearman Correlation Coefficient (r)	p values (2-tailed)
Age	0.124	0.451
Sex	-0.043	0.797
Educational Level	0.139	0.399

3.2. Comparison of List Length of Numbers (No.), Letters that sound different (LSD), Letters that sound alike (LSA), Short words (SW) and long words (LW)

The Pearson correlation test demonstrated in Table 3 revealed no statistical significance ($p > 0.05$) between responses (correct/incorrect) and List Length of Numbers. These results showed that the length of numbers did not affect the memory in this test. On the other hand, the List Length of Letters that sound different (LSD), Letters that sound alike (LSA) and short words (SW) obtained a positive correlation with statistically significant difference ($p < 0.05$) with response. This indicated the correct rate was higher than the incorrect rate. The List Length of Long words (LW) demonstrated negative correlation with response meaning the correct rate was lower than the incorrect rate. The Letters that sound different (LSD), Letters that sound alike (LSA), Short words (SW) and long words (LW) were affected by the length of the list in the memory test.

Table 3 The association of the List Length of Numbers (No.), Letters that sound different (LSD), Letters that sound alike (LSA), Short words (SW), and long words (LW) with responses in the application of Pearson correlation test in 39 participants

Association the Responses with List Length of following items	Pearson Correlation Coefficient (r)	p values (2-tailed)
Numbers (No.)	0.139	0.53
Letters that sound different (LSD)	0.364	0.00016*
Letters that sound alike (LSA)	0.441	0.00011*
Short words (SW)	0.245	0.001*
Long words (LW)	-0.264	0.00019*

* Correlation is significant at the 0.05 level (2-tailed).

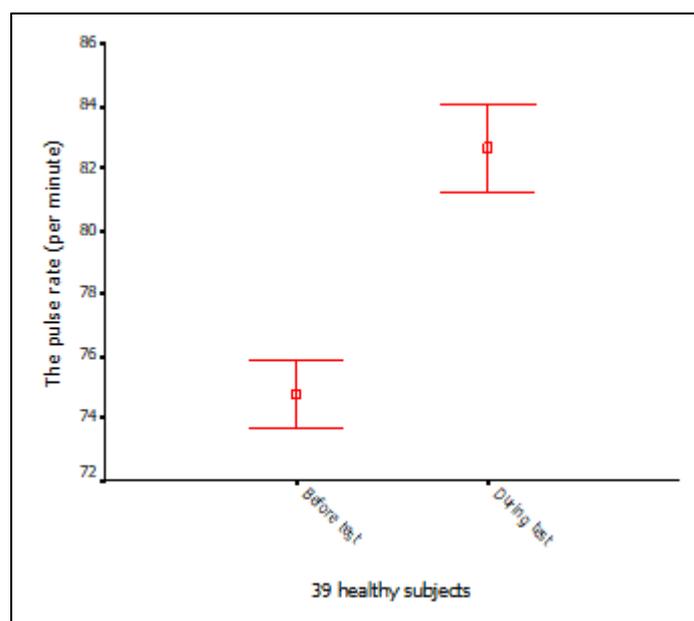
3.3. Pulse rate and blood pressure were analyzed by T-test

Table 4 shows a statistically significant difference in the mean pulse rate before and during the test, but no difference was observed for blood pressure. A graphical demonstration was included in Figure 2. The accelerated pulse measured during the memory test might enhance or inhibit the results of the test.

Table 4 The mean pulse rate and blood pressure (Mean \pm SD) before and during the test in 39 participants

Physical Parameters		Mean	<i>p</i> values
Pulse	Before test	74.77 \pm 3.44	0.00016*
	During test	82.67 \pm 4.31	
Systolic Blood Pressure	Before test	93.67 \pm 8.92	0.744
	After test	94.337 \pm 9.01	
Diastolic Blood Pressure	Before test	65.95 \pm 5.77	0.897
	During test	66.15 \pm 6.07	

* Independent t-test is significant at the 0.05 level (2-tailed).

**Figure 2** Mean pulse rate before and during the test with statistically significant difference

3.4. Comparison among Short words (SW), Long words (LW), Number (No.), Letter that sounds different (LSD) and Letter that sounds alike (LSA) with Responses

Pearson Chi-squared test, listed in Table 5, was applied to examine the difference in tested items with the responses. The correct rate for Numbers (No.) was 2.7-fold with a 95% confidence interval ranging from 1.74 to 4.05, which was significantly higher than that for Letters that sound different (LSD) ($p = 0.0005$). The correct rate for Numbers (No.) was 2.4-fold with a 95% confidence interval ranging from 1.60 to 3.73 which was higher than that for Letters that sound alike (LSA) ($p = 0.0003$). The other two tested items of Short (SW) and long words (LW) when compared with Numbers (No.) also showed a significant difference ($p = 0.05$). However, their odds ratios were not higher than the Numbers (No.). The Pearson Chi-squared test for the rest of groups yielded no statistically significant difference among them. This result showed that Numbers (No.) were easiest to be remembered.

Table 5 Pearson Chi-squared test was applied to examine the differences in test items (Short words-SW; Long words-LW; Number-No.; Letters that sound different-LSD and Letter that sound alike-LSA) with the responses (Correct-C and In-correct-IC)

Tested items	Response C (%)	Response IC (%)	Response C versus Response IC	
			OR (95% CI)	χ^2 (p values)
SW	51.30	48.70	1.33 (0.89-1.99)	2.02 (0.1560)
LW	44.10	55.90		
SW	51.30	48.70	0.39 (0.26-0.59)	19.21 (0.0001*)
No.	72.8	27.2		
SW	51.30	48.70	1.04 (0.70-1.55)	0.04 (0.8390)
LSD	50.30	49.50		
SW	51.30	48.70	0.96 (0.65-1.43)	0.04 (0.8390)
LSA	50.30	49.50		
LW	44.10	55.90	0.29 (0.19-0.45)	33.11 (0.0008*)
No.	72.80	27.20		
LW	44.10	55.90	0.781 (0.52-1.16)	1.48 (0.2240)
LSD	50.30	49.70		
LW	44.10	55.90	0.72 (0.48-1.07)	2.63 (0.1050)
LSA	52.30	47.70		
No.	72.80	27.20	2.65 (1.74-4.05)	20.97 (0.0005*)
LSD	50.30	49.70		
No.	72.80	27.20	2.44 (1.60-3.73)	17.52 (0.0003*)
LSA	52.3	47.70		
LSD	50.30	49.70	0.921 (0.62-1.37)	0.16 (0.6850)
LSA	52.30	47.70		

* Pearson Chi-squared test is significant at the 0.05 level

4. Discussion

Over the century, STM capacity has attracted numerous psychologists in extensive investigation. It is helpful to develop mnemonic strategies once the possible variables affecting memory span are identified. The current research was motivated by an attempt to evaluate the magnitude of the suggested factors (word length, phonological similarity and individual differences) on span performance.

Consistent with previous studies (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Cowan, Keller, Hulme, Roodenrys, McDougall and Rack, 1994; Nuha and Suharso, 2025; Machinskaya, *et al.*, 2025), our results appeared to replicate the detrimental effects of word length. Augmented error rate was detected for lengthy words (LW) while participants obtained a higher correct rate for short words (SW). Unfortunately, the underlying mechanisms for the word length effect were not measured in the current study. Both the time-dependent decay theory and interference hypothesis might play a part during the prolonged rehearsal or recalling of the long words (LW).

Amongst all stimuli, the highest correct rate was obtained in the span task with numbers. Various hypotheses might help to answer the observed outperformance of digit to word span. First of all, due to the single syllables of Chinese articulation for digits, the articulation time for pronouncing a sample syllable should be much shorter than lengthy

vocabularies (LW), such as refrigerator, helicopter, which consisted of multi-syllabic words (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025). As stated by Baddeley and colleagues, span-rehearsal rate was determined by the number of word syllables which in turn the articulation time. It is undoubtedly to conclude the lesser articulation time of digits, to a certain extent, outperformed the other span tasks (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025).

Apart from the span-rehearsal rate, the fluency in word identification could be interfered by the usage of English vocabularies in word span. Acquiring English as the second language among all the 39 participants, the efficiency in word recognition and the degree of vocabulary familiarity might also attributable to differentials results among the stimuli (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025). It is conceivable to state that automaticity (rapid and effortless decoding) of word recognition for Arabic numbers in general population. On the contrary, the native language, especially true for those with less familiar or daily-use vocabularies, somewhat impinges the efficiency of word decoding process. This might cause participants a considerable variability in time of word recognition, in turn span performance became more prone to the two hypotheses of STM forgetting: decay theory and interference hypothesis (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025).

Unlike earlier studies (Conrad and Hull, 1964; Lian, Karlsen and Eriksen, 2004; Misra and Goh, 2006; Cheng, *et al.*, 2025), our findings failed to illustrate the phonological similarity effects on STM capacity. No statistical differences were attained when comparing the phonological similar (LSA) and distinctive (LSD) letters. It was noteworthy that though getting similar results, both exhibited a relatively high incorrect rate. A possible explanation was the drawback of the current laboratory of not defining incorrect in details. A typical error patterns with more order errors for phonological similar (LSA) and more omission and item errors for distinctive-sound (LSD) letters have been documented by numerous scholars. However, measuring only the incorrect rate deterred the further elaboration on the error patterns (Conrad and Hull, 1964; Lian, Karlsen and Eriksen, 2004; Misra and Goh, 2006; Cheng, *et al.*, 2025).

To explore alternative reasons for span decay, articulatory suppression (continuously whispering meaningless speech e.g. the-the-the) as an interference task has been proposed (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025). Undergoing articulatory suppression together with visual stimulus has been inferred to reduce the word-length effect and phonological similarity effect, in which blocking the articulatory rehearsal process (acoustic encoding of visually presented materials) and thereby leaving memory traces in the phonological loop to decay (Baddeley, Thomson and Buchanan, 1975; Jefferies, Frankish and Noble, 2011; Hughes, 2025; Dejun and Haiyan, 2025).

Regarding the individual differences, age, sex and educational level were unable to acquire statistical significance. To a certain extent, this study failed to obtain the ageing effect on span performance documented (Maylor, Vousden and Brown, 1999; Multhaup, Balota and Cowin, 1996; Salthouse, 1991; Murphy and Castel, 2025). Increasing sample size and recruitment of older participants (>65 years old) were considered in the future study. Interestingly to detect a drastic rise (approximately 10%) in pulse rate after experiment ($p < 0.00016$), further investigation is required to examine the intensity of anxiety and stress level induced by the experiment (Maylor, Vousden and Brown, 1999; Multhaup, Balota and Cowin, 1996; Salthouse, 1991; Murphy and Castel, 2025).

The span task is essentially a task that involves retrieval of order as well as retrieval of items. The current study, however, concentrated upon factors that primarily affect item information. No in-depth examination of the extent to which maintenance of order information that has been reported as a powerful determinant of span. In addition, the strategies utilized by each individual were largely ignored in this study. It has been stated that a wide variety of memory strategies, (namely, chunking, visual imagery and semantic other than verbal rehearsal) are normally used to perform the span task (Logie, Della Salla, Laiacona, Chalmers and Wynn, 1996; McCullough, 2025). The authors had made no attempt to disambiguate the memory strategies, leaving the probable coalesce of rehearsal, lexical and output processes unexplored.

5. Conclusion

The pilot study results indicate that the Numbers (No.) test was the most effective for assessing short-term memory across all age and sex groups.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

- [1] Atkinson, R.C. & Shiffrin, R.M. (1968). "Human memory: a proposed system and its control processes". In K.W. Spence and J.T. Spence (eds.). *The Psychology of Learning and Motivation*, (Vol 2., pp. 89-195). New York: Academic Press.
- [2] Mijalkov, M., Storm, L., Zufiria-Gerbolés, B., Veréb, D., Xu, Z., Canal-Garcia, A., ... & Pereira, J. B. (2025). Computational memory capacity predicts aging and cognitive decline. *Nature communications*, 16(1), 2748.
- [3] Baddeley, A. D. (1966). Short-term memory for word sequences as a function of acoustic, semantic and formal similarity. *Quarterly Journal of Experimental Psychology*, 18A, 362-365.
- [4] Hughes, R. W. (2025). The phonological store of working memory: A critique and an alternative, perceptual-motor, approach to verbal short-term memory. *Quarterly Journal of Experimental Psychology*, 78(2), 240-263.
- [5] Baddeley, A. D. (1986). *Working memory*. London: Oxford University Press.
- [6] Hitch, G. J., Allen, R. J., & Baddeley, A. D. (2025). The multicomponent model of working memory fifty years on. *Quarterly Journal of Experimental Psychology*, 78(2), 222-239.
- [7] Baddeley, A., Chincotta, D., Stafford, L. & Turk, D. (2002). Is the word length effect in STM entirely attributable to output delay? Evidence from serial recognition. *The Quarterly Journal of Experimental Psychology*, 55, 353 – 369.
- [8] Ghosh, S., Sharma, H., & Sinha, J. K. (2021). Short-Term Memory. In *Encyclopedia of Animal Cognition and Behavior* (pp. 1-6). Springer, Cham.
- [9] Baddeley, A.D., Thomson, N., & Buchanan, M. (1975). Word length and the structure of short term memory. *Journal of Verbal Learning and Verbal Behavior*, 14, 575–589.
- [10] Jefferies, E., Frankish, C., & Noble, K. (2011). Strong and long: Effects of word length on phonological binding in verbal short-term memory. *Quarterly Journal of Experimental Psychology*, 64(2), 241-260.
- [11] Hughes, R. W. (2025). The phonological store of working memory: A critique and an alternative, perceptual-motor, approach to verbal short-term memory. *Quarterly Journal of Experimental Psychology*, 78(2), 240-263.
- [12] Dejun, G., & Haiyan, G. (2025). Long-Term Memory. In *The ECPH Encyclopedia of Psychology* (pp. 859-860). Singapore: Springer Nature Singapore.
- [13] Belleville, S., Rouleau, N., & Caza, N. (1998). Effect of normal aging on the manipulation of information in working memory. *Memory & Cognition*, 26, 572–583.
- [14] Coltheart, V., & Langdon, R. (1998). Recall of short word lists presented visually at fast rates: Effects of phonological similarity and word length. *Memory and Cognition*, 26, 330–342.
- [15] Conrad, R. & Hull, A. J. (1964). Information, acoustic confusion and memory span. *British Journal of Psychology*, 55, 429-432.
- [16] Cheng, S., Geng, K., He, C., Qiu, Z., Xu, L., Qiu, H., ... & Li, H. (2025). Distribution-Level Memory Recall for Continual Learning: Preserving Knowledge and Avoiding Confusion. *IEEE Transactions on Multimedia*.
- [17] Cowan, N., Keller, T.A., Hulme, C., Roodenrys, S.J., McDougall, S. & Rack, J. (1994). Verbal memory span in children: Speech timing clues to the mechanisms underlying age and word length effects. *Journal of Memory and Language*, 33, 234–250.
- [18] Nuha, F. I., & Suharso, P. L. (2025). Boosting Verbal Memory Capacity in Elementary School Students: A Face to Face Intervention Study. *Jurnal Paedagogy*, 12(2), 217-229.

- [19] Machinskaya, R. I., Korneev, A. A., Kurgansky, A. V., & Lomakin, D. I. (2025). Functional organization of working memory during delayed coping of verbal and visuo-spatial sequences in children aged 10–12 years. Analysis of ERPS in response to imperative signals. *Zhurnal Vysshei Nervnoi Deyatelnosti Imeni IP Pavlova*, 75(1), 78-96.
- [20] Craik, F. I. M., & McDowd, J. M. (1987). Age differences in recall and recognition. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 13, 474–9.
- [21] Craik, F. I. M., Morris, R. G., & Gick, M. L. (1990). Adult age differences in working memory. In G. Vallar & T. Schalllice (Eds.), *Neuropsychological impairments of short-term memory* (pp. 247–267). Cambridge, England: Cambridge University Press.
- [22] Shahid, M. S., Naeem, S., Alam, S., Shabbir, K. H., & Rahman, R. (2025). WORKING MEMORY AND AGING: A COMPARATIVE QUANTITATIVE STUDY OF PAKISTANI ADULTS. *Insights-Journal of Health and Rehabilitation*, 3(3 (Health & Rehab)), 166-175.
- [23] Daneman, M. & Carpenter, P.A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behavior*, 19, 450–466.
- [24] Teng, M. F. (2025). Reading in a Foreign Language Special Issue: Conceptualizing individual differences in reading.
- [25] Elliott, J. M. (1992). Forward digit span and articulation speed for Malay, English, and two Chinese dialects. *Perceptual and Motor Skills*, 74, 291-295.
- [26] Ellis, N.C. & Hennesly, R.A. (1980). A bilingual word-length effect: Implications for intelligence testing and the relative ease of mental calculation in Welsh and English. *British Journal of Psychology*, 71, 43 - 51.
- [27] Foos, P. W. (1989). Adult age differences in working memory. *Psychology and Aging*, 4, 269–275.
- [28] Francis, G., Neath, I., MacKewn, A. & Goldthwaite, D. (2003). *CogLab*, book and CD, Wadsworth/Thomson Learning, pp41-42.
- [29] Argyriou, P., Benamar, K., & Nikolajeva, M. (2022). What to blend? Exploring the relationship between student engagement and academic achievement via a blended learning approach. *Psychology Learning & Teaching*, 21(2), 126-137.
- [30] Hasher, L. & Zacks, R. T. (1988). Working memory, comprehension and aging: A review and a new view. In G. H. Bower (Ed.). *The psychology of learning and motivation*, (Vol. 22, pp. 193-225). San Diego, CA: Academic Press.
- [31] Horn, S., Fandakova, Y., & Shing, Y. L. (2025). The Interplay of Memory and Decision Making–Developmental and Aging Processes. *European Psychologist*.
- [32] Henson, R. N. A., Norris, D. G., Page, M. P. A. & Baddeley, A. D. (1996). Unchained memory: Error patterns rule out chaining models of immediate serial recall. *Quarterly Journal of Experimental Psychology*, 49A, 80 – 115.
- [33] Hulme, C., Thomson, N., Muir, C., & Lawrence, W.A. (1984). Speech rate and the development of short-term memory span. *Journal of Experimental Child Psychology*, 38, 241–253.
- [34] Kintsch, W. & Buschke, H. (1969). Homophones and synonyms in short-term memory. *Journal of Experimental Psychology*, 80, 403 – 407.
- [35] Aitim, A., & Satybaldiyeva, R. (2025). A COMPARISON OF KAZAKH LANGUAGE PROCESSING MODELS FOR IMPROVING SEMANTIC SEARCH RESULTS. *Eastern-European Journal of Enterprise Technologies*, 133(2).
- [36] Lian, A., Karlsen, P. J. & Eriksen, T. B. (2004). Opposing effects of phonological similarity on item and order memory of words and nonwords in the serial recall task. *Memory*, 12, 314-337.
- [37] Lin, Y. C., Chen, H. Y., Lai, Y. C., & Wu, D. H. (2015). Phonological similarity and orthographic similarity affect probed serial recall of Chinese characters. *Memory & Cognition*, 43, 538-554.
- [38] Logie, R. H., Della Salla, S., Laiacona, M., Chalmers, P. & Wynn, V. (1996). Group aggregates and individual reliability: The case of verbal short-term memory. *Memory and Cognition*, 24, 305-321.
- [39] McCullough, A. K. (2025). Use of posterior probabilities from a long short-term memory network for characterizing dance behavior with multiple accelerometers. *Journal of Alzheimer’s Disease*, 105(4), 1069-1084.
- [40] Maylor, E. A., Vousden, J. I., and G. D. A. Brown (1999). Adult age differences in short-term memory for serial order: data and a model. *Psychology and Aging*, 14, 572–594.

- [41] Murphy, D. H., & Castel, A. D. (2025). Serial and strategic memory processes in younger and older adults. *Aging, Neuropsychology, and Cognition*, 32(2), 207-236.
- [42] Miller, G. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *The Psychological Review*, 63, 81-97.
- [43] Kankam, H. (2025). Foundations of Cognitive Psychology. In *A Brief Excursion into Human Cognition: The Evolving Influence of Social Media & Artificial Intelligence* (pp. 11-16). Cham: Springer Nature Switzerland.
- [44] Kankam, H. (2025). Introduction to Human Cognition. In *A Brief Excursion into Human Cognition: The Evolving Influence of Social Media & Artificial Intelligence* (pp. 1-9). Cham: Springer Nature Switzerland.
- [45] Vásquez Duque, O. (2025). The Magical Number 2 (Minus Two): An Empirical Analysis on the Efficacy of Choice Screens to Increase Competition in Digital Markets. Available at SSRN 5264993.
- [46] Misra, R. & Goh, W.D. (2006). Phonological Similarity Effects in Simple and Complex Word Spans. *Proceedings of the Cognitive Science Society*, 1829 – 1834.
- [47] Multhaup, K. S., Balota, D. A., & Cowan, N. (1996). Implications of aging, lexicality, and item length for the mechanisms underlying memory span. *Psychonomic Bulletin & Review*, 3, 112–20.
- [48] Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Hillsdale, N.J.: Erlbaum.
- [49] Schweickert, R., & Boruff, B. (1986). Short-term memory capacity: Magic number or magic spell? *Journal of Experimental Psychology: Learning Memory and Cognition*, 12, 419-425.
- [50] Claxton, G. (Ed.). (2025). *Cognitive psychology: New directions*. Taylor & Francis.
- [51] Service, E. (1998). The effect of word length on immediate serial recall depends on phonological complexity, not articulatory duration. *Quarterly Journal of Experimental Psychology*, 51A, 283–304.
- [52] Tehan, G. & Lalor, D.M. (2000). Individual differences in memory span: The contribution of rehearsal, access to lexical memory and output speed. *Quarterly Journal of Experimental Psychology*, 53A, 1012-1038.