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The Clenching Effect: Neurocognitive Insights into a Boost for Visual Memory

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Abstract

Background; Unilateral hand clenching is known to modulate activity in the contralateral hemisphere's frontal lobe, potentially influencing cognitive processes. The Hemispheric Encoding/Retrieval Asymmetry (HERA) model suggests specific benefits of hemispheric activation on memory performance. However, the impact of this technique on visual memory remains underexplored. **Aim;** To investigate the effect of unilateral hand clenching on visual memory recall and evaluate the effectiveness of different hand clenching protocols using visual word memory test. Methodology; One hundred right-handed first-year MBBS students (50 male, 50 female) participated in this study. They were divided into five groups: No Hand Clenching (N/N), Right Hand Clenching Before Encoding and Recall (R/R), Right Hand Clenching Before Encoding and Left-Hand Clenching Before Recall (R/L), Left Hand Clenching Before Encoding and Recall (L/L), and Left Hand Clenching Before Encoding and Right-Hand Clenching Before Recall (L/R). Each group performed hand clenching before encoding and recall tasks, followed by a visual word memory test. **Result**; ANOVA revealed significant differences in recall performance among the groups (f-ratio = 3.61024, p = .007288). The R/L condition showed the highest recall performance, followed by R/R, L/R, L/L, and N/N. This supports the HERA model, indicating enhanced memory performance through strategic hemispheric activation. **Conclusion:** Our findings support the HERA model's applicability to visual memory tasks, demonstrating that unilateral hand clenching significantly enhances visual memory recall. The R/L condition appears most effective, highlighting the importance of strategic hemispheric activation during encoding and recall phases. This technique shows promise for educational applications and cognitive enhancement.

Keywords; Unilateral hand clenching, HERA model, visual memory, hemispheric activation, cognitive enhancement

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INTRODUCTION

Unilateral hand clenching, a unique method of neuromodulation, activates the contralateral hemisphere's frontal lobe, influencing various cognitive processes. A brief 90 seconds of left-hand clenching enhances right hemisphere activity, whereas right-hand clenching augments left hemisphere activity[1]. This technique serves as an innovative approach to investigating cerebral hemisphere specializations in intact humans, with potential implications for performance enhancement in tasks requiring specific brain resources. Unilateral hand clenching offers promise for fundamental research into functional asymmetries and therapeutic applications, given the differential involvement of brain hemispheres in functions such as language, emotion, aggression, spatial processing, and information processing[2,3]. Researchers have employed unilateral hand clenching to modulate hemispheric activation, especially to assess asymmetrical contributions to perceptual processing. While its effects on emotional states are well-documented, the impact on cognitive functions, particularly short-term and working memory, remains underexplored. The Hemispheric Encoding/Retrieval Asymmetry (HERA) model posits that right-hand clenching (left hemisphere activation) before encoding and left-hand clenching (right hemisphere activation) before recall may enhance episodic memory performance. Some studies suggest a nuanced HERA model applicable to both verbal and nonverbal materials[4]. Recent electrophysiological studies reveal increased prefrontal cortical activity contralateral to the clenched hand[5]. Although PET and fMRI studies generally support the HERA pattern, some report neutral results, potentially due to the nature of the stimuli (verbal vs. nonverbal)[6,7,8]. Visual memory, crucial for processing and retaining visual information, can be modulated through unilateral hand clenching, which may influence visual memory encoding and retrieval. The right hemisphere, associated with spatial and visual processing, might be particularly responsive to left-hand clenching, enhancing visual memory encoding. Conversely, right-hand clenching, by activating the left hemisphere, could facilitate retrieval processes due to the hemisphere's role in detailed information processing and sequential tasks[9].

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Research suggests that visual stimuli are primarily processed in the right hemisphere, which is integral to spatial memory and visual detail recognition. Consequently, left-hand clenching might bolster visual memory encoding by enhancing right hemisphere activity, while right-hand clenching could support retrieval processes through left hemisphere activation, which aids in organizing and structuring visual information[10]. Despite the potential of hand clenching to affect cognition, particularly short-term visual memory, and few studies have systematically examined this relationship. Therefore, we propose to test the HERA model's applicability to visual materials using unilateral hand clenching. This technique could predispose processing towards the activated hemisphere, potentially improving visual memory recall in young adults. The simplicity and accessibility of this method make it promising for enhancing cognitive functions, especially in students, by potentially improving their ability to memorize and recall visual information efficiently.

METHODOLOGY

The participants in this observational study were 100 healthy, right-handed first-year MBBS students, aged 18 to 24 years, with an equal distribution of 50 male and 50 female subjects. The study took place at the Department of Physiology, National Institute of Medical Sciences and Research, Jaipur. Informed consent was obtained from all subjects. Purposive sampling was employed to select the sample population. Participants were included if they were cooperative and willing to provide consent, aged 18-25 years, and of either sex. Participants were excluded if they had neurological disorders or a history of head injury, chronic systemic diseases or chronic pain that might affect cognitive function, if they were smokers, alcoholics, individuals with upper limb musculoskeletal disability, or if they had auditory diseases impacting cognitive functions. The study involved five condition groups for hand clenching, each consisting of 20 subjects.

Groups and Hand Clenching Protocols: The participants were divided into five groups, each following a specific hand clenching protocol during encoding and recall tasks. The protocols and their representations are as follows:

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1. **No Hand Clenching (N/N) Group:** This group comprised 20 subjects who did not engage in hand clenching during either encoding or recall tasks.
2. **Right Hand Clenching Before Encoding and Recall (R/R) Group:** Consisting of 20 subjects, this group performed right-hand clenching before both encoding and recall tasks.
3. **Right Hand Clenching Before Encoding and Left-Hand Clenching Before Recall (R/L) Group:** With 20 participants, this group engaged in right-hand clenching before encoding and left-hand clenching before recall tasks.
4. **Left Hand Clenching Before Encoding and Recall (L/L) Group:** This group included 20 subjects who performed left-hand clenching before both encoding and recall tasks.
5. **Left Hand Clenching Before Encoding and Right-Hand Clenching Before Recall (L/R) Group:** Comprising 20 subjects, this group conducted left-hand clenching before encoding and right-hand clenching before recall tasks.

Materials: The study utilized a visual word memory test shown on a laptop screen. The memory stimuli consisted of 10 PowerPoint slides with common and unrelated words displayed visually.

Procedure: Clenching stimuli involved participants clenching a 5 cm diameter rubber ball before encoding and recall. The 'Memory Test' was neutral in character, ensuring equal applicability to both male and female subjects. Participants were familiarized with the testing process. Each subject was tested individually for visual memory in a quiet, controlled environment at the Department of Physiology; NIMS&R. Items of the visual subtest were shown to subjects one after another with a gap of 3 seconds. The entire presentation process took approximately 30 seconds. Following the presentation, there was a two-minute delay during which light conversation unrelated to the memory task was held with the subjects. During this period, for groups involving hand clenching, subjects continued clenching a rubber ball for 45 seconds twice, with a 15-second rest in between. After the delay, participants were asked to recall as many words from the list they saw earlier as they could within 30 seconds, in any order, on a preprinted 10-squares sheet of paper. Subjects then waited for 60 seconds before starting the next subtest.

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Scoring: Each trial of the Visual Word Memory (VWM) subtest was scored based on the number of correct responses. The correct responses in each trial were recorded to provide data for statistical analysis.

RESULT

A one-way analysis of variance (ANOVA) was conducted to compare the effect of different hand clenching conditions on the total number of words correctly recalled during the visual recall test. The ANOVA examining the total correctly recalled words was significant for the visual word recall test. The f-ratio value was 3.61024. The p-value was .007288. Hence the result is significant at $p < .05$. Post hoc examination of effects revealed that Right Encoding/ Left Recall [R/L] was > Right Encoding/Right Recall [R/R] > Left Encoding Right Recall [L/R] > Left Encoding/Left Recall [L/L] >No Encoding/No Recall [N/N] for visual word memory recall test.

Table 1: Correctly recall score of Visual memory test as a function of Hand Clenching paradigm

Hand Clenching condition	N/N	R/R	R/L	L/L	L/R
Average recall score	4.9	5.15	5.75	5.05	5.12

Bar diagram 1: Correctly recall score of Visual memory test as a function of Hand Clenching paradigm.

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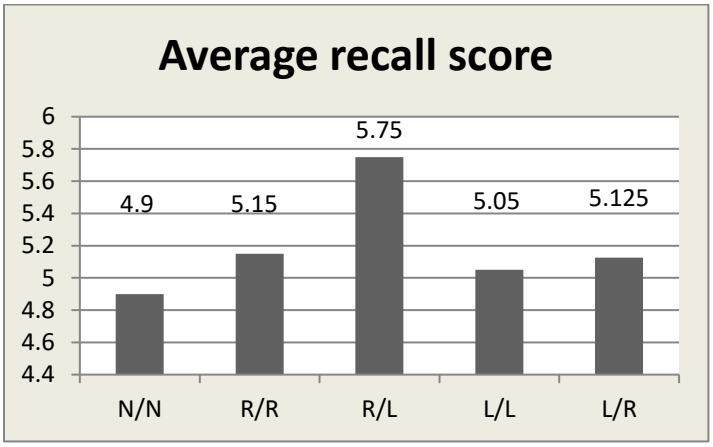

These findings indicate that the Right Encoding/Left Recall (R/L) condition resulted in the highest recall performance and other conditions also. The recall performance of all the Hand Clenching conditions is shown below in table 2.

Table 2: Showing order of effectiveness of Hand Clenching paradigm

Hand Clenching Condition	**Effectiveness**
Right Encoding/Left Recall (R/L)	Most effective
Right Encoding/Right Recall (R/R)	Highly effective
Left Encoding/Right Recall (L/R)	Moderately effective
Left Encoding/Left Recall (L/L)	Less effective
No Encoding/No Recall (R/R)	Baseline

DISCUSSION

Our study explored the impact of unilateral hand clenching on visual memory recall, applying the Hemispheric Encoding/Retrieval Asymmetry (HERA) model to young adults. Our findings revealed significant differences in recall performance across various hand clenching conditions, supporting the hypothesis that specific hemisphere activations through hand clenching can enhance memory performance. Specifically, the Right Encoding/Left Recall (R/L) condition yielded the highest recall performance, followed by Right Encoding/Right Recall (R/R), Left Encoding/Right Recall (L/R), Left Encoding/Left Recall (L/L), and finally No Encoding/No

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Recall (N/N) which was actually taken as the baseline score as shown above in Table 1,2 and Bar diagram 1.

The results align with previous study, indicating that hand clenching can modulate hemispheric activation, thereby influencing cognitive functions. The HERA model suggests that left hemisphere activation (induced by right-hand clenching) is beneficial during encoding, whereas right hemisphere activation (induced by left-hand clenching) aids in retrieval. Our findings corroborate this model, showing that R/L clenching is most effective, likely due to the optimal engagement of both hemispheres during their respective phases of encoding and recall. These findings are consistent with studies by Propper et al. (2013)[11], which demonstrated that right-hand clenching before learning and left-hand clenching before recall could improve episodic memory performance. Propper and colleagues found that such hand clenching techniques could modulate hemispheric activity, influencing memory performance in line with the HERA model. Similarly, studies by Lyle et al. (2010)[12] reported that hand clenching influenced episodic memory tasks, supporting the notion that lateralized motor activities could affect cognitive processes. Contrary to some studies reporting neutral effects of hand clenching on cognitive tasks, our study highlights significant improvements in visual memory recall, particularly under the R/L condition. This discrepancy might be attributed to the specific nature of visual memory tasks, which differ from the verbal tasks commonly used in earlier studies. For instance, Neubauer et al. (2010)[13] observed that while hand clenching had minimal effects on verbal tasks, it significantly influenced tasks requiring spatial and visual processing. Moreover, electrophysiological studies[4,5] have demonstrated increased prefrontal cortical activity contralateral to the clenched hand, supporting the idea that hand clenching effectively modulates cortical activation patterns. Our study extends the current understanding by demonstrating that the hand clenching technique is not only applicable to verbal memory tasks but also significantly enhances visual memory performance. This is particularly relevant given the right hemisphere's role in visual and spatial processing. Left-hand clenching before encoding appears to optimize the right hemisphere's involvement, thereby enhancing visual memory encoding. Research by Gallina et al. (2015)[14] supports this view, showing that left-hand clenching can enhance spatial memory performance by engaging the right hemisphere more effectively. The findings also

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underscore the potential applications of unilateral hand clenching in educational settings. The simplicity and accessibility of this technique make it a promising tool for students to improve their memory recall, particularly for visually presented information. This could have broader implications for developing non-invasive cognitive enhancement strategies that leverage natural hemispheric asymmetries.

However, our study has **limitations** that warrant consideration. The sample was limited to right-handed first-year MBBS students, which may limit the generalizability of the findings to other populations. Additionally, the short duration of the hand clenching intervention suggests that further research is needed to explore the long-term effects and potential applications in clinical settings. Future research should investigate the underlying neural mechanisms through advanced imaging techniques such as fMRI and PET scans to elucidate the specific brain regions involved in hand clenching-induced memory enhancements. Moreover, studies should explore the effects of hand clenching on other cognitive functions, such as long-term memory and attention, to fully understand the scope of this technique's impact on cognitive performance.

CONCLUSION

Our study supports the HERA model's applicability to visual memory tasks, demonstrating that unilateral hand clenching can significantly enhance visual memory recall. The R/L condition, in particular, appears to offer the most substantial benefits, highlighting the importance of strategically activating specific hemispheres during encoding and recall phases. These findings open new avenues for cognitive enhancement techniques and underscore the need for further research to optimize and apply these strategies in various contexts.

AUTHORS' CONTRIBUTIONS

Tarun Raikwar contributed to data collection and statistical analysis. Heera Lal Kumawat, as the corresponding author, supervised the study, provided critical revisions, and coordinated the manuscript submission. Bittoo Kumar Surlya assisted in the literature review and manuscript drafting. Adil Abbas contributed to manuscript writing, editing, and reviewing. Abid Manzoor

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designed the study, interpreted the results, and critically revised the manuscript. Shilpa Rattan assisted in data acquisition, and Priya Duvedi helped in data analysis and manuscript proofreading.

CONFLICT OF INTEREST

The authors declare no conflicts of interest concerning this study.

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REFERENCES

1. Harmon-Jones, E. (2006). Unilateral right-hand contractions cause contralateral alpha power suppression and approach motivational affective experience. *Psychophysiology, 43*(6), 598-603.
2. Schiff, S., Rumiati, R., Basso, D., & Mapelli, D. (2015). Left- and right-hand contraction effects on hemispheric asymmetry. *Experimental Brain Research, 233*(1), 277-282.
3. Davidson, R. J. (2004). What does the prefrontal cortex "do" in affect: Perspectives on frontal EEG asymmetry research. *Biological Psychology, 67*(1-2), 219-234.
4. Tulving, E., Kapur, S., Craik, F. I. M., Moscovitch, M., & Houle, S. (1994). Hemispheric encoding/retrieval asymmetry in episodic memory: Positron emission tomography findings. *Proceedings of the National Academy of Sciences, 91*(6), 2016-2020.
5. Miller, G. A., Crocker, L. D., Spielberg, J. M., Infantolino, Z. P., & Heller, W. (2013). Issues in localization of brain function: The case of lateralized frontal cortex in cognition, emotion, and psychopathology. *Frontiers in Integrative Neuroscience, 7*, 2.
6. Grabner, R. H., Fink, A., Stipacek, A., Neuper, C., & Neubauer, A. C. (2004). Intelligence and working memory systems: Evidence of neural efficiency in alpha band ERD. *Cognitive Brain Research, 20*(2), 212-225.
7. Nyberg, L., Cabeza, R., & Tulving, E. (1996). PET studies of encoding and retrieval: The HERA model. *Psychonomic Bulletin & Review, 3*(2), 135-148.
8. Habib, R., & Nyberg, L. (2008). Neural correlates of availability and accessibility in memory. *Brain and Cognition, 66*(1), 79-94.
9. Corballis, M. C. (2003). From mouth to hand: Gesture, speech, and the evolution of right-handedness. *Behavioral and Brain Sciences, 26*(2), 199-208.
10. Kosslyn, S. M., Thompson, W. L., Kim, I. J., & Alpert, N. M. (1995). Topographical representations of mental images in primary visual cortex. *Nature, 378*(6556), 496-498.

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11. Propper, R. E., McGraw, S. E., Brunyé, T. T., & Weiss, M. (2013). Hemispheric differences in memory performance following unilateral hand contractions. *Brain and Cognition*, 81(1), 102-108.
12. Lyle, K. B., Logan, J. M., & Roediger, H. L. (2010). Handedness induction leads to asymmetric memory effects in paired associate learning. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 36(3), 686-690.
13. Neubauer, A. C., Fink, A., & Grabner, R. H. (2010). Sensitivity of EEG coherence to cognitive and situational demands. *Neuroscience & Biobehavioral Reviews*, 34(7), 934-941.
14. Gallina, J., Gawryluk, J. R., & Kirton, A. (2015). Hemispheric differences in the spatial memory of children. *Neuropsychologia*, 75, 329-335.