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The Power Grip of Memory: Unilateral Hand Clenching and Short-Term Auditory Recall

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ABSTRACT:

Background: Unilateral hand clenching is a method that activates the contralateral hemisphere's frontal lobe, potentially enhancing emotional and cognitive processing. While its impact on emotional states is well-documented, its effects on cognition, particularly short-term auditory memory, remain underexplored. This study investigates the influence of hand clenching on short-term auditory memory in young adults. **Aim:** to investigate the influence of unilateral hand clenching on short-term auditory memory in young adults. **Methods:** The study included 100 healthy, right-handed first-year MBBS students aged 18-24 years, equally divided by gender. Participants were randomly assigned to five groups based on different hand clenching protocols: no 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). Auditory memory was assessed using an Auditory Word Memory (AWM) test, where participants recalled words from audio clips after hand clenching. **Results:** ANOVA results indicated significant differences in recall performance across hand clenching conditions ($F(4, 95) = 6.45$, $p < 0.05$). The R/L group exhibited the highest recall performance, followed by L/L, R/R, L/R, and N/N. Post hoc analysis confirmed the superior performance of the R/L condition compared to other groups. **Conclusion:** Unilateral hand clenching significantly improves short-term auditory memory in young adults. This technique, particularly right-hand clenching before encoding and left-hand clenching before recall, can be applied to boost cognitive performance, offering practical benefits for learning and memory enhancement.

1. Introduction

Unilateral hand clenching, a unique method, activates the opposite hemisphere's frontal lobe and is linked to heightened emotional processing[1]. A brief 90 seconds of left-hand clenching boosts right hemisphere activity, while the same duration of right-hand clenching increases left hemisphere activity[2]. This approach can be a valuable tool to examine cerebral hemisphere specializations in intact humans, potentially enhancing performance in tasks requiring distinct brain resources. Unilateral hand clenching holds promise for basic research into functional variations and therapeutic applications, considering the differential involvement of brain hemispheres in various activities like language, emotion, aggression, spatial processing, and information processing[3, 4]. Unilateral hand clenching has been utilized by researchers to manipulate hemispheric activation, particularly in assessing asymmetrical contributions to perceptual processing. While the impact of hand clenching on emotional states is well-documented, few studies have explored its effects on cognition, especially short-term and working memory. The Hemispheric Encoding/Retrieval Asymmetry (HERA) model suggests that right hand clenching (left hemisphere activation) prior to encoding and left-hand clenching (right hemisphere activation) prior to recall may enhance episodic memory recall. Some studies propose a refined HERA model applicable to both verbal and nonverbal materials[5].Recent electrophysiological research indicates increased prefrontal cortical activity contralateral to the clenched hand[6]. While PET and fMRI investigations generally support the HERA pattern, exceptions exist, with a few studies reporting neutral results, possibly influenced by material type (verbal/nonverbal stimuli) [7, 8, 9]. Specifically, the auditory modality plays a significant role in memory processes, and its connection with hand clenching has shown potential in enhancing auditory memory encoding and retrieval. Auditory memory, critical for processing and retaining spoken information, can be influenced by hemispheric activation through unilateral hand clenching. Studies indicate that auditory stimuli are primarily processed in the left hemisphere, which is associated with language and verbal memory functions. Right hand clenching, therefore, might enhance auditory memory encoding by activating the left hemisphere, while left hand clenching could facilitate retrieval processes by engaging the right hemisphere, which supports broader cognitive functions, including attention and context integration. Few studies have explored how unilateral hand clenching affects cognition, particularly short-term auditory memory. Hence, we propose testing the HERA model's precision using varied auditory materials. Hand clenching may predispose processing toward the activated hemisphere, and we aim to assess its impact on short-term memory, focusing on auditory routes in young adults. This simple technique holds promise for enhancing cognitive functions, especially in students, by potentially improving their capacity to memorize and recall auditory information efficiently.

2. 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. Inclusion criteria for the study encompassed subjects aged 18-25 years, of both sexes, who were cooperative and willing to provide consent. Exclusion criteria comprised individuals with neurological disorders or a history of head injury, chronic systemic diseases or chronic pain that might affect cognitive function, smokers, alcoholics, individuals with upper limb musculoskeletal disability, and those with 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:

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**: Similar to the previous groups, 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 for the study included a battery of memory test comprising auditory memory subtest. The auditory memory test included Auditory Word Memory test (AWM). Memory stimuli consisted of 10 PowerPoint slides with common and unrelated words played as audio clips. 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 auditory memory in a noise-free research lab at the Department of Physiology; NIMS&R. Items of the auditory subtest were played 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 heard 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.
Scoring. Each trial of the Auditory Word Memory (AWM) subtest was scored based on the number of correct responses. The correct responses in each trial were recorded to provide data for statistical analysis.

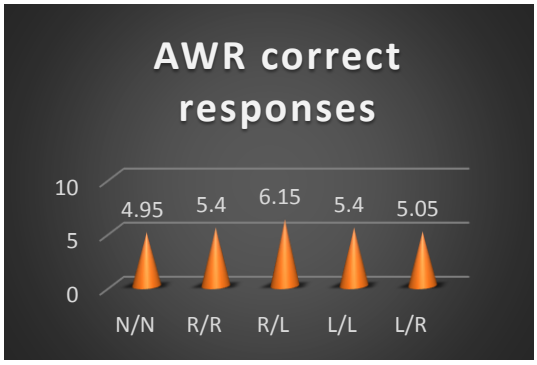
3. Observations and Result

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 auditory recall test. The ANOVA examining the total correctly recalled words was significant for the auditory word recall test, with an F-ratio value of 6.45151. The p-value was 0.000068,

indicating that the results were significant at $p < 0.05$. Post hoc analysis revealed significant differences in recall performance across the hand clenching conditions. The effectiveness of the hand clenching conditions on auditory word recall, ranked from highest to lowest, was as follows

Hand Clenching Condition	N/N	R/R	R/L	L/L	L/R
Average correctly recall score	4.95	5.4	6.15	5.4	5.05

Figure 1: Showing average Number of Words Recalled



Pie diagram 1: Correctly recalled score for auditory word recall test as a function of hand clenching.

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 is shown below as:

- **Most effective**: Right Encoding/Left Recall (R/L)
- **Highly effective**: Left Encoding/Left Recall (L/L)
- **Moderately effective**: Right Encoding/Right Recall (R/R)
- **Less effective**: Left Encoding/Right Recall (L/R)
- **Baseline**: No Encoding/No Recall (N/N)

4. Discussion

The ability to memorize and recall auditory information plays a crucial role in cognitive functions essential for learning and various activities. Short-term memory, the ability to retain a limited amount of information for a brief period, is influenced by factors such as attention, repetition, and the type of stimuli presented. Recent research has delved into the impact of physical actions, particularly hand clenching, on auditory memory in young adults. This study aims to investigate the effect of hand clenching on auditory routes of memorization for short-term memory in young adults through two-minute recall tests. In the auditory memory recall tests, individuals who encoded information immediately after right-hand clenching (associated with left hemisphere activation) and recalled it after left-hand clenching (associated with right hemisphere activation) demonstrated superior performance compared to those who did not engage in hand clenching. This condition significantly outperformed the control condition of no hand clenching, consistent with previous findings. Notably, this result aligns closely with the study by Ruth E. Propper10, "Getting a grip on memory: unilateral hand clenching alters episodic recall." Propper's study similarly found that encoding language-based information

after right-hand clenching and recalling it after left-hand clenching led to superior episodic memory compared to other hand clenching conditions. The pattern observed in both studies suggests a consistent enhancement of memory when utilizing this hand clenching protocol. When considering material-specific hemisphere asymmetries, a study by Nylberg ET al11. Emphasizes that material-specificity can occur irrespective of process specificity, supporting the Hemispheric Encoding/Retrieval Asymmetry (HERA) model. This model proposes that the right prefrontal cortex (PFC) is biased towards retrieval of verbal content, with supporting evidence from studies by Fletcher ET al12. And Lee ET al13. Similarly, the left PFC is implicated in encoding verbal materials during memory consolidation, as argued by Tulving et al., and also in encoding non-verbal materials, as concluded by Owen et al. However, our study refines this model by specifically examining short-term memory and finds consistent left PFC involvement in memory encoding, regardless of the type of auditory stimuli used. Additionally, our results indicate that the right PFC is differentially more involved in retrieving encoded auditory information for short-term memories, further supporting the HERA model. While hemisphere activation was not quantified in our analysis, recent research by CK Peterson et al[14]. Suggests that unilateral hand clenching activates the contralateral prefrontal cortex, potentially explaining the observed memory enhancements. These findings offer compelling insights into the potential applications of hand clenching in experimental, clinical, and real-world settings to study and modify the functional specialization of cerebral hemispheres, particularly in the auditory domain. Our study underscores the simplicity and efficacy of this technique, suggesting that unilateral hand clenching can serve as a practical method to enhance auditory memory performance, with implications for improving learning outcomes and cognitive rehabilitation strategies.

5. Conclusion

In conclusion, this study reveals that unilateral hand clenching can effectively enhance short-term auditory memory in young adults. The protocol of right-hand clenching before encoding and left-hand clenching before recall significantly improves recall performance, aligning with the HERA model. These results suggest that hand clenching is a simple yet powerful tool for boosting cognitive function, with potential applications in educational and clinical settings.

Authors' Contributions

Abid Manzoor: Conceptualization, Methodology, Investigation, Data Curation, Writing - Original Draft.
Adil Abbass: Methodology, Validation, Formal Analysis, Data Curation, Writing - Review & Editing.
Alolika Bhattacharyya: Investigation, Resources, Data Collection, Visualization.
Diksha Mittal: Formal Analysis, Visualization, Writing - Review & Editing.
Amit Kumar Verma: Supervision, Project Administration, Writing - Review & Editing. Vanshika Sharma Review & Editing.

Conflict of Interest

The authors declare that they have no conflict of interest. All the authors have gone through and agreed to the manuscript. The results from this research are not influenced by financial, personal or professional issues.

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