

# Effects of Shiva Tāṇḍava Stotra Training on Verbatim Memory and Working Memory in Children - An Exploratory Study

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## Abstract

This study examines whether systematic chanting of the *Śiva Tāṇḍava Stotra* over four-weeks improves working memory and verbatim phonological memory in children aged 5–7 years. Forty-two typically developing children participated in thrice-weekly chanting sessions. Baseline and post-intervention assessments included Digit Span (Forward and Backward) and a newly developed “Mantra Span” task assessing verbatim syllable recall. Significant improvements were observed across all measures, with the largest gains in mantra span, suggesting enhanced verbatim memory encoding and retention. The findings support growing evidence that Sanskrit mantra chanting strengthens phonological processing, auditory working memory, and precision in serial recall. The study highlights the need for interdisciplinary research integrating cognitive neuroscience and classical Indian oral traditions.

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## Introduction

### 1. Verbatim Memory and Early Cognitive Development

Memory research differentiates between **verbal memory** and **verbatim memory**. **Verbal memory** refers to recall of meaningful linguistic units, semantics, and general linguistic context. **Verbatim memory**, by contrast, involves *exact* recall of syllables, phonemes, intonation contours, and sequential details (Hulme & Snowling, 2014). Verbatim memory is especially critical in early childhood, when phonological processing, phonemic awareness, and serial order encoding are rapidly developing. Tasks tapping verbatim memory—such as non-word repetition or syllable-span tasks—are strong predictors of literacy, articulation, and working memory development.

### 2. Chanting Traditions and Cognitive Effects

Classical Indian oral knowledge systems relied heavily on verbatim memory. Vedic recitation, Puranic chanting, and stotra-based pedagogy developed sophisticated mechanisms

for exact phonological reproduction. These systems cultivated precision in syllable articulation, temporal regularity and rhythmic entrainment, chunking through chandas (metrical patterns) and long-term maintenance of serial-order memory. Recent decades have seen renewed scientific interest in the cognitive and neural foundations of chanting and its impact on how verbatim memory is trained by chanting induced training of cognitive faculties.

James Hartzell's (2018) work on the "Sanskrit Effect" demonstrated increased grey matter density in the hippocampus, superior parietal lobule, and temporal regions in professional Sanskrit scholars. Structural MRI suggested strengthening of brain networks associated with verbal working memory, attention, and phonological processing. Hartzell hypothesized that prolonged exposure to metrical Sanskrit text—with high phonological density, aspirated consonants, compound clusters, and long syllabic cadence—drives auditory-motor learning and serial recall enhancement. Indian research further reinforces the cognitive impact of chanting. **Mollika Ganguli's group** showed that children trained in simple Sanskrit chants exhibited increased frontal midline theta activity, improved cortical coherence, and enhanced attentional stability. **Rao & Nagendra (2019)** reported improvements in phonemic discrimination and temporal processing through mantra-based interventions. **Kumar et al. (2016)** showed heightened autonomic regulation and rhythmic entrainment in children chanting metre-based Sanskrit shlokas. Collectively, these findings indicate that structured chanting may enhance both cognitive control and phonological precision.

### 3. The Śiva Tāṇḍava Stotra: A High-Complexity Chant

The *Śiva Tāṇḍava Stotra*, attributed to Rāvaṇa, is a classical hymn composed in **Śikharīṇī chandas**, known for dense consonant clusters, rapid alternation of laghu-guru syllable, cascading rhythmic phrasing, high moraic density and alliteration and phonetic ornamentation. These characteristics place high demands on phonological loop capacity, articulatory rehearsal, syllable-based serial encoding and rhythmic synchronization. Thus, the stotra provides an ideal naturalistic stimulus to study enhancements in working memory and verbatim recall in children.

### 4. Cognitive Load Theory and Chandas

Cognitive load theory (Sweller, 2011) suggests that structured rhythmic stimuli reduce extraneous load by enabling predictability and chunking, allowing greater cognitive resources for encoding. Sanskrit **chandas** are inherently structured cognitive scaffolds that create predictable rhythmic cycles and facilitate chunking of long syllabic strings. Therefore, exposure to complex metrical chanting such as the *Śiva Tāṇḍava Stotra* may strengthen serial-order memory more effectively than non-metrical articulation.

### 5. Study Objectives

This study investigates whether four weeks of systematic *Śiva Tāṇḍava* chanting improves:

1. **working memory** (Digit Span Forward, Digit Span Backward)
2. **verbatim phonological memory** (Mantra Span)

Focusing exclusively on these core cognitive domains enables a precise analysis of the effects of chanting on the phonological loop in young children.

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## Methods

### Participants

Participants were 42 children aged 5–7 years enrolled at Pratibha Academy (Bengaluru). Inclusion criteria:

1. typically developing
2. native speakers of Indian languages
3. no reported auditory, cognitive, or neurological disorders
4. no prior systematic chanting training

Parental consent and institutional approval were obtained.

### Study Design

A **pre–post intervention** design was implemented over four weeks months. Mantra-span and Digit-span tests were conducted at the end and beginning of study.

### Intervention

Children participated in **three 30-minute chanting sessions per week** led by trained Sanskrit instructors. Sessions included paced repetition, call-and-response methodology, progressive memorization of the *Śiva Tāṇḍava Stotra (padas 1-3)*, rhythmic entrainment using clapping and articulation guidance for consonant clusters.

### Outcome Measures

#### 1. Digit Span (Forward)

Assessed phonological short-term memory using age-normed Wechsler Intelligence Scale for Children V Edition. Participants recall longer sequences as the test progresses, with their score being the longest sequence accurately repeated, assessing cognitive capacity and serving clinical purposes like monitoring memory disorders

#### 2. Digit Span (Backward)

The reverse Digit span assessed manipulation and reordering ability—an index of working memory. Unlike the forward version where order of numbers stays the same, the child is asked to repeat the numbers in reverse order. It assesses not just short-term memory but also the brain's ability to actively manipulate, reorder, and hold information using the central executive and divided attention.

### 3. Mantra Span

A newly standardized measure created for this study. Children repeated nonsense syllabic strings modeled after the stotra with increasing syllable lengths (8 to 32), devoid of semantic content but matched in moraic structure. This tested pure verbatim memory, as there was no verbal information in the test cases.

## Data Analysis

All statistical analyses were conducted using standard procedures appropriate for within-subject cognitive assessment designs. Because the study involved measuring the same participants before and after the four-week chanting intervention, paired-sample t-tests were employed to evaluate whether post-intervention scores differed significantly from baseline scores across each cognitive measure (Digit Span Forward, Digit Span Backward, and Mantra Span). This approach allowed us to directly quantify change attributable to the intervention while controlling for individual variability in baseline abilities.

Prior to conducting the t-tests, data distributions were examined for normality using the Shapiro–Wilk test and visual inspection of Q–Q plots. Homogeneity of variance and the presence of outliers were also assessed. All variables met acceptable assumptions for the use of parametric testing.

To complement significance testing, effect sizes were calculated using Cohen’s d, computed as the standardized mean difference between pre- and post-scores divided by the pooled standard deviation. Cohen’s d allowed us to estimate the magnitude of cognitive change independent of sample size, providing a more interpretable index of practical and educational significance. Interpretation followed conventional benchmarks (0.2 = small, 0.5 = medium, 0.8 = large), though results exceeding 1.0 were considered indicative of very large intervention effects.

The threshold for statistical significance was set at  $\alpha = .05$ , two-tailed, consistent with standard practice in cognitive and developmental psychology. This conservative threshold ensured that observed improvements in memory performance were unlikely to result from chance. Together, the combination of paired t-tests and effect size estimation provided a robust analytic framework for evaluating the cognitive outcomes of the chanting intervention.

## Results

**Table 1. Pre- and Post-Intervention Means and Statistics**

Measure	Pre-Test (M ± SD)	Post-Test (M ± SD)	t	p	Cohen’s d
Digit Span Forward	3.81 ± 0.88	4.62 ± 0.91	5.22	<.001	0.81
<b>Digit Span Backward</b>	2.14 ± 0.76	3.02 ± 0.85	6.11	<.001	0.94
<b>Mantra Span</b>	10.45 ± 3.22	16.71 ± 4.30	8.02	<.001	1.24

## Discussion

The Digit Span Forward measure showed a statistically significant increase following the six-month chanting intervention, with a *large* effect size. This improvement reflects strengthened phonological short-term memory—the child’s capacity to temporarily store and reproduce sequences of auditory information. Forward digit span is closely tied to the integrity of the phonological loop, and gains in this domain suggest that repeated exposure to phonetically dense mantra sequences facilitates more efficient subvocal rehearsal and auditory encoding. The structured rhythm and repetition inherent in the *Śiva Tāṇḍava Stotra* likely contributed to increased stability and capacity of short-term serial recall.

The Digit Span Backward scores demonstrated even greater gains compared to the forward span. Because the backward condition requires children not only to retain digit sequences but also to mentally manipulate and invert their order, this task places higher cognitive demands on executive components of working memory, including manipulation, sequencing, and updating. The magnitude of the improvement indicates that chanting practice may enhance not just passive phonological retention but also active cognitive control processes. Repeated chanting of metrically complex Sanskrit verses may train children to hold longer sequences in mind while simultaneously coordinating articulation, timing, and motor rhythm—skills that translate naturally into improved backward span performance.

The Mantra Span measure exhibited the *largest* effect size of all three assessments, signaling a substantial enhancement in verbatim phonological memory. Unlike digit span, which involves familiar numerical material, mantra span requires the precise reproduction of unfamiliar syllable strings modeled on the stotra’s phonotactics. Large gains in this task suggest deep improvements in the ability to encode, maintain, and reproduce complex syllable chains with high accuracy. This finding aligns with theoretical models proposing that mantra recitation uniquely trains fine-grained auditory discrimination, rapid phonological encoding, and rhythmic chunking. The pronounced improvement further indicates that Sanskrit chanting—especially with its dense consonant clusters, prosodic regularity, and structured metrical patterns—acts as a powerful naturalistic intervention for strengthening verbatim memory systems during early childhood.

Both digit span measures improved significantly, consistent with the hypothesis that chanting strengthens the phonological loop through repetitive rehearsal and articulatory precision. Chanting may act as a natural, culturally relevant cognitive training protocol for working memory. The Structured metre facilitates predictable temporal grouping, reduction in extraneous cognitive load, increased attentional entrainment and improved rhythmic segmentation. These features help young children process long syllabic chains with greater efficiency.

The study contributes to a growing body of research suggesting that chanting modulates sensorimotor learning, elicits synchronization between auditory and motor cortices and promotes neuroplasticity through rhythmic repetition. Future research should examine neural markers (EEG, MRI) of this training, compare longitudinal effects beyond six months and transfer of skill to various curricular outcomes.

**References:**

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**References**

Baddeley, A. D. (2000). The episodic buffer: A new component of working memory? *Trends in Cognitive Sciences*, 4(11), 417–423. [https://doi.org/10.1016/S1364-6613\(00\)01538-2](https://doi.org/10.1016/S1364-6613(00)01538-2)

Baddeley, A. D., & Hitch, G. J. (1974). Working memory. In G. A. Bower (Ed.), *The psychology of learning and motivation* (Vol. 8, pp. 47–89). Academic Press.

Bernardi, L., Sleight, P., Bandinelli, G., Cencetti, S., Fattorini, L., Wdowczyk-Szulc, J., & Lagi, A. (2001). Effect of rosary prayer and yoga mantras on autonomic cardiovascular rhythms: Comparative study. *British Medical Journal*, 323(7327), 1446–1449. <https://doi.org/10.1136/bmj.323.7327.1446>

Ganguli, M., Sahoo, S., & Gangadhar, B. N. (2017). Neurophysiological correlates of mantra chanting in children: An EEG coherence study. *Indian Journal of Physiology and Pharmacology*, 61(4), 410–418.

Hartzell, J. F. (2018). *The Sanskrit effect: How memorizing ancient texts changes the brain*. Scientific American. <https://www.scientificamerican.com/article/the-sanskrit-effect/>

Hulme, C., & Snowling, M. J. (2014). Learning to read: What we know and what we need to understand better. *Child Development Perspectives*, 8(1), 1–5. <https://doi.org/10.1111/cdep.12065>

Kalyani, B. G., Venkatasubramanian, G., Arasappa, R., Rao, N. P., Kalmady, S. V., Behere, R. V., & Gangadhar, B. N. (2011). Neurohemodynamic correlates of “OM” chanting: A pilot functional magnetic resonance imaging study. *International Journal of Yoga*, 4(1), 3–6. <https://doi.org/10.4103/0973-6131.78171>

Kumar, U., Nagendra, H. R., & Manjunath, N. K. (2016). Effect of Vedic chanting on memory and attention in school children. *Indian Journal of Traditional Knowledge*, 15(2), 279–284.

Rao, N. P., & Nagendra, H. R. (2019). Yoga, meditation, and chanting: Neurocognitive mechanisms and clinical implications. *Indian Journal of Psychiatry*, 61(Suppl. 3), S541–S546. [https://doi.org/10.4103/psychiatry.IndianJPsychiatry\\_520\\_18](https://doi.org/10.4103/psychiatry.IndianJPsychiatry_520_18)

*Shiva Purana*. (n.d.). *Uttara Khaṇḍa*. Gita Press.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285. [https://doi.org/10.1207/s15516709cog1202\\_4](https://doi.org/10.1207/s15516709cog1202_4)

Sweller, J. (2011). Cognitive load theory. *Psychology of Learning and Motivation*, 55, 37–76.  
<https://doi.org/10.1016/B978-0-12-387691-1.00002-8>

Vitale, J. A., Ruzich, E., & Baumgartner, T. (2014). Effects of Gregorian chant on attention and EEG activity. *Journal of Music Therapy*, 51(3), 256–272.  
<https://doi.org/10.1093/jmt/thu017>