# It’s About Time: Rhythmic Foundations of Inner Thought

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The rhythmic patterns that shape human speech may be fundamental to the very nature of thought itself. In their innovative framework, Kreiner and Eviatar suggest prosody - the melody and rhythm of speech - is not a mere feature of overt expression, but a structural property organising inner speech and verbal thought [1]. Their thesis, grounded in embodiment theory, argues that prosodic features of overt speech - its rhythm, intonation, and stress patterns - are preserved in expanded inner speech, providing a physical form to structuring thought and supporting various cognitive functions. This timely theoretical advance not only addresses a critical gap in understanding inner speech form - an aspect that has long been overlooked - but also links it with related cognitive functions, raising deeper questions about the very nature of conscious thought.

The authors assemble their framework on converging evidence from behavioural and neuroscientific studies showing preserved acoustic features in inner speech, from phonemic interference in silent tongue-twisters [2,3] to neural signatures of prosodic processing [4,5]. These findings suggest that expanded inner speech retains phonological and prosodic features that function similarly to overt speech, such as supporting working memory through chunking and rehearsal [6,7], guiding syntactic parsing during silent reading [8,9], and facilitating emotional understanding and self-regulation via verbal labelling and formulation [10,11].

However, the authors acknowledge that many of these connections rely on indirect evidence, because inner speech is private and challenging to study directly. How, then, may we investigate the prosodic features of inner speech and their proposed functional roles?

One promising avenue lies in examining how biological rhythms organise mental activity across time. These fundamental temporal patterns may provide a measurable window into inner speech’s temporal organisation through observable neural signals. By studying these neural rhythms that give rise to mental structure, we might better understand not only the nature and dynamics of inner speech prosody but also its functional influence on cognition and thought.

This perspective is grounded in the observation that rhythmic organisation is a fundamental signature of life itself [12]. From metabolic control to stimulus-induced oscillatory behaviours to endogenous biological rhythms, living systems operate through orchestrated oscillatory processes that optimise energy distribution and coordinate various functions across different timescales [13]. Within

the brain, these biological rhythms manifest as neural oscillations - synchronised patterns of neuronal activity occurring at different frequencies. These oscillations serve as a core mechanism for information processing, with distinct frequencies coupling together to support sensory and cognitive functions [14].

Research has revealed how these neural rhythms are fundamentally involved in speech processing. Neural oscillations across different frequency bands correspond to temporal dynamics of distinct linguistic units: delta oscillations (1-4 Hz) correspond to prosodic phrases, theta oscillations (4-8 Hz) align with syllabic rate, and faster beta and gamma oscillations process phonemic features [15]. Oscillations across these frequencies work together through phase-amplitude coupling, where slower rhythms modulate faster ones, creating a hierarchical structure that mirrors the temporal organisation of speech itself [16].

While this temporal hierarchy is well-established in overt speech processing, evidence for oscillatory mechanisms in speech imagery and inner speech is only beginning to emerge. Recent studies have shown that imagining hearing Chinese poems word-by-word at 4Hz produced an emergent oscillatory signature that reflects the rhythmic organisation of five-word sentences at 0.8Hz [17]. Moreover, silent reading of direct speech quotes elicited vivid inner speech through increased phase synchrony in the auditory cortex, suggesting oscillatory encoding of inner speech dynamics [18].

These studies reveal that the temporal coordination of neural rhythms, especially through phase relationships, may provide the biological basis for inner speech prosody. The timing of neural rhythms directly creates the temporal structure of inner speech rhythm, while variations in phase synchrony influence the strength of coordinated neural responses, similar to stress patterns and intonational contours. These phase relationships between neural rhythms thus could orchestrate the prosodic manifestation of inner speech, allowing it to interface with sensory and cognitive processes through rhythmic coupling [14].

This oscillatory perspective aligns with and extends Kreiner and Eviatar's framework by identifying potential biological mechanisms underlying the prosodic features they describe. The integration of neural rhythms with inner speech prosody raises several critical questions about both the nature of inner speech form and its broader implications for conscious thought:

To start, how closely does inner speech mirror the oscillatory hierarchy of overt speech? Are prosodic features preserved across multiple temporal scales, from phonemic rhythms to prosodic contours? How might these rhythmic signatures differ between condensed and expanded inner speech?

The relationship between neural oscillations and inner speech functions also merits exploration: How do specific patterns of neural rhythmicity support different inner speech functions?

Does the precision and synchronicity of temporal coordination predict task performance relying on functions such as working memory or emotional regulation? How do these temporal metrics relate to the clarity and utility of inner speech?

Perhaps most intriguingly, these prosody-like neural rhythms may offer insights into conscious thought itself: If inner speech preserves the rhythmic architecture of overt speech, what does this tell us about the fundamental organisation of verbal thought? Does the temporal structure of inner speech reflect a deeper principle about how consciousness unfolds in time through language?

Building on Kreiner and Eviatar's innovative framework linking prosodic features to inner speech functions, the neural oscillations perspective offers a promising approach for investigating their theoretical predictions. By providing measurable biological signatures of temporal organisation in inner speech, this approach may help validate and extend their insights about prosody's role in thought organisation. This synthesis thus offers a concrete path forward for understanding both the form and function of inner speech, advancing our understanding of how inner prosody orchestrates consciousness across time.

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