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Rhythmic encoding improves recognition memory

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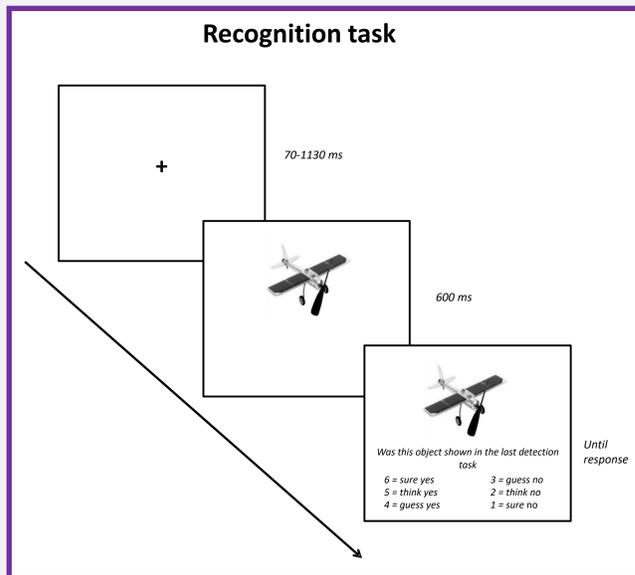
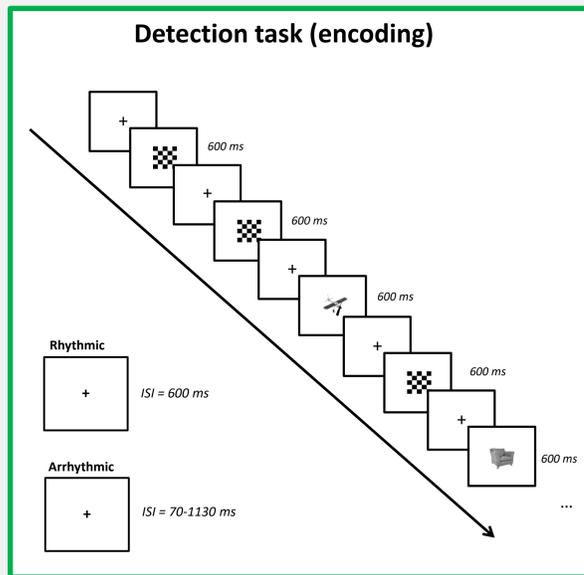
Highlights

- Rhythmic temporal structure at encoding enhances later recognition performance
- Enhanced PLF for rhythmic over arrhythmic conditions
- Encoding conditions did not influence early perceptual ERP components but affected differential neural activity based on memory (DM)
- Memory specific ERP components at retrieval influenced by temporal structure at encoding
- FN400 not affected by temporal structure whilst LPC old/new effect only present for rhythmic items

Background

Presenting events in a rhythm has shown to enhance perception and facilitates responses for stimuli that appear in synchrony with the rhythm (Nobre & van Ede, 2017; Haegens & Golumbic, 2017), but little is known about how rhythm during encoding influences later recognition. It is well established that the way in which information is processed during encoding determines how efficiently memories are formed and later retrieved (Davichi & Dobbins, 2008). Recently, Clouter et al. (2017) showed that associative memory depends upon the timing synchrony between different sensory cortices at the theta frequency, and Thavabalasingam et al. (2016) reported on the effect of temporal structure on recognition memory. However, little is known how rhythm affects recognition memory and the underlying neural processes involved. The current research addresses this.

Methods and Procedure



Detection task
Participants (N=24) viewed a continuous stream of checkerboards and objects. Task was to press space as quickly as possible if the object was an animal (10% of trials)

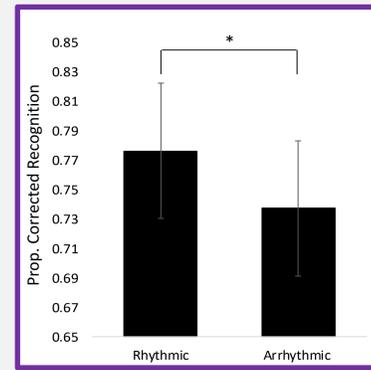
Presentation of items in followed a either rhythmic (1.67 Hz) or arrhythmic temporal pattern, of which participants were not made aware.

Recognition task
Participants were presented with an object and asked whether or not it has appeared in the prior detection task.

Design
Encoding - 3 rhythmic and 3 arrhythmic encoding blocks, each with 40 objects and 120 checkerboards. (ratio 3:1)

Recognition test - 40 old and 40 new objects per block

Results



Recognition task (retrieval)

Behaviour: Recognition was significantly greater in the rhythmic condition than the arrhythmic condition ($p = .032$, $d = 0.30$) but there was no difference in recognition RTs.

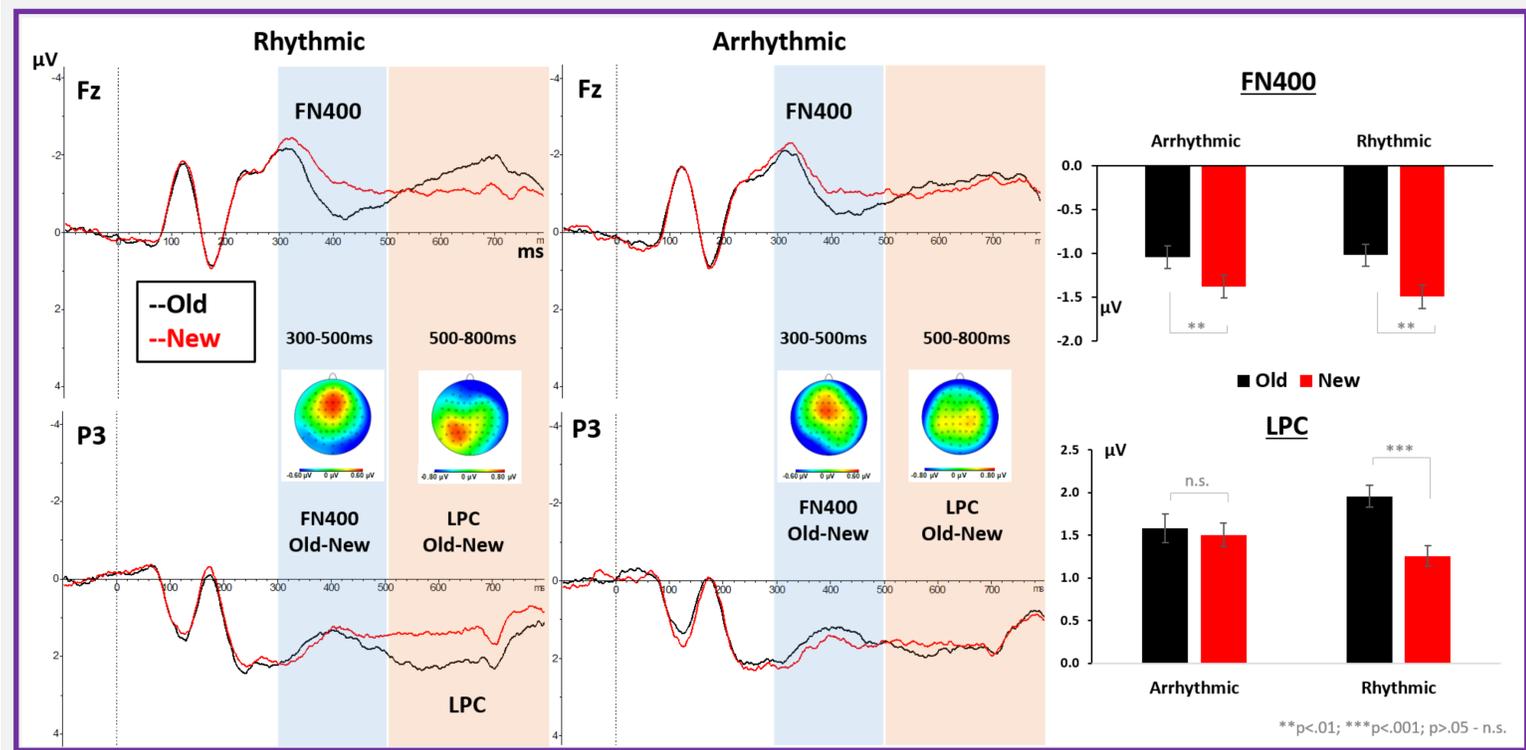
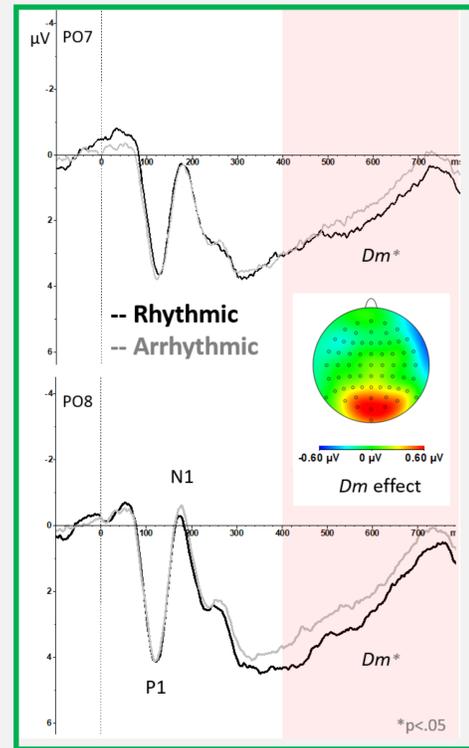
ERP: A FN400 old/new effect was present in both conditions with the LPC old/new effect only for rhythmically encoded objects. Bayes Factor analysis (0.24, 0.034% error) confirmed no difference of he LPC in the arrhythmic conditions.

Detection task (encoding)

Behaviour: No difference between correct detection of targets, and erroneous keypresses to non-targets between conditions, ($p = .283$, $d = 0.30$) and ($p = .723$, $d = 0.10$), respectively. However, participants were faster in detecting targets in the rhythmic than the arrhythmic condition ($p = .024$, $d = 0.56$). Only 3/23 reported awareness that presentation timings in the detection task varied across blocks.

EEG: A higher Phase locking factor (PLF) in the rhythmic compared to the arrhythmic encoding condition ($p = .001$, $\eta_p^2 = .39$).

ERP: No difference between arrhythmic and rhythmic at P1 or N1 but a larger *Dm* (Difference due to subsequent memory) for rhythmic over arrhythmic.



Conclusion

The study provides new evidence through EEG and behavioural measures that presenting stimuli in a rhythmic manner provides a benefit to recognition memory. Memory specific components during both encoding and retrieval are affected by temporal structure, even though participants were largely unaware of timing manipulation during encoding.