TEMPORAL AND SPATIAL ATTENTION IMPROVE RECOGNITION MEMORY

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Highlights

- **Recognition greater for items presented in a rhythmic relative to an arrhythmic manner, and for attended compared to unattended items.**
- **An interaction demonstrates that rhythmic presentation boosted recognition only for attended and not unattended items.**
- **Memory specific ERP components at recognition (the FN400 and late positive component (LPC) old/new effect) were differentially affected by both temporal structure and attention during encoding.**

Background

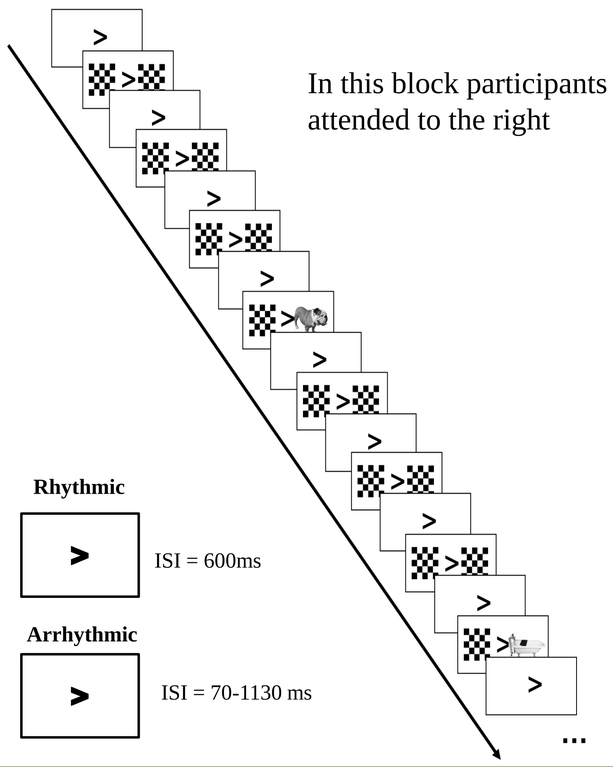
In order to efficiently interact with our environment we need to generate predictions about where and also when events occur. Endogenously attending to a location in space facilitates behaviour for attended over unattended stimuli (Carrasco, 2014). Moreover, presenting events in a rhythm has been shown to enhance perception and facilitate responses for stimuli that appear in synchrony with the rhythm (Large & Jones, 1999). Recently, we demonstrated that presenting stimuli in a rhythmic manner also provides a benefit to recognition memory (Jones & Ward, 2019). The current research investigates how temporal and spatial attention interact during item encoding to influence later recognition memory.

Methods

- **28 participants** (18-33 years old)
- **Visual stimuli:** The stimuli were 400x400 pixel greyscale images of everyday objects (e.g. a car, an apple) and checkerboards. Sixteen objects were animals (targets).

A detection task (encoding) was followed by a recognition task. There were 8 blocks (4 rhythmic and 4 arrhythmic encoding blocks).

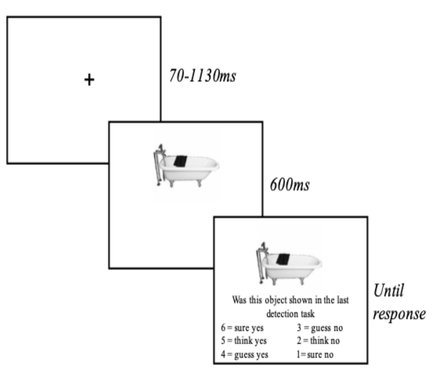
Encoding phase, animal detection task



Detection task:

In each block, a stream of objects were presented to the left and right side of the screen. Object pairs were either both checkerboards or one checkerboard and one object. An arrow (fixation point) was presented in the centre of the screen to cue attention to one side. Participants responded to targets only at the attended side. Each block followed a rhythmic (constant, predictable) or arrhythmic (random, unpredictable) temporal structure.

Old/new recognition task



Recognition task:

Participants judged whether they had seen the object before or not. In each block, 36 old objects along with 36 new objects were presented.

EEG Recording & pre-processing

EEG was recorded from 64 scalp electrodes (Active Two, BioSemi) + 2 x HEOG. 0.1-40Hz bandpass filter. Segmented -100 to 800 ms after stimulus onset 100 ms baseline correction. Artefact rejection ±100µV.

Awareness

At the end of the study participants completed a questionnaire to gauge awareness of the temporal manipulation.

Results

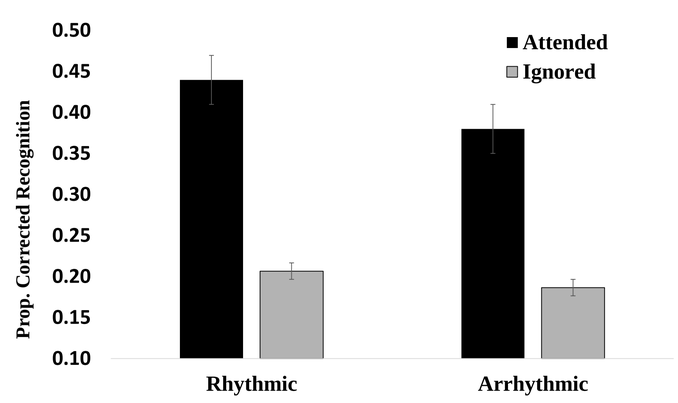
Behavioural:

Detection task

- Target detection speed was faster in the rhythmic compared to arrhythmic condition (p = .050). Correct detection of targets, and erroneous keypresses to non-targets did not significantly differ between the rhythmic and arrhythmic conditions (p = .058 and p = .350 respectively).

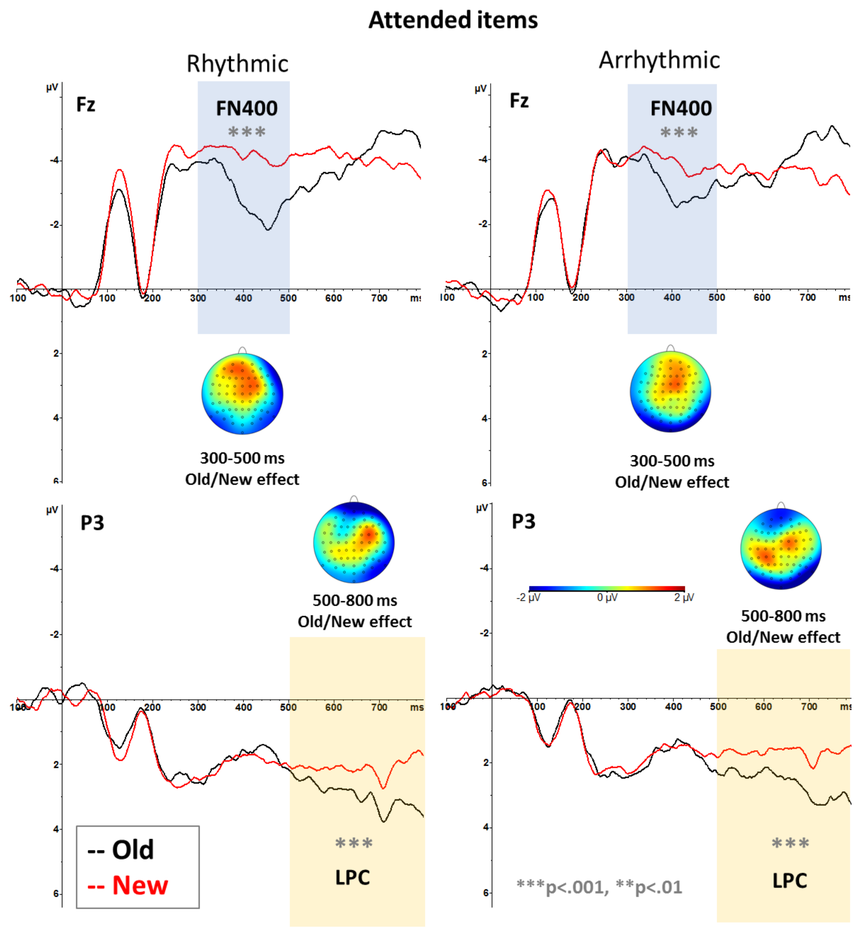
Recognition task

- Main effect of Spatial attention (p = .041), Temporal structure, (p < .001), and Spatial attention*Temporal attention interaction (p = .028).
- Recognition performance for attended items was greater in rhythmic compared to the arrhythmic condition (p = .011). No difference for ignored items (p = .311, d = 0.08).



ERP:

ERPs were time locked to recognition stimulus onset and analysis was separated by attended and unattended items. The mean ERP amplitude was computed for the FN400 (300-500 ms, Fz electrode) and Late Positive Component (LPC; 500-800, P3 electrode) and analysed using a 2x2 ANOVA with factors Temporal structure (rhythmic, arrhythmic) x Item (old, new objects).



FN400

- ***Attended Items only***

Main effect of Item (p < .001). No effect of Temporal structure (p = .360), nor Temporal structure*Item interaction (p = .606).

- ***Unattended Items only***

Main effect of Item (p = .026) and significant interaction between Temporal Structure and Item (p = .037). There was no effect of Temporal structure (p = .117).

- ***FN400 summary***

The FN400 showed old/new effect for attended items in both rhythmic and arrhythmic condition, whereas for unattended items in only rhythmic condition.

LPC

- ***Attended stimuli only***

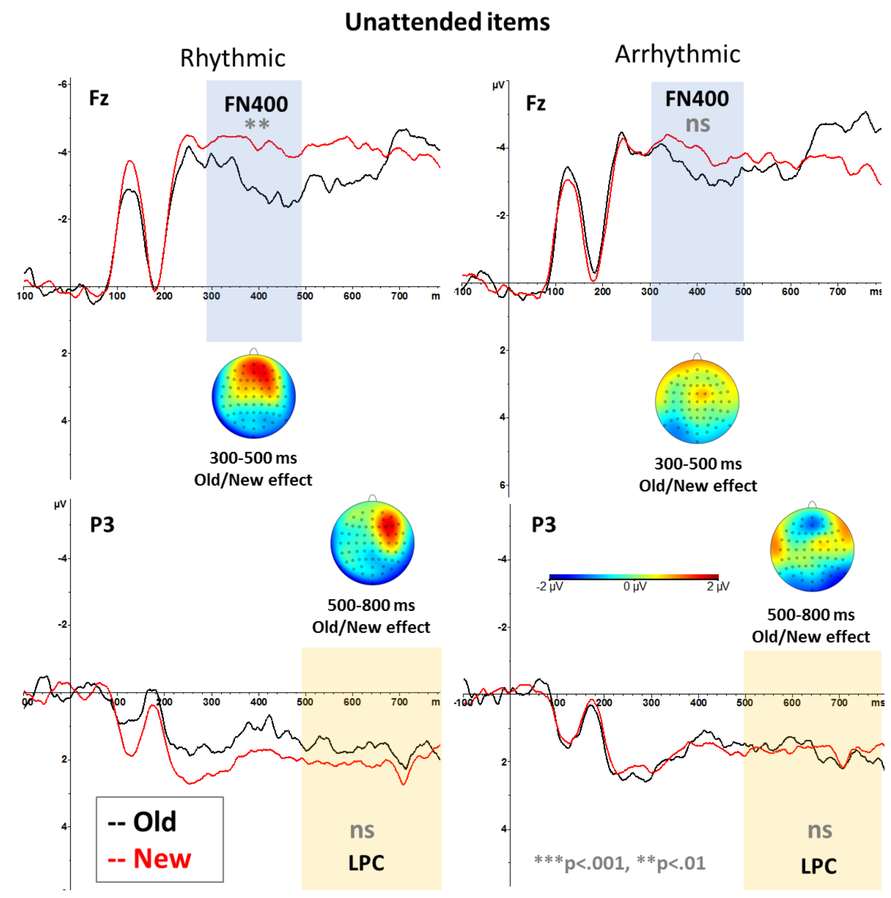
Main effect of Item (p = .002) whilst no significant effect of Temporal structure (p = .215) nor Temporal structure*Item interaction (p = .760).

- ***Unattended stimuli only***

No main effect of Item (p = .604), Temporal structure (p = .542), Temporal structure*Item interaction (p = .420).

- ***LPC summary***

There was a LPC Old/New effect for items encoded in the rhythmic and arrhythmic condition, but only for attended items.



References

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Jones, A., & Ward, E. V. (2019). Rhythmic temporal structure at encoding enhances recognition memory. *Journal of Cognitive Neuroscience*, 1-14. https://doi.org/10.1162/jocn_a_01431

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Conclusion

The study provides new evidence that temporal and spatial attention influence memory encoding to enhance subsequent recognition. Manipulating spatial attention and rhythm at encoding was associated with distinct memory specific ERP components at recognition, suggesting deeper encoding for spatially attended compared to unattended items and those encoded with arrhythmic timings.