The Effect of Temporal Structure in a Visual Sequential Learning Paradigm
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Introduction

- Sequential learning (SL) is the ability to encode ordinal patterns in our surrounding environment.
- When patterns are not fully random but contain a degree of temporal or ordinal regularity, our brain is able to extract regularities to facilitate processing using predictive mechanisms, that is, by learning to predict future stimuli in the sequence (Selichenkova et al., 2014).
- The current study uses a probabilistic visual serial learning task with a manipulation of temporal synchronicity within the task (Jost et al., 2015).
- We examined the relationship between whether participants were exposed to synchronous or asynchronous temporal conditions first and learning of the statistical contingencies between stimuli, while event related potentials (ERPs) were recorded.

Methods

- Twenty adult participants (11 females, 18-34 years old) without reported language, cognitive, neurological, or psychological deficits were recruited and performed two SL paradigm tasks (Figure 1).
- Synchronous task: Inter-stimulus interval (ISI) was 1000ms.
- Asynchronous task: ISI was randomized between 600 and 1400ms.
- The SL paradigm, based on Jost et al. (2015), involved the presentation of a sequence of colored circles (brown, blue, grey, pink, orange, red, purple, yellow, green, white) in the center of a computer screen with a black background.
- Participants were asked to press a button whenever they saw a circle of a specified color (the “target”).
  - The target circle followed the “high predictor” on 80% of the trials, with a filler circle following 20% of the time.
  - The target circle followed the “low predictor” 20% of the time, with a filler circle following 80% of the time.
  - The target circle never followed the “zero predictor” circle.
  - ERPs time-locked to the predictor were analyzed according to nine topographic regions of interest (ROIs).

Results

- Three regions of interest (Left (LPo), Central (POz), and Right (RPo) posterior regions) were defined for the ERP analysis, based on previous research and visual inspection.
- We found an interaction between predictor and timing condition \( F(2,34) = 4.01; p = .027 \), indicating that participants were learning the statistical contingencies between HP and Z, but only in the synchronous condition.
- We found an interaction between timing condition and whether the participant completed the synchronous or the asynchronous task first \( F(1,17) = 11.14, p = .04 \). 300 to 700ms post predictor onset in the posterior ROIs (Figures 4 & 5).
- This result indicates that for the synchronous task, the ERP means were significantly higher if the participant saw the asynchronous task first. However, for the asynchronous task, which task you saw first had no effect on average ERP amplitude.
- We also found an interaction between block and whether the participant completed the synchronous or the asynchronous task first \( F(1,17) = 11.14, p = .04 \) (Figure 6).
- This indicates that mean ERP amplitudes showed opposite effects according to which task you saw first. If you were exposed to the synchronous task first, overall amplitudes decreased, while they increased if you were exposed to the asynchronous first.

Conclusions

- The ERP results of the synchronous condition mirrors those of Jost et al. (2015), who also observed a P300-like ERP component for the HP predictor, reflecting the learning of the probabilistic contingencies between stimuli.
- Interestingly, ERPs also showed an effect of which task was seen first, indicated by overall higher ERP means for the asynchronous first conditions.
- Altogether, we interpret these data to mean that if participants were exposed to the asynchronous task first, their overall level of arousal was heightened. However, this heightened arousal did not facilitate learning of the statistical patterns within the sequence.

References


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