Timecourse of concurrent learning of adjacent and nonadjacent dependencies

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Background & Aims

- Visual statistical learning is a form of implicit learning of the statistical regularities among adjacent and nonadjacent elements across time and/or space.
- Adjacent dependencies
  - E.g., 'pre' is more likely to be followed by 'ty' than 'on'
- Nonadjacent dependencies
  - E.g., rules such as *"**is** X-**ing**"* (where X is a verb)
- Both coexist in languages.
  - E.g., She **is** go**ing** to a party.
- We use syntax rules to make predictions in language.
  - E.g., when we hear "she" we predict "is", not "are", will follow.

- Most research has focused on adjacent dependency learning. This study aims to test learning of adjacent and nonadjacent dependencies individually and simultaneously (Iao et al., 2021)
  - Also focuses on timecourse of learning either dependency.

Participants

	Experiment 1	Experiment 2	Experiment 3
Total	32	32	32
Female	24	24	25
Male	7	8	7
Age – Mean (SD)	24 (2.51)	23 (14.43)	27 (11.82)
Age range	18 – 29 years	18 – 62 years	19 – 57 years

Methods

Presentation of a 3 items sequence during time
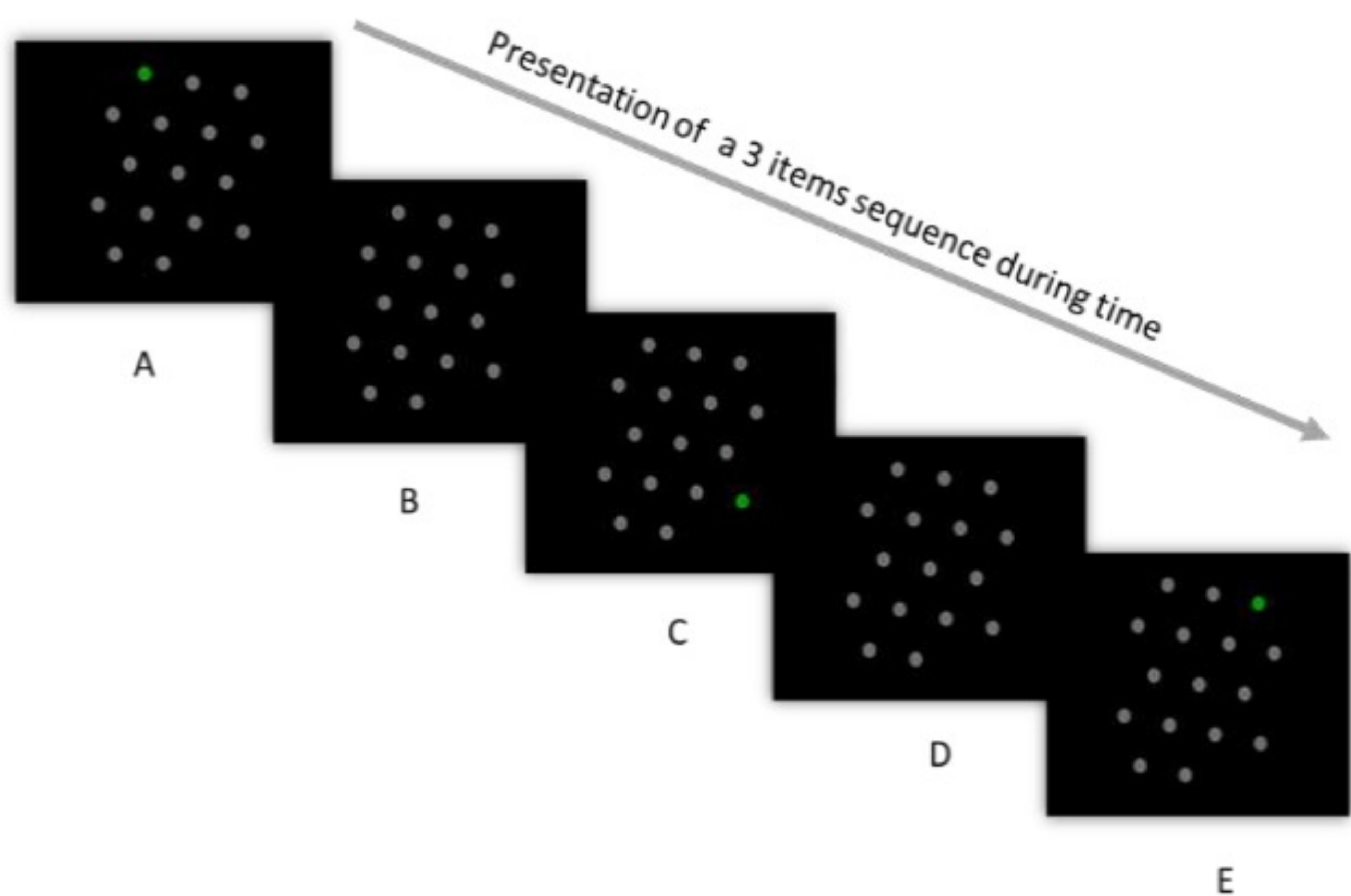
Phase A	Beginning of 3 items sequence. 1st item of sequence is presented. Gaze contingent eye-tracking until gaze hits target. Time displayed for 275 ms after gaze hits target.
Phase B, D	Time displayed for 750 ms of the blank period that guessing occurs.
Phase C	2nd item of sequence is presented. Gaze contingent eye-tracking until gaze hits target. Time displayed for 275 ms after gaze hits target.
Phase E	3rd item of sequence is presented. Gaze contingent eye-tracking until gaze hits target. Time displayed for 275 ms after gaze hits target.

Learning is quantified as the number of raw eye-samples on the target location during the 750ms guessing period.

Credit: Sofia Tsitsopoulou

- All participants were exposed to adjacent and nonadjacent dependencies
  - Adjacent dependencies A-B-C
  - Nonadjacent dependencies A-B-C.

  ■ Dependee (yellow)
  ■ Target (green)
  ■ Random (red)

- Two blocks with four sequences of three elements, repeated 40 times per block (all experiments)
- Participants were either encouraged to predict the next target (experiments 2 & 3) or not (experiment 1).
- Adjacent and nonadjacent dependencies presented in separate blocks (experiments 1 & 2) or concurrent blocks (experiment 3).

Results

Fixed effects summaries for main effects and interactions of adjacent and nonadjacent dependency (compared to baseline) and occurrence id with linear and quadratic term

Predictor	Experiment 1		Experiment 2		Experiment 3	
	Est. with 95% PI	H₁	Est. with 95% PI	H₁	Est. with 95% PI	H₁
Occurrence id (linear)	91.93 [82.42 – 98.71]	>100	91.81 [81.83 – 100.3]	>100	95.75 [88.14 – 101.06]	>100
Occurrence id (quadratic)	-30.68 [-33.48 – -27.23]	>100	-31.1 [-33.63 – -27.99]	>100	-29.41 [-32.12 – -26.36]	>100
Adjacent	**0.17 [0.09 – 0.26]**	**>100**	**0.21 [0.13 – 0.29]**	**>100**	**0.08 [0 – 0.17]**	**2.36**
Nonadjacent	**-0.16 [-0.24 – -0.08]**	**>100**	**-0.15 [-0.23 – -0.07]**	**>100**	**-0.08 [-0.17 – 0]**	**2.68**
Occurrence id (linear) : Adjacent	**-8.59 [-15.23 – -0.26]**	**15.1**	**-9.77 [-15.41 – -2.49]**	**72.31**	**-1.38 [-5.77 – 1.1]**	**1.37**
Occurrence id (quadratic) : Adjacent	0.59 [-1.53 – 3.4]	0.98	1.16 [-1.08 – 4.6]	1.3	0.1 [-2.15 – 2.46]	0.88
Occurrence id (linear) : Nonadjacent	-1.47 [-9.6 – 1.79]	1.26	-0.37 [-4.73 – 2.48]	1.04	-0.98 [-4.79 – 1.37]	1.2
Occurrence id (quadratic) : Nonadjacent	0.74 [-1.36 – 3.68]	1.03	0.24 [-1.85 – 2.56]	0.84	-0.1 [-2.45 – 2.14]	0.89

Note:
H₁ = evidence in favour of the alternative hypothesis over the null hypothesis (Bayes Factor); PI = probability interval; ':' = interaction
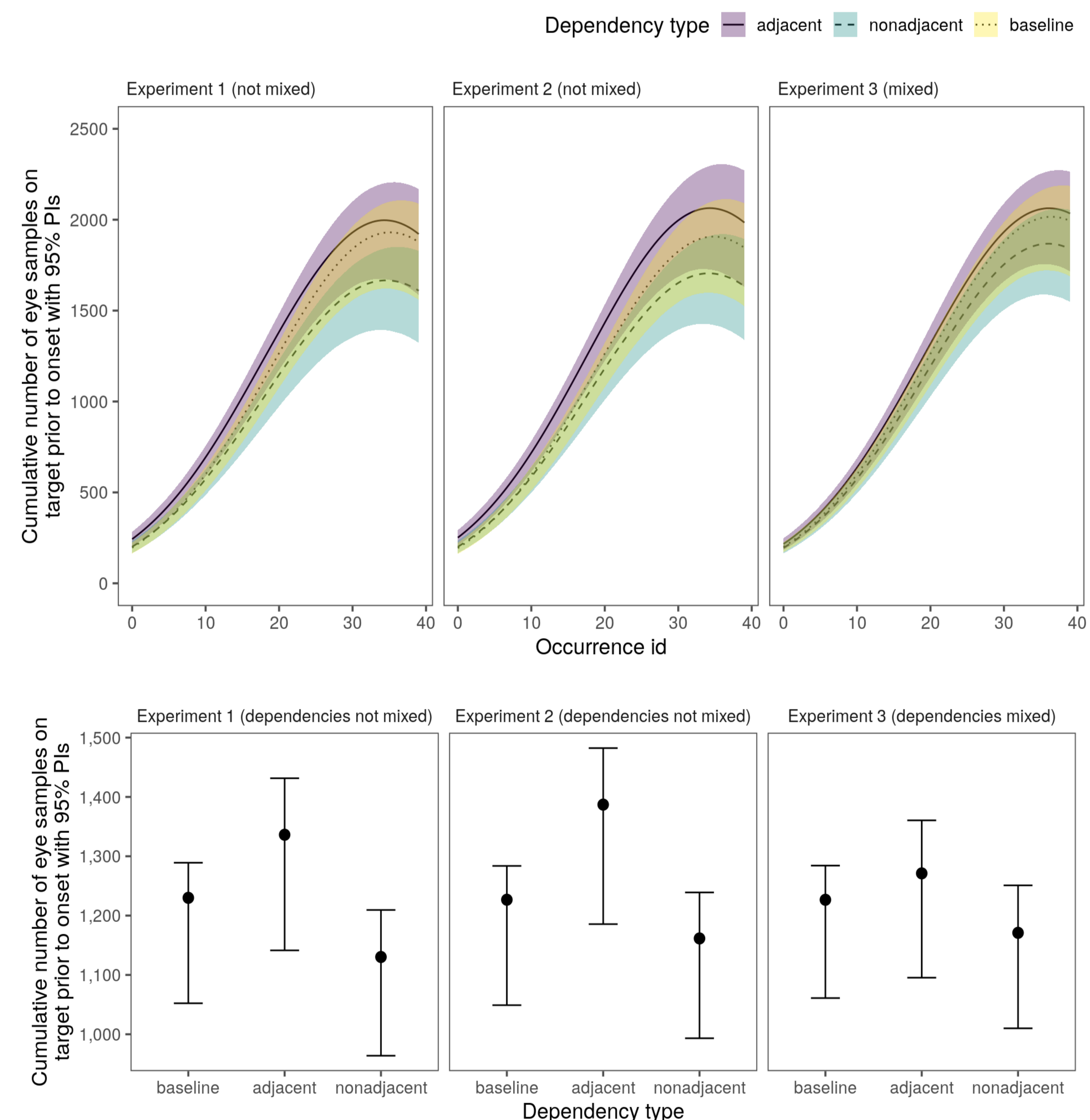
Findings

- Adjacent dependencies showed learning relatively early in the timecourse (experiments 1 & 2)
- No learning for nonadjacent dependencies (experiments 1 & 2)
- When presented concurrently, nonadjacent dependencies inhibited learning for adjacent dependencies (experiment 3)
- Explicitness of instructions did not seem to impact on learning

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References

Iao, L.., Roeser, J., Justice, L. and Jones, G. (2021). Concurrent visual learning of adjacent and nonadjacent dependencies in adults and children. *Developmental Psychology*, 57(5), pp.733–748..