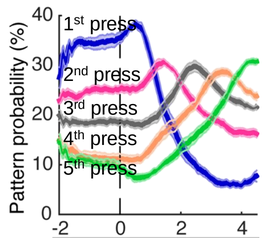
Competitive queuing state of actions during planning predicts execution accuracy of a motor sequence

Myrto Mantziara, Tsvetoslav Ivanov, George Houghton and Katja Kornysheva

School of Psychology, Bangor University, UK

Introduction

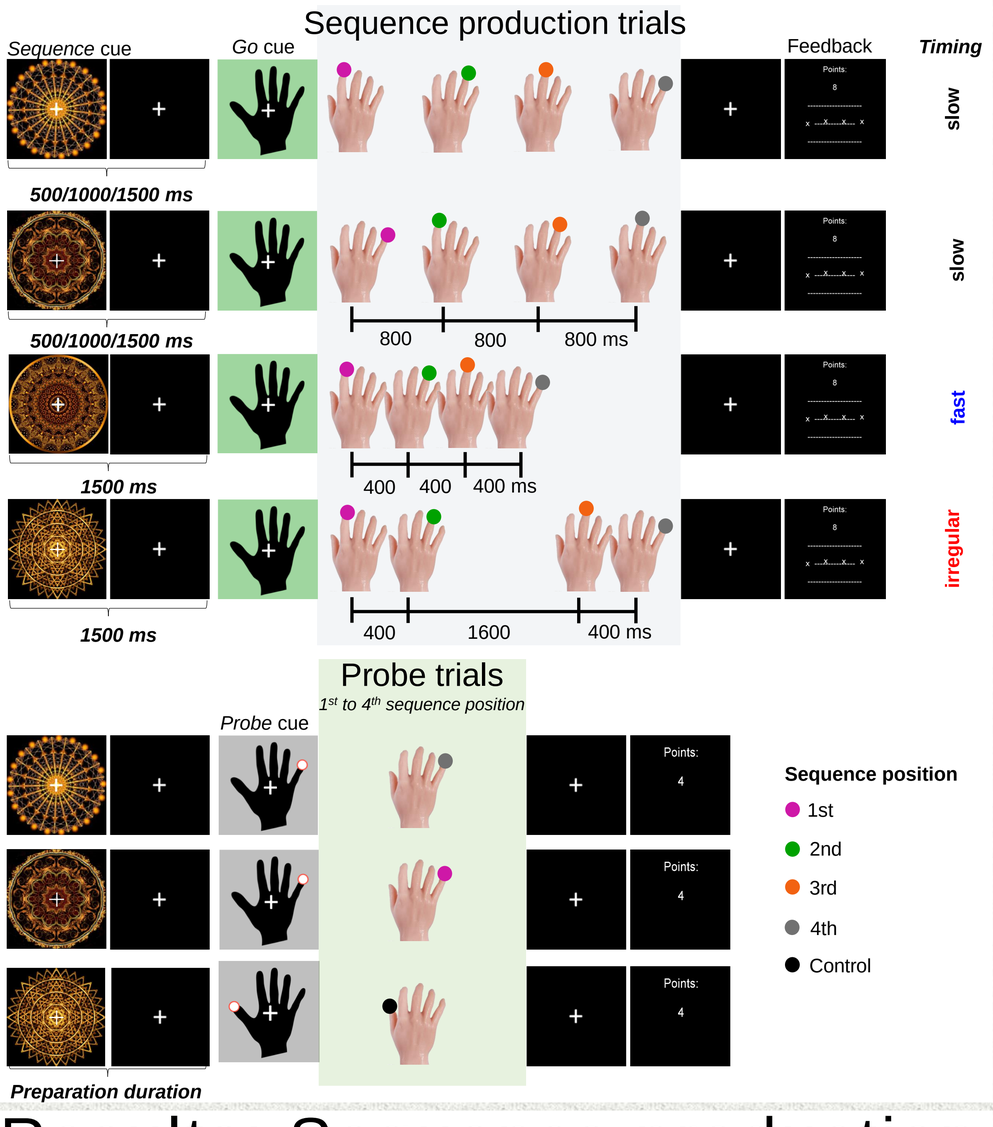
- Actions of a sequence are represented in a parallel activation gradient and selected for output through competition (competitive queuing; CQ)[1-3].
- Parallel weighting of action related neural activity during sequence planning depends on serial position; this gradient predicts subsequent execution accuracy[4].
- The CQ gradient may also be modulated by the temporal structure of the planned sequence[5].



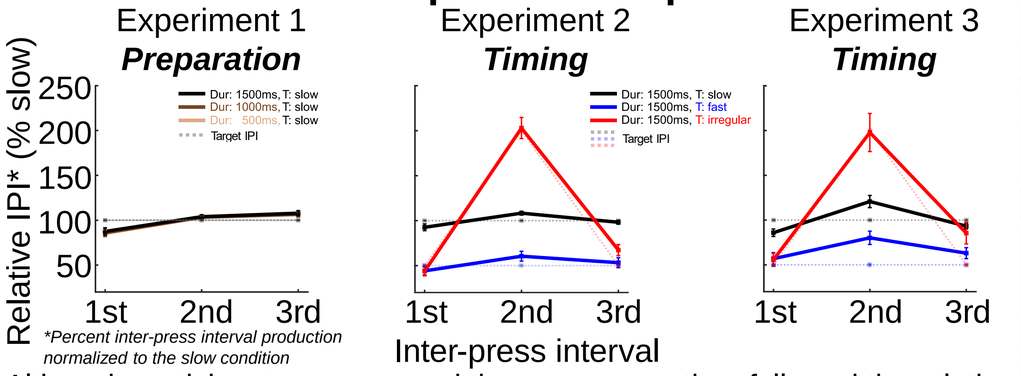
Aims & Predictions

1) Behavioural readout of CQ state of action elements during preparation reflective of their original position in the to-be-performed sequence.
2) Does the preparatory CQ gradient determine accuracy or temporal planning?
   - If the CQ gradient codes for accuracy of actions plan, it should be stronger with longer preparation and related to production accuracy.
   - If it codes for sequence timing (speed & temporal grouping), its pattern should change with timing manipulations.

Methods

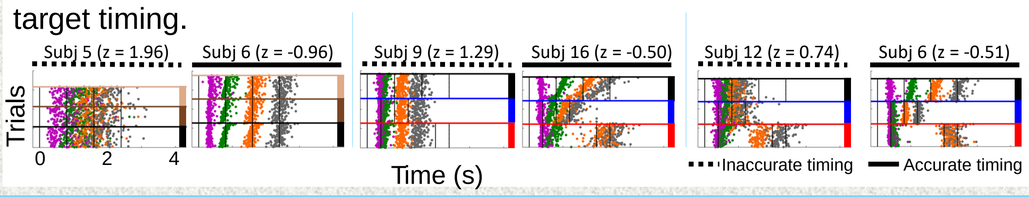


Results: Sequence production



*Percent inter-press interval production normalized to the slow condition

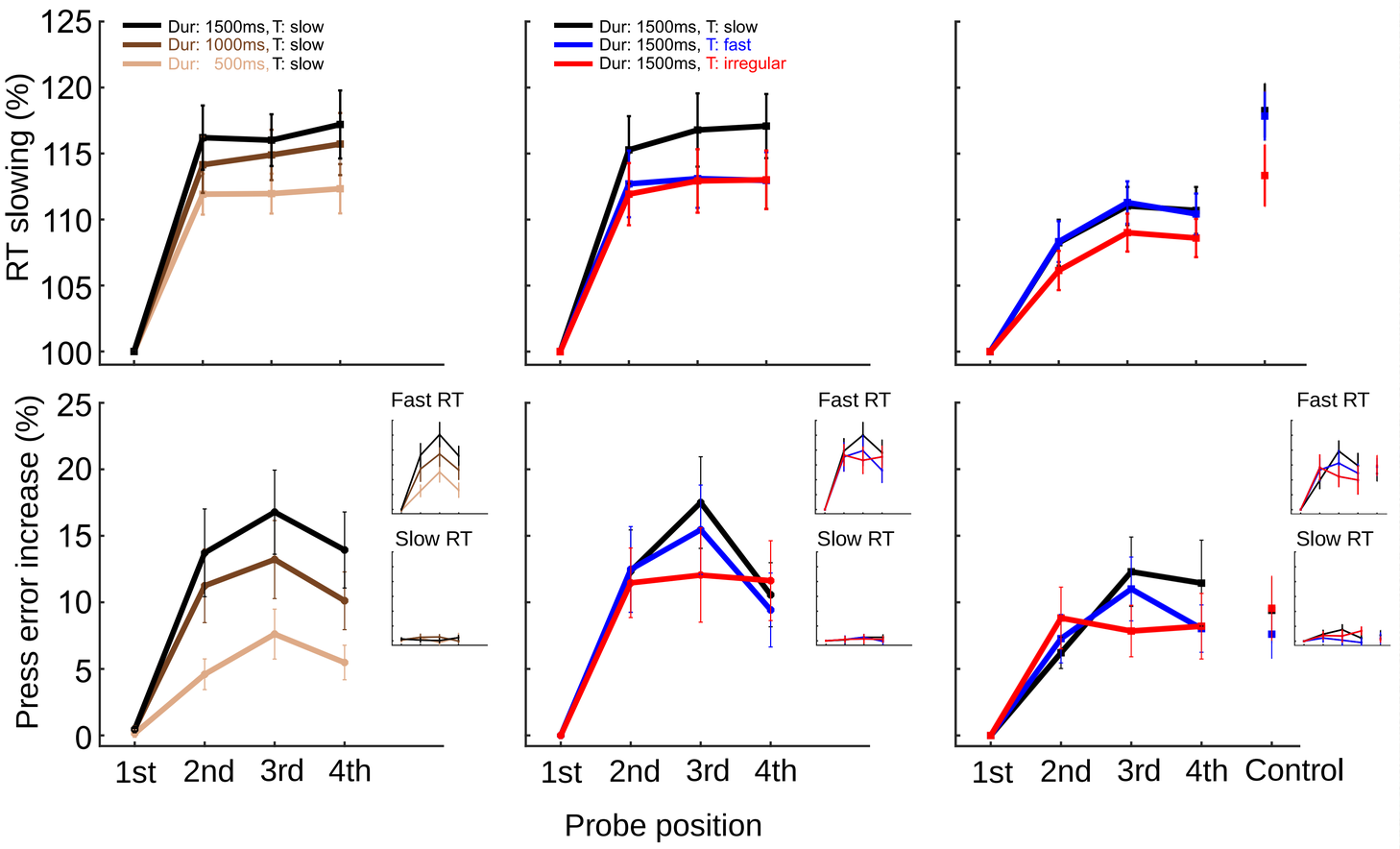
Although participants compressed the sequences, they followed the relative target timing.



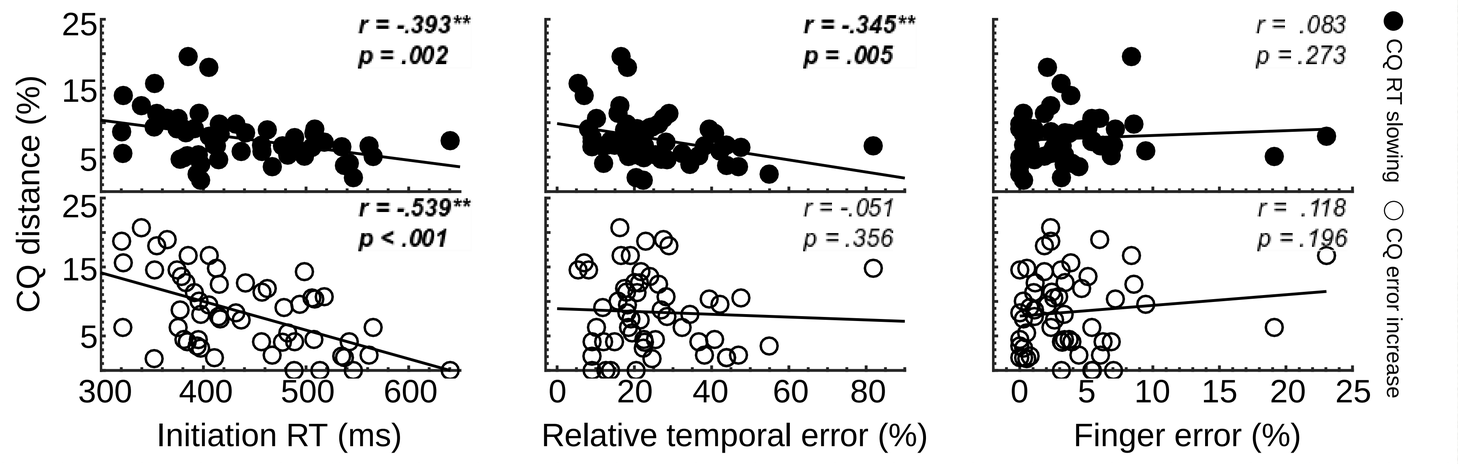
Results: CQ during preparation

Experiment 1 **Experiment 2** **Experiment 3**

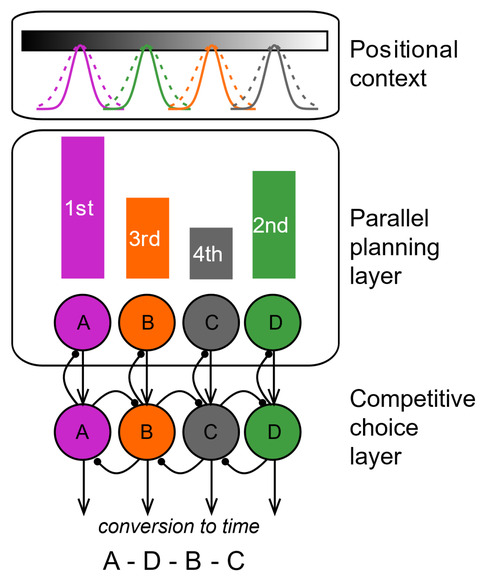
Action probes form a graded activation of sequence elements which corresponds to their initial serial position and is modulated by preparation duration but not sequence timing.

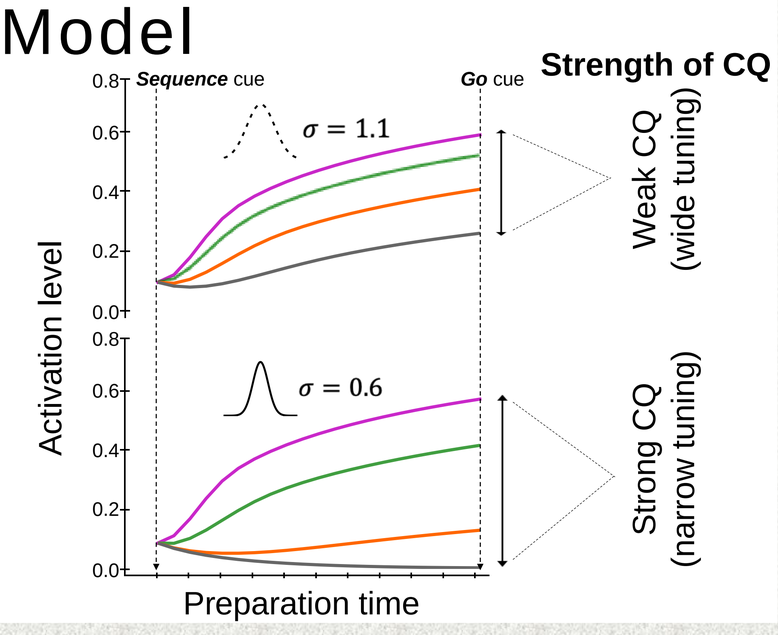


The CQ gradient during preparation correlates* with temporal accuracy and initiation speed in sequence production. *(*Group correlations across experiments)*



CQ Model





Discussion

- First behavioural evidence to show that the preparatory activation gradient of competitive upcoming actions of a sequence reflects the readiness for accurate and fluent execution.
- The planned temporal structure of the sequence is not controlled by the CQ mechanism during preparation.
- The CQ gradient encodes the relative availability of each planned sequential element to convert to serial motor output according to its initial serial position; the later the position the less available.
- The CQ gradient is a fast, automatic planning mechanism for motor sequence production.

References

1. Houghton, G. (1990). *Acad. Press Prof., Inc.*, 287.
2. Bullock, D., & Rhodes, B. J. (2003). *MIT Press*, Eds: M.A. Arbib.
3. Averbeck, B., *et al.* (2002). *PNAS*, *99* VN-r(20), 13172.
4. Kornysheva, K., *et al.* (2019). *Neuron, 101*, 1.
5. Burgess, N. & Hitch, G. J. (1999). *Psychol. Rev. 106*, 551

e.kornysheva@bangor.ac.uk

m.mantziara@bangor.ac.uk