Motor Timing in Adults and Children: Relationships with Reading and Attention

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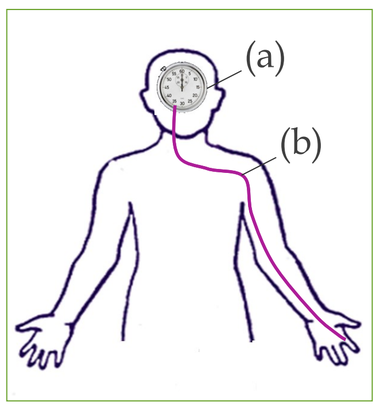
❶ Introduction

Using Information Processing Models of Timing: Models such as that by Wing & Kristofferson (1973) allow decomposition of variance components within timed responses. We can separate variance attributable to (a) the **timekeeper** and (b) the **implementation** mechanisms. This approach has been successful in analysing the type of timing difficulties experienced by particular clinical populations where neural level differences are well defined.



Motor Timing in Clinical Populations: For example, finger tapping tasks have been used to explore timing deficits in groups with Parkinson's and Huntington's disease, with the former being associated with timekeeping difficulties (Harrington et al. 1998) and the more pervasive Huntington's related to changes in both timekeeper and implementation variance (Freeman et al. 1996).

Temporal Processing in Developmental Disorders: Deficits in Temporal Processing, on a range of tasks, are found in both Dyslexia and ADHD. These difficulties have been linked to skills that are form the core symptoms of the disorders such as reading (e.g. Waber et al. 2000) and impulsivity (e.g. Toplak et al. 2006).

Aim: to examine whether motor timing difficulties in developmental disorders are attributable to timekeeper or implementation variance and if performance is associated with measures that are predictive of the disorders.

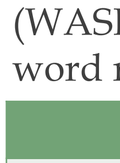
❷ Participants & Psychometrics

35 Adults, 49 Child Controls and **18 Child Clinical** participants (from on-site Dyslexia Clinic), completed measures of reasoning (WASI/WISC), reading and spelling (WIAT), non- and irregular-word reading, and ADHD symptoms reports.

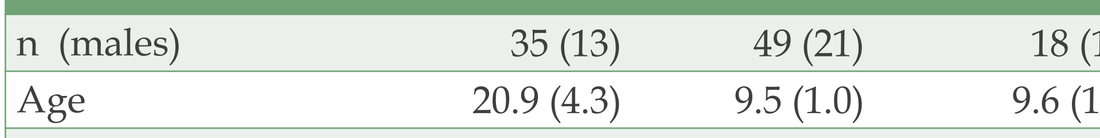
	Adults	Children	Child Clinical
n (males)	35 (13)	49 (21)	18 (14)
Age	20.9 (4.3)	9.5 (1.0)	9.6 (1.1)
Reading SS	108.0 (18.2)	102.1 (16.0)	89.1 (13.0)
Spelling SS	112.2 (9.3)	96.4 (15.4)	87.4 (12.7)
Verbal Reas SS	112.0 (7.1)	114.6 (15.2)	107.5 (8.6)
Non-Verbal Reas SS	104.1 (8.4)	97.2 (13.0)	109.4 (10.6)
Hyperactivity	6.7 (3.8)	5.0 (7.0)	14.2 (5.9)
Inattention	5.8 (3.9)	4.0 (7.0)	6.9 (5.3)

Participant descriptive statistics. Means (standard deviations) unless indicated. ADHD measures max score 18. SSs have mean 100, SD 15.

❸ Finger Tapping Task



SYNCHRONISATION 15 responses | CONTINUATION 35 responses recorded



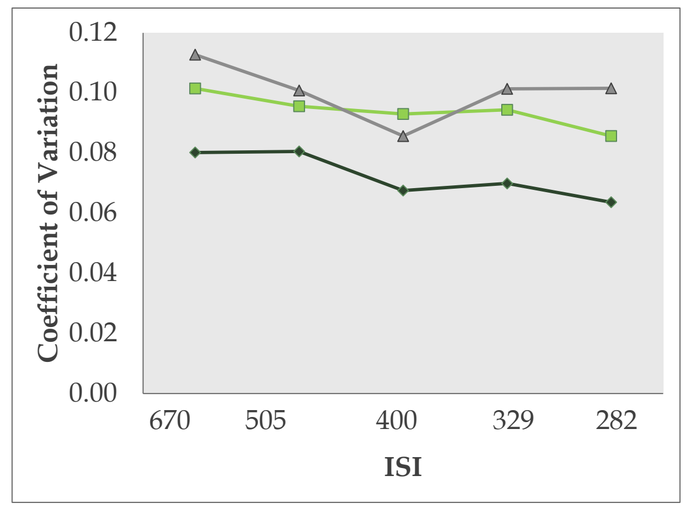
Tapping at 5 ISIs (670, 505, 400, 329 and 282 ms). Continuation IRI data was also decomposed into timekeeper and implementation variance via the Wing & Kristofferson model. Motor variance is estimated as the covariance between successive responses, which can be subtracted from IRI variance to yield timekeeper variance.

❹ Results (a) Group Performance

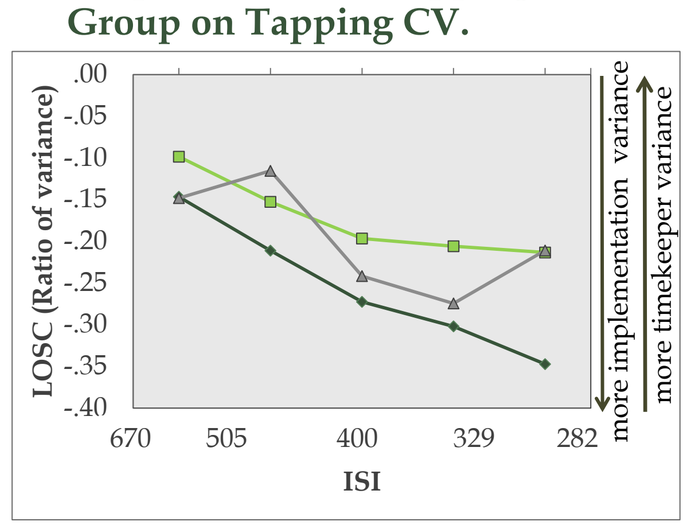
adults — children — clinic group

Performance:
- Children more variable than adults.
- Clinic children did not differ from control children on IRI variability.
- There was an effect of tapping speed on variability.

Decomposed Variance:
- Children have greater timekeeper & implementation variance than adults.
- Clinic children did not differ from controls on these measures.
- The ratio of timekeeper variance to implementation variance removes the between-groups difference in amount of variability (see Graph 2). Since an adult-child group difference remains, the groups must differ in their relative proportions of variance.



Graph 1: Effect of Tapping rate & Group on Tapping CV.



Graph 2: Effect of Tapping rate & Group on Ratio of Timekeeper to Implementation Variance.

- On the ratio measure clinic children did not differ from either the adults or the control children, but as a group appear to be unable to implement a consistent approach to the task across tapping speeds.

(b) Associations

- **Tapping performance in adults** did not correlate with measures of Reading, Spelling, Reasoning or ADHD self reports.
- **Tapping performance in control children** (measured as accuracy across trials) correlated with Inattention symptoms (r=-0.38), Reading (r=-0.38), Spelling (r=-0.43) and Verbal Reasoning (r=-0.36), but only **Inattention symptoms** were a unique predictor of performance (Adj $R^2 = 0.13$, $F_{(1,47)} = 7.97$, $p<0.01$).
- Accuracy of **tapping performance in clinic children** was only associated with **Non-word reading ability** (r=-0.52).
- At faster tapping speeds, **the variance ratio in clinic children** was associated with Reading (r=-0.88), Spelling (r=-0.77), Verbal (r=-0.67) and Non-verbal reasoning (r=-0.71), and sustained attention (r=-0.55). **Reading** was the only unique predictor of variance ratio (Adj $R^2 = 0.77$, $F_{(5,14)} = 10.46$, $p<0.01$).

❺ Conclusions

- Children have more variability than adults on motor timing tasks.
- This stems from a qualitative difference in the way the timing systems complete the task.
- The way in which the task is performed is strongly associated with inattention in the control children and reading ability in the clinic children.
- This method of compartmentalising variance in performance adds detail to our understanding of the origins of motor timing difficulties in developmental populations.

References:
Wing & Kristofferson (1973). *Percept. & Psychophys, 14*, 5-12. Harrington et al. (1998). *Neuropsych., 12*, 3-12. Freeman et al. (1996). *Parkinsonism & Rel. Dis., 2*, 81-93. Waber et al. (2000). *Dev. Neuropsych., 17*, 181-197. Toplak et al. (2006). *J. Neurosci. Methods., 151*, 15-29.