

A behavioural and ERP investigation of letter-sound processing: Is a lack of automaticity a proximal cause of dyslexia?

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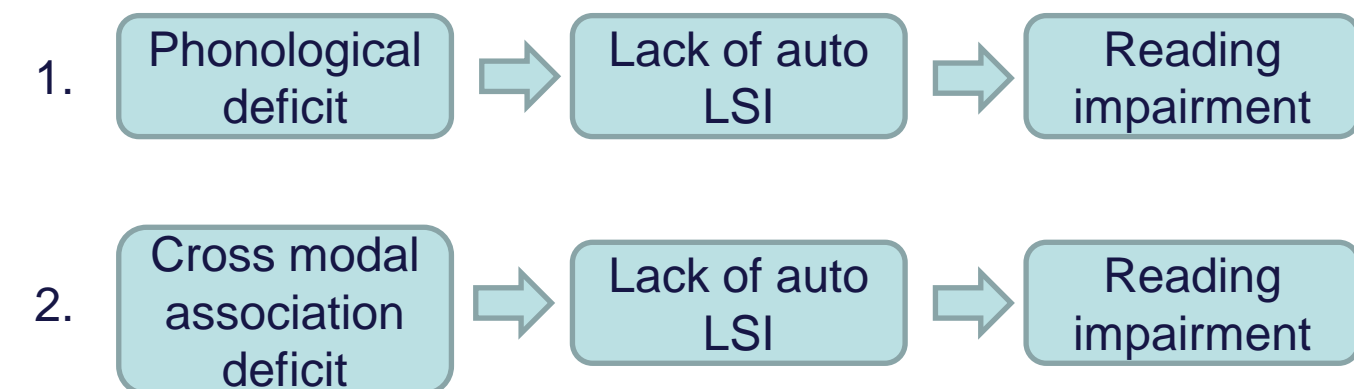
Maggie Snowling, Charles Hulme, Genevieve McArthur, Yatin Mahajan, Debbie Gooch, Ruth Leavett, Francina Clayton, Silvana Mengoni & Kurt Steinmetzger



Background

Automatic Letter-Sound Integration (LSI; Blomert, 2011)

- The efficiency with which sounds can be activated from letters
 - crucial for fluent reading (decoding)
 - develops over a prolonged period (result of brain maturation & reading experience)
- Lack of automatic LSI hypothesised to be a **proximal** cause of dyslexia
 - Even when individuals with dyslexia have seemingly learned L-S associations there remains a persisting lack of automaticity such that they are unable to retrieve or apply their knowledge of letter-sound associations quickly during reading



Existing evidence

fMRI (Blau et al., 2009; 2010)

- Typical Dutch readers showed greater activation for speech sounds in the STG following congruent letters compared to incongruent. However, this was driven by increased suppression in the incongruent condition rather than increased activation in the congruent compared to speech sounds in isolation. In dyslexic adults and children activation for speech sounds is not modulated by the presentation of letters

MMN (Froyen et al., 2009; 2010; 2011)

- The typical auditory MMN is enhanced in normal adult and 11-year-old readers by an incongruity between the speech sound and a visually presented letter
- This is not the case in typical 8-year-old readers or 11-year-old dyslexics, but they do show a late discriminant negativity that could reflect non-automatic processing

Behavioural

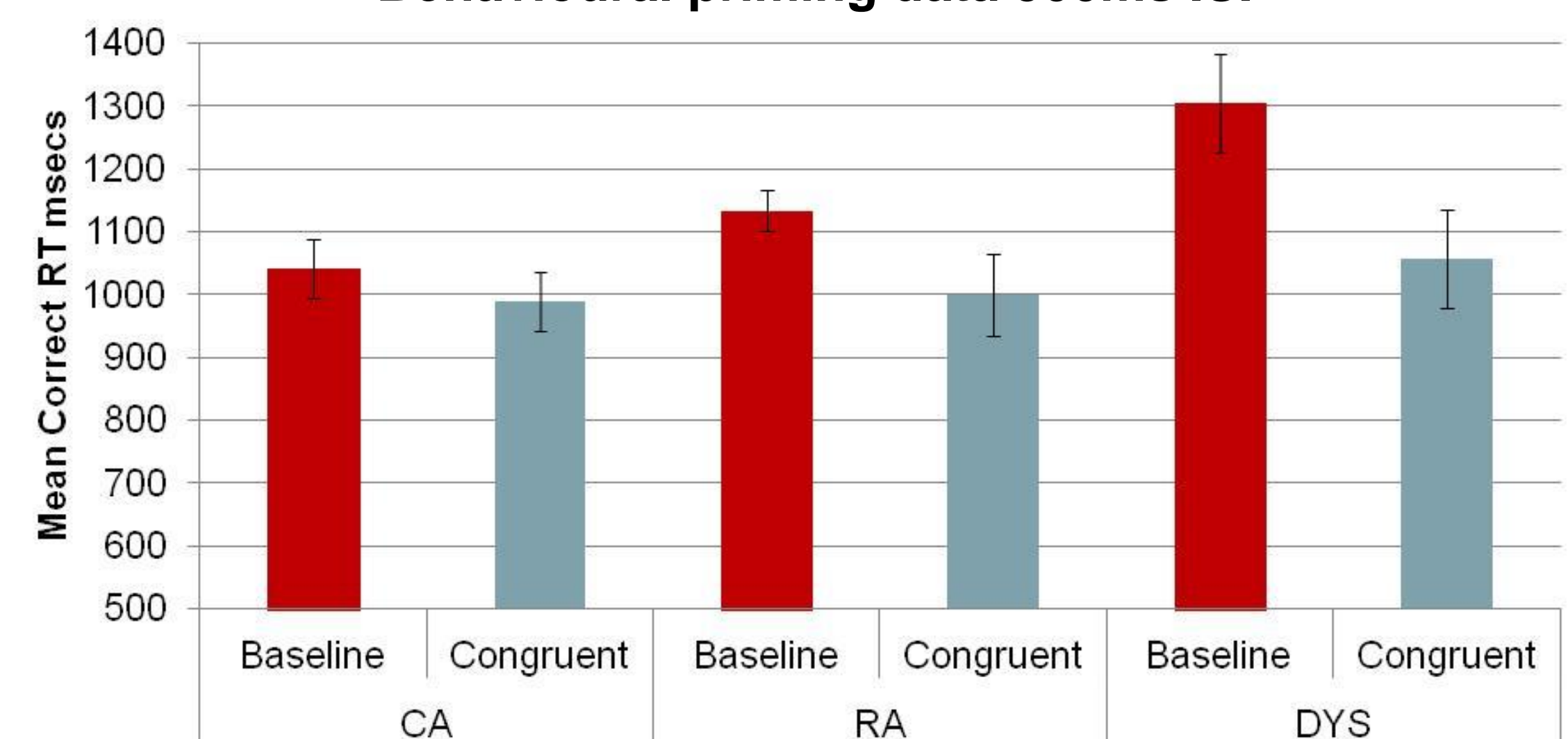
- Dyslexics are slower to respond correctly in a letter-sound matching task, but this could simply reflect slower processing

Dyslexic children, CA & RA controls

- Is there any evidence of reduced automatic LSI in children who have dyslexia?
- Is it a potential cause of reading difficulties or a consequence of reading level?
 - If a deficit in auto LSI is a proximal cause of dyslexia then children with dyslexia should show a lack of auto LSI in comparison to both CA and RA controls
 - If auto LSI is a product of reading level then they should resemble RA controls
- Behavioural experiment (ISI 500ms) and passive EEG experiment to explore the neural correlates of processing

Group	Age	Literacy (SS)	IQ (SS)	Reading (raw)
CA controls (17)	10:08	112	114	50
RA controls (17)	8:04	107	113	39
Dyslexics (14)	11:02	88	104	37

Behavioural priming data 500ms ISI



Research Questions

There is evidence to suggest a connection between less successful automatic LSI and reading difficulties in dyslexia, but...

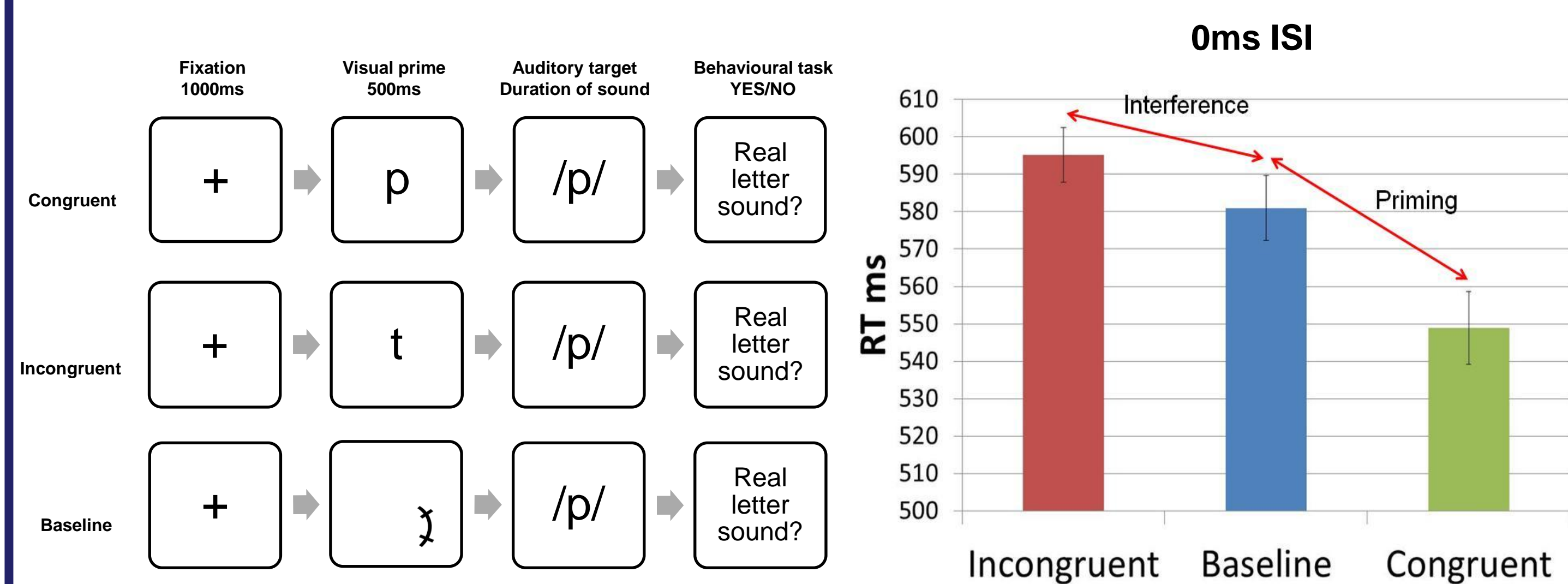
- The data have been collected by one research group and from Dutch readers
- It's not clear whether a lack of automatic LSI is cause of reading impairment or a consequence of reading experience
- There is a paucity of published behavioural data

- Can we find behavioural evidence of auto LSI in typical adult readers using a priming task?
- Can we find evidence of auto LSI in typically developing (TD) children using a similar task?
- Can we find evidence of auto LSI in ERP data from TD children?
- Is there any evidence of less successful integration in dyslexic children?

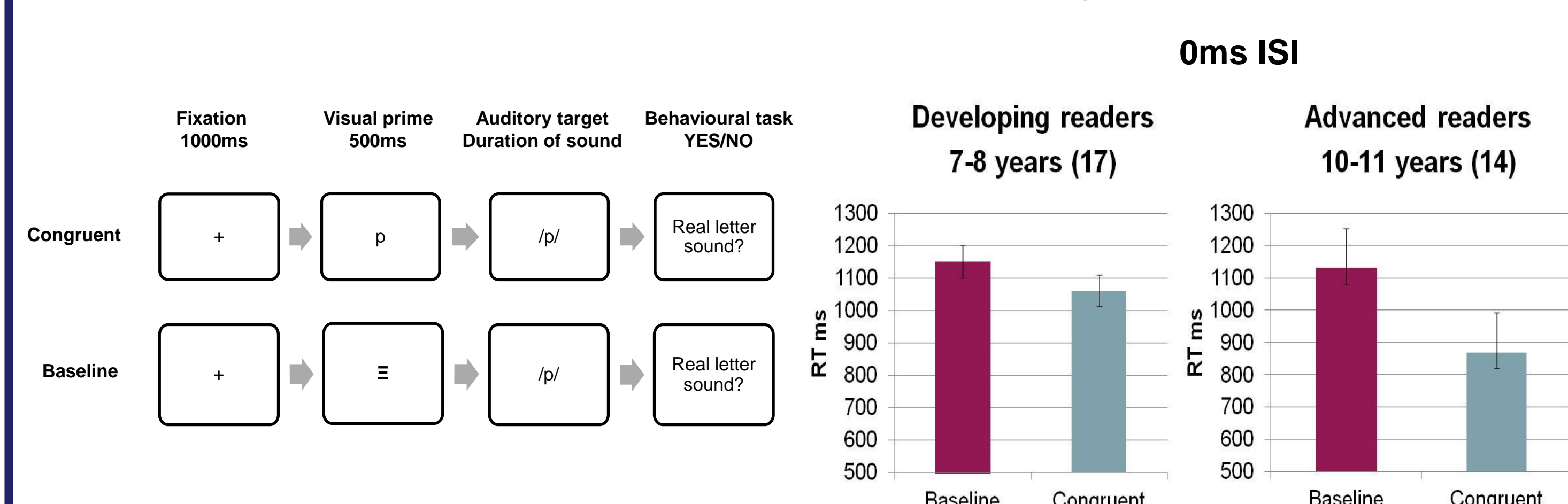
Priming paradigm

If the presentation of a congruent letter increases the speed of processing the speech sound then we can infer that in processing the letter there was some activation of the sound i.e., automatic LSI

Behavioural data: typical adult readers



Behavioural data: typically developing children

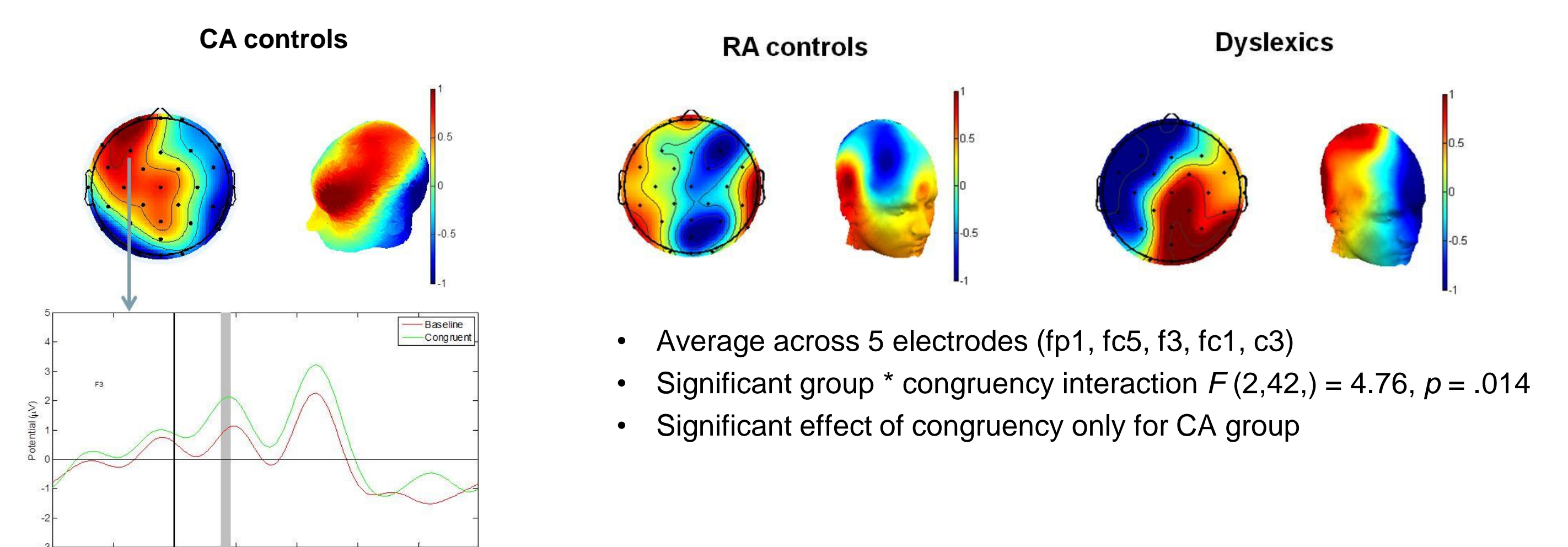


Significant priming in both reader groups replicated at 500ms ISI

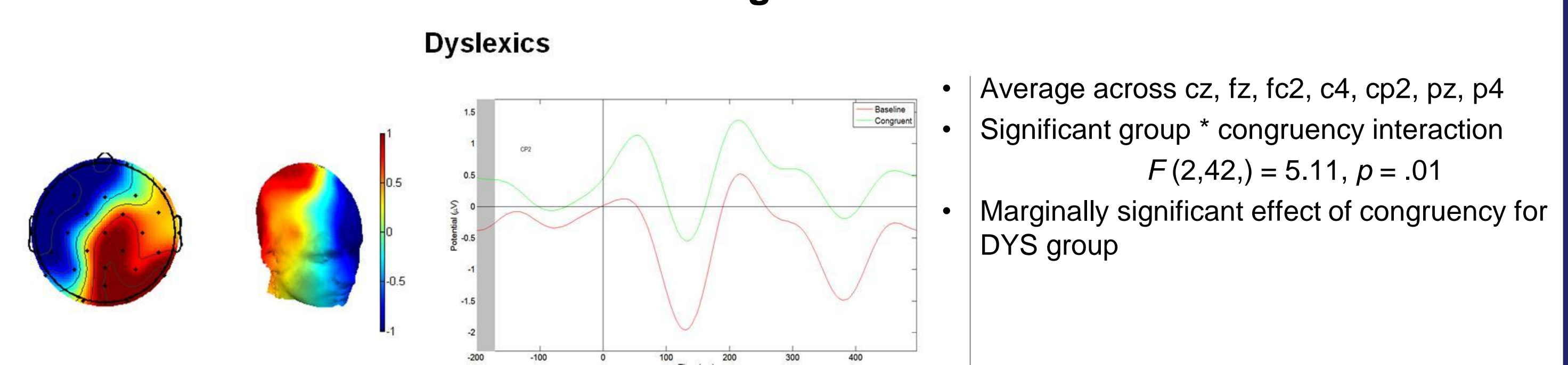
Auditory ERP components

- | | |
|--|---|
| <p>P1</p> <ul style="list-style-type: none"> 50ms Largest over frontal & central regions Larger amplitude in left hemisphere over anterior temporal region Source localised to the STG Thought to reflect preferential attention to sensory inputs | <p>N1</p> <ul style="list-style-type: none"> 100ms Largest over fronto-central region Bilateral Source localised to primary auditory cortex Thought to reflect selective attention to stimulus characteristics, amplitude enhanced by increased attention |
|--|---|

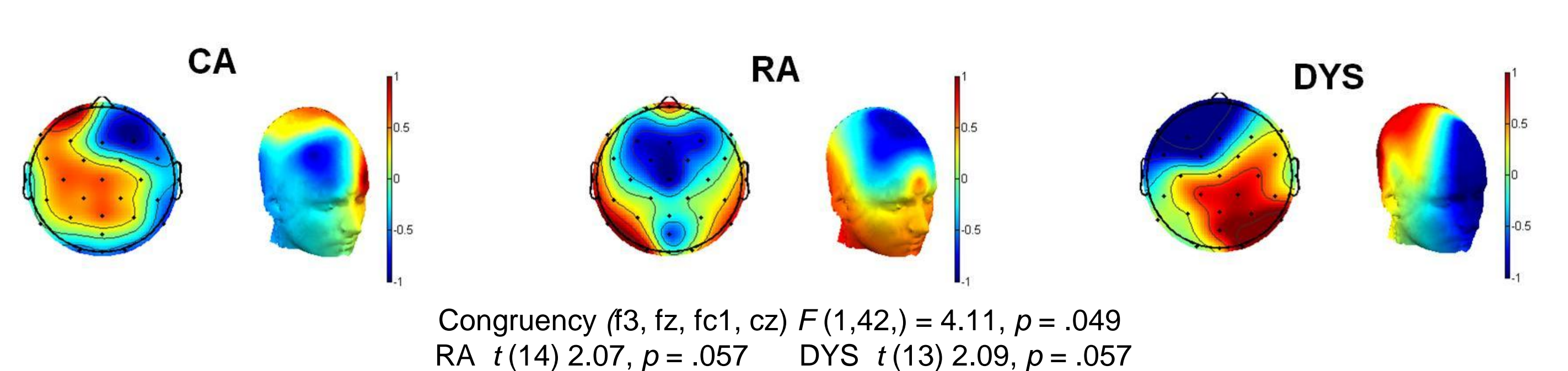
P1: 75-100ms after speech sound onset



P1: 75-100ms Right lateralised



N1: 125-150ms



Research questions & findings

- Did we find behavioural evidence of auto LSI in typical adult readers using a priming task? **YES**
- Did we find evidence of auto LSI in typically developing (TD) children using the same task? **YES**
- Did we find evidence of auto LSI in ERP data from TD children? **YES**
- Was there any evidence of less successful integration in dyslexic children? **???**
 - The more advanced TD readers and the dyslexic children showed an early effect of congruency (P1, greater amplitude in congruent), but in different hemispheres
 - The developing TD readers and dyslexic children showed a later effect of congruency (N1, greater amplitude in congruent) – could this reflect attentional processes?