Visual processing in children with dyslexia and children with autism

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Overview of the talk

- Background to visual processing in dyslexia
- Background to visual processing in autism
- Our study
- Research priorities
- Q&A

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Visual processing in dyslexia: an obvious starting point?

"Congenital word blindness"

Percy F., 14-year-old boy with reading difficulties:

"He seems to have no power of preserving and storing up the visual impression produced by words – hence, the words, though seen, have no significance for him… His eyes are normal… his eyesight is good" (William Pringle Morgan, 1896)

Visual processing in dyslexia: an obvious starting point?

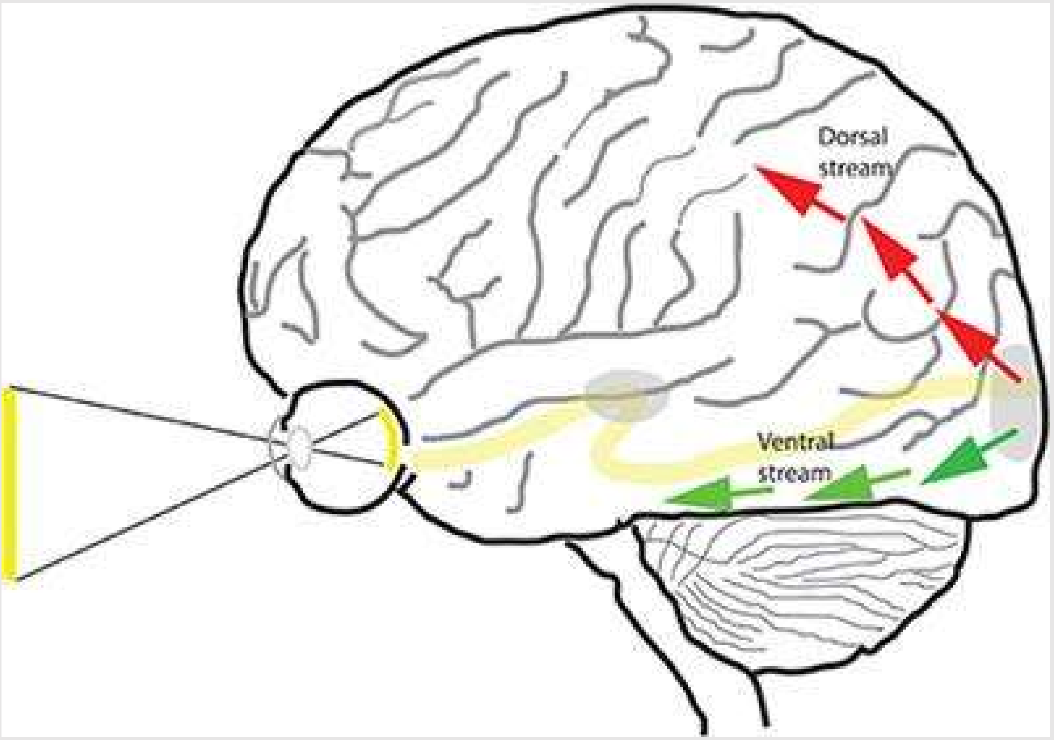
Samuel T. Orton (1930s)

Letter reversals (e.g., b / d) due to differences in how the two halves of the brain function

(no longer thought to be true, Lachmann & Geyer 2003)

Visual differences in dyslexia are not restricted to words

Visual processing in dyslexia: a contemporary theory



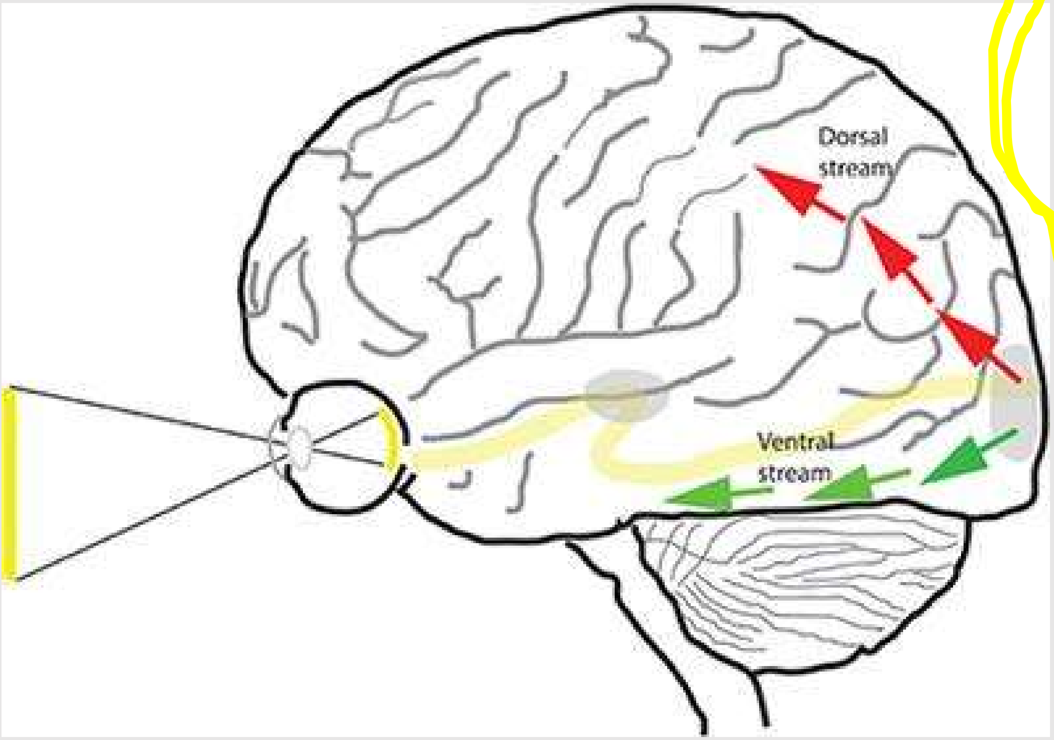
Magnocellular / dorsal stream: “where” pathway

Parvocellular / ventral stream: “what” pathway

Figure reproduced from Sheth & Young, 2016
https://doi.org/10.3389/fnint.2016.00037

Lovegrove, 1984; Stein 2001, 2019

Visual processing in dyslexia: a contemporary theory



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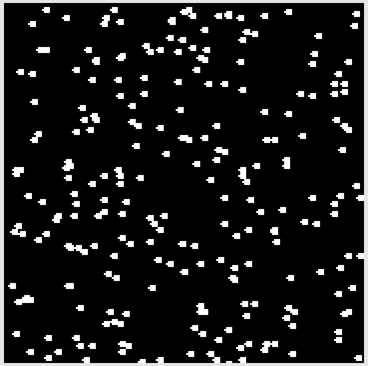
Magnocellular / dorsal stream: "where" pathway

Parvocellular / ventral stream: "what" pathway

Lovegrove, 1984; Stein 2001, 2019

Visual processing in dyslexia: a contemporary theory

Visual motion processing relies on the dorsal/magnocellular system



Dyslexic people have difficulties in motion coherence tasks

(Benassi et al., 2010)

Causal or not?

Yes!

- Children with dyslexia are less sensitive to motion information even before they learn to read (Boets et al., 2011; Gori et al., 2016)
- Training the magnocellular-dorsal pathway leads to improved reading in those with dyslexia (Gori et al., 2016)

?

No!

- Not a strong relationship between magnocellular/dorsal functioning and reading
- Not everyone with dyslexia has motion processing difficulties (Conlon et al., 2012)
- Magnocellular/dorsal functioning improves after reading intervention (Olulade et al., 2013)

Causal or not?

- The jury is still out…
- Differences in visual tasks can tell us about how the brain works differently in dyslexic individuals
- Difficulties with processing motion information could have implications for children’s lives

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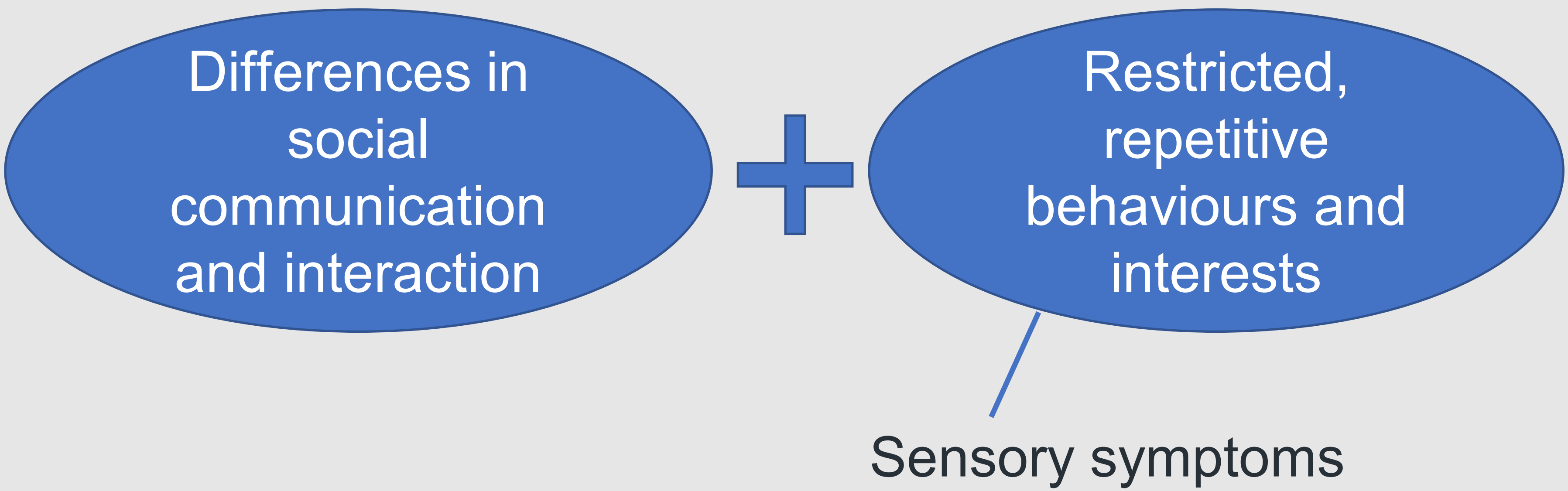
Visual processing in autism

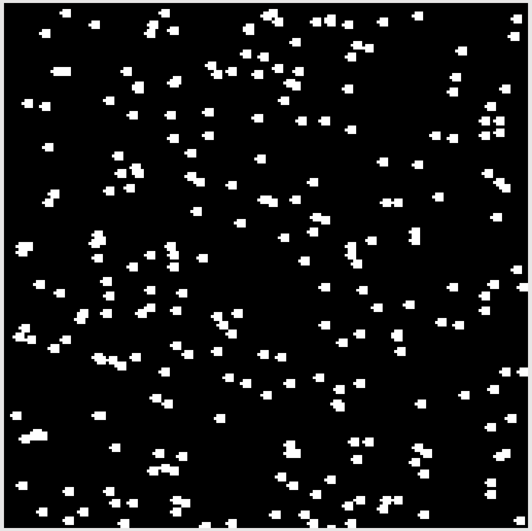
- Another developmental condition but with a distinct profile



- Sensory symptoms: hyper-reactivity, hypo-reactivity, sensory seeking

Visual processing in autism

- Attention to detail at expense of whole (Frith, 1989)
- Atypical development of magnocellular-dorsal stream (Braddick et al., 2003)



Autistic people have difficulties in motion coherence tasks, like in dyslexia

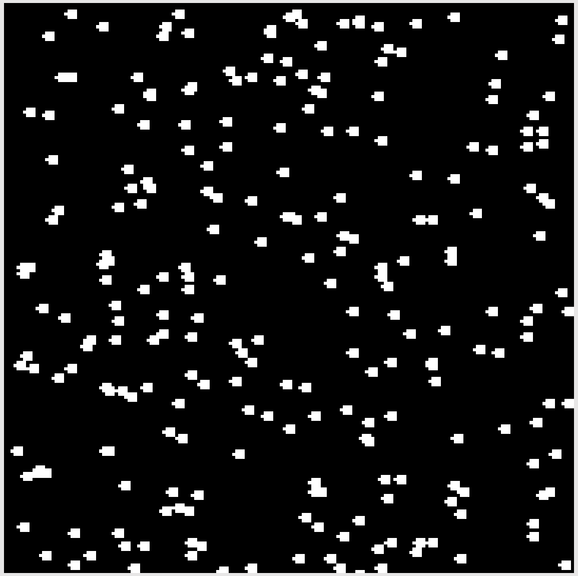
(van der Hallen et al., 2019)

Open question

Both dyslexic and autistic people show differences in motion processing, but is it for the same reasons?

nb. Currently few studies directly compare the two developmental conditions

Multiple stages of processing

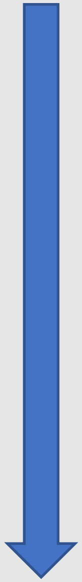


Sensory encoding

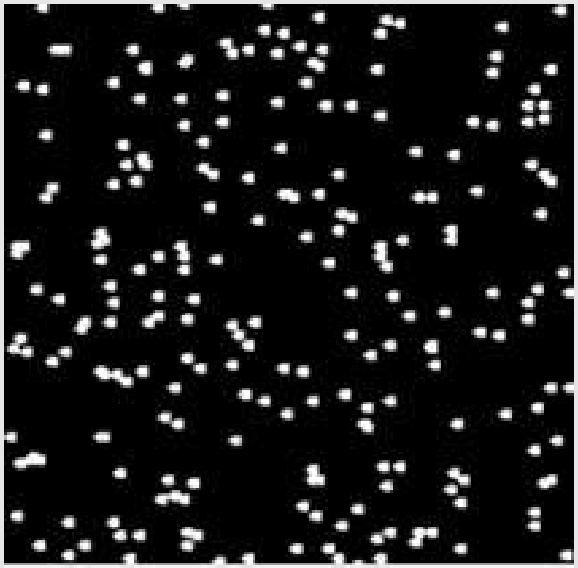
Accumulating evidence

Making a decision

Making a response



Multiple stages of processing



Sensory encoding

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Which stages are affected in dyslexia?
Does this differ in autism?

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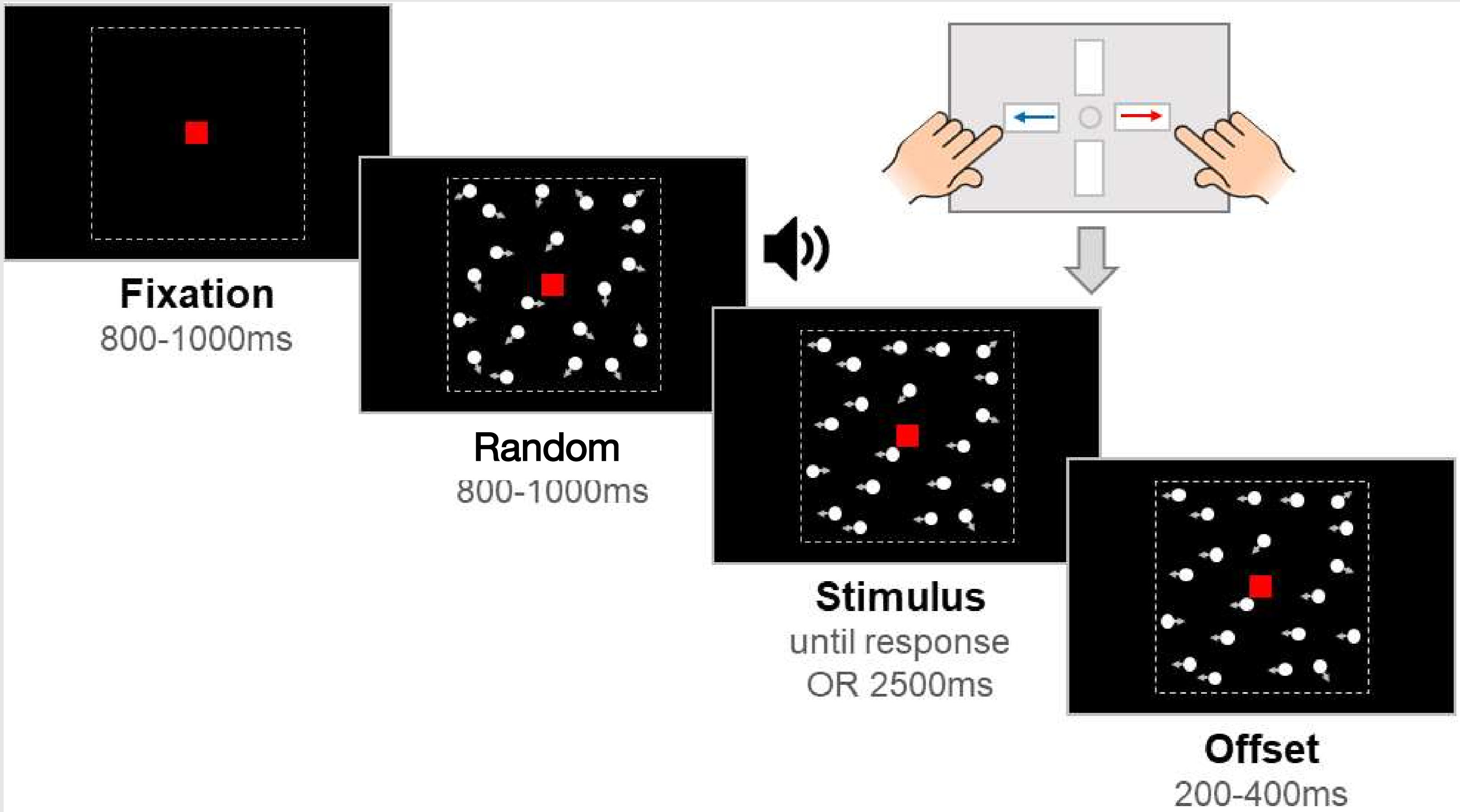
Techniques that can tell us about different processing stages

Mathematical modelling

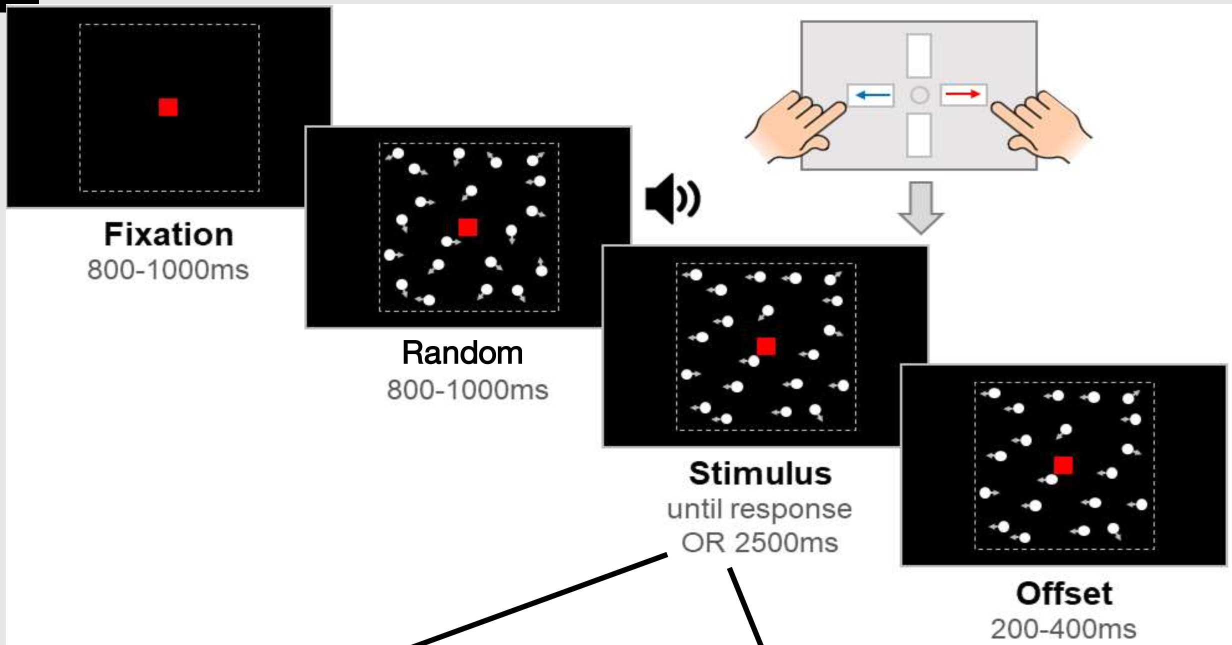
+

EEG

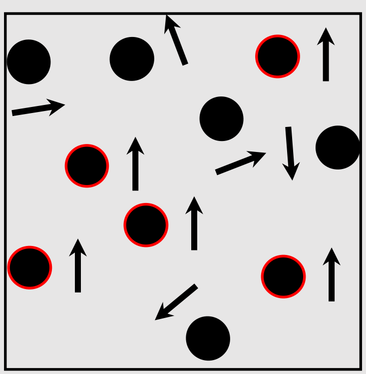
The task


Fixation
800-1000ms
Random
800-1000ms
Stimulus
until response
OR 2500ms
Offset
200-400ms

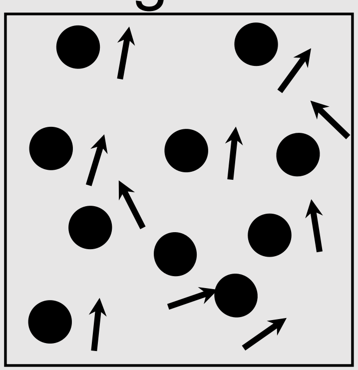
The task



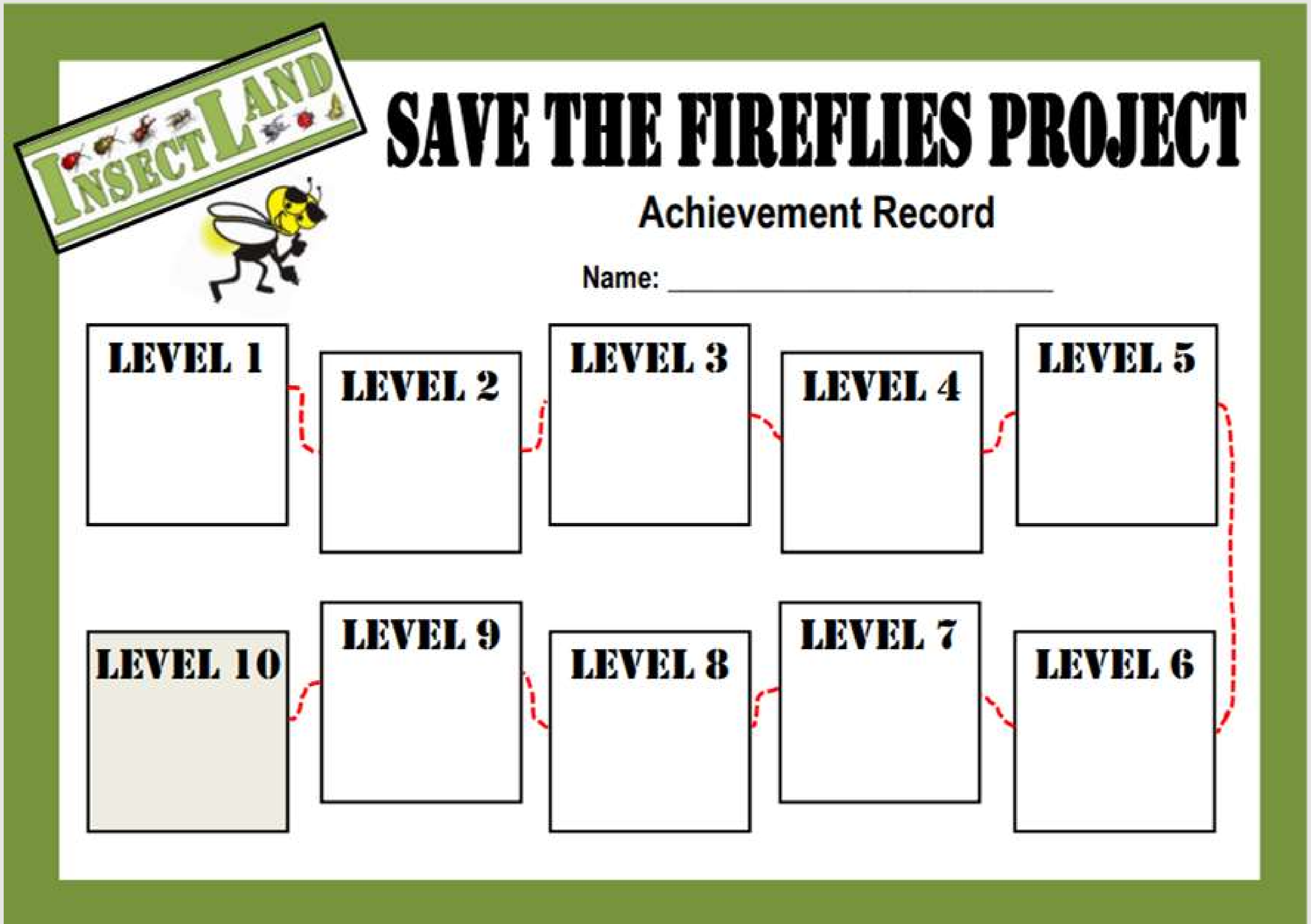
Motion coherence task



Motion integration task



The task

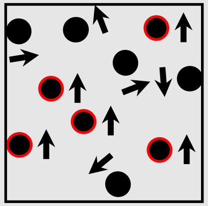

INSECTLAND
SAVE THE FIREFLIES PROJECT
Achievement Record
Name: ______________________
LEVEL 1
LEVEL 2
LEVEL 3
LEVEL 4
LEVEL 5
LEVEL 6
LEVEL 7
LEVEL 8
LEVEL 9
LEVEL 10

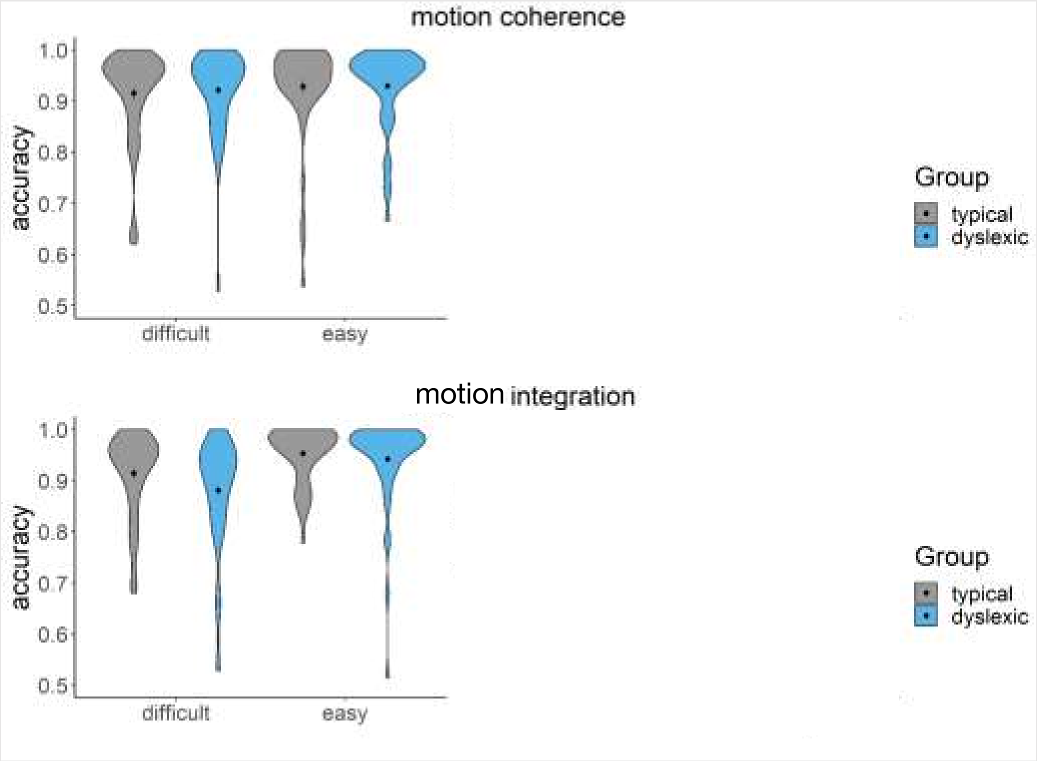
Participant characteristics

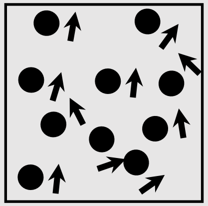
	TYPICALLY DEVELOPING (n = 50)	DYSLEXIC (n = 50)
Age	10.65 (6.55 – 14.98)	11.08 (7.81 – 14.53)
Sex	28 M 22 F	24 M 26 F
IQ – Verbal	110.60 (95 – 127)	98.56 (77 – 118)
IQ – Performance	109.30 (81 – 145)	99.40 (72 – 141)
TOWRE Phonemic Decoding Efficiency (PDE)	111.20 (81 – 153)	79.16 (51 – 99)
WIAT Spelling	105.70 (80 – 127)	77.86 (58 – 99)
Composite score	108.50 (89.5 – 138.0)	78.51 (54.5 – 89.0)

+ 50 AUTISTIC children

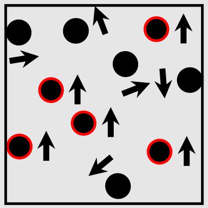
Comparing behavioural responses

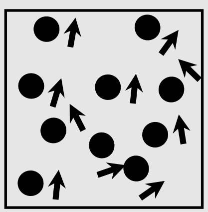


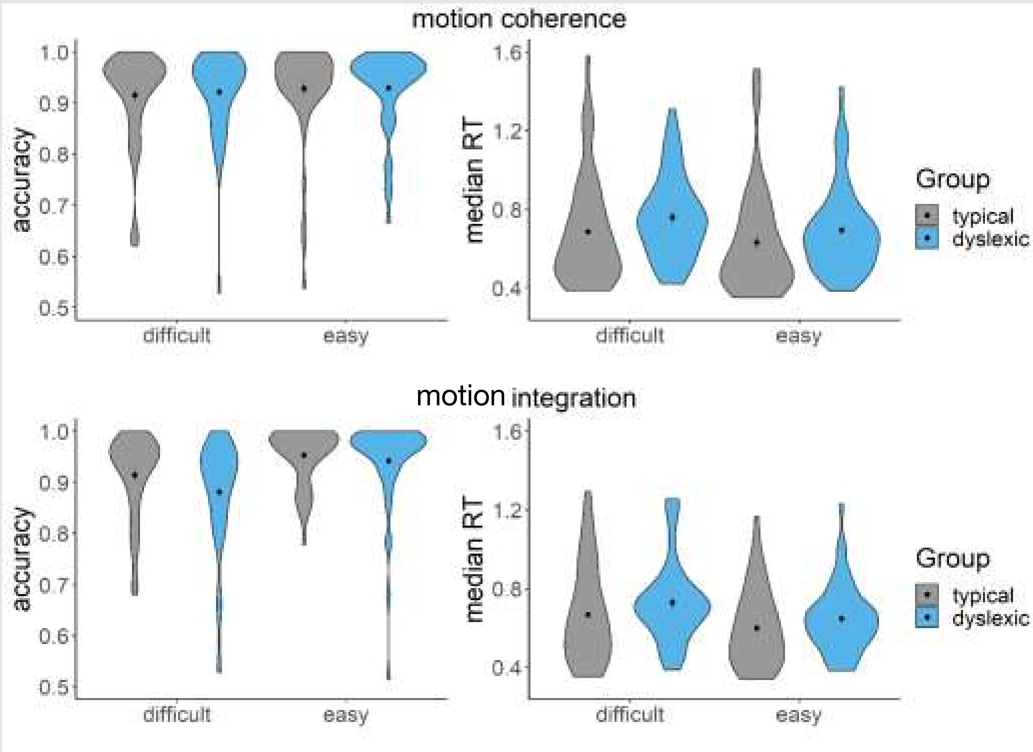




Comparing behavioural responses



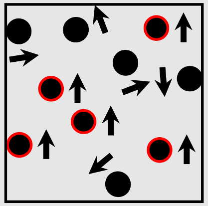


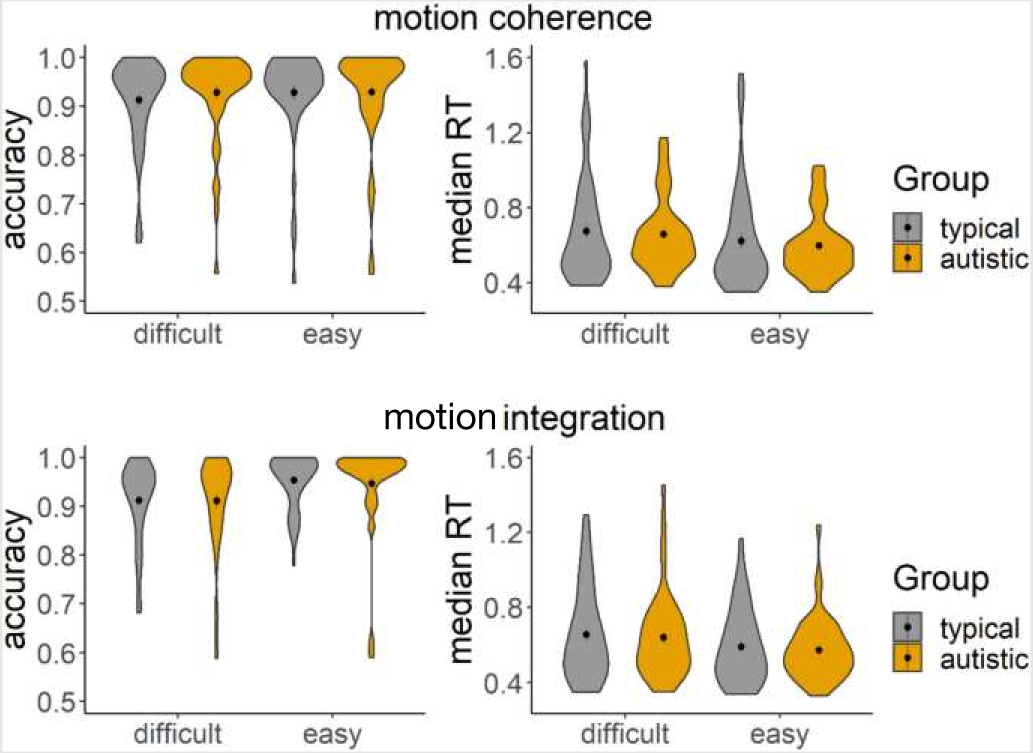


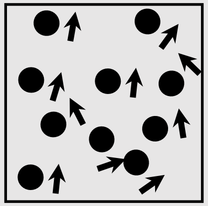
Dyslexic children are slightly slower and less accurate than typical children

Mathematical modelling: dyslexic children are slower to pick up information in both tasks compared to typical children

Comparing behavioural responses



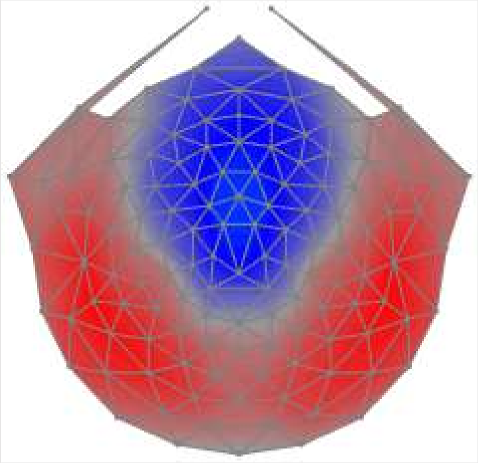




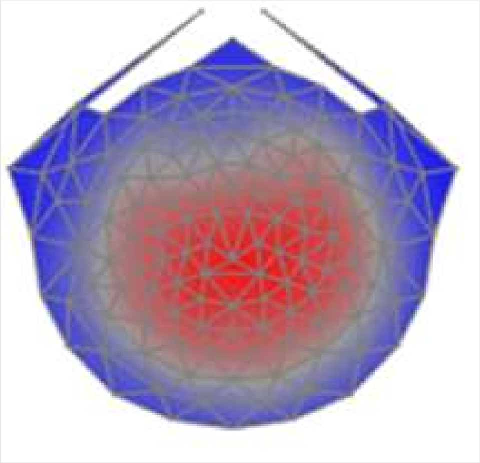
No clear differences between autistic and typically developing children's performance

Mathematical modelling: autistic children are very similar to typically developing children

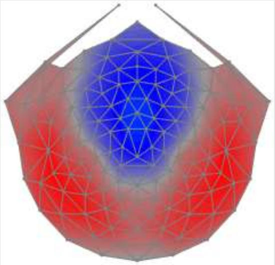
EEG



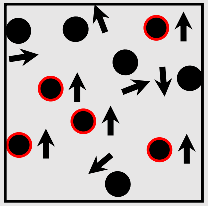
Visual processing
(back of the head)



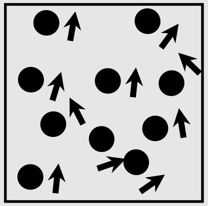
Decision-making
(centre of head)



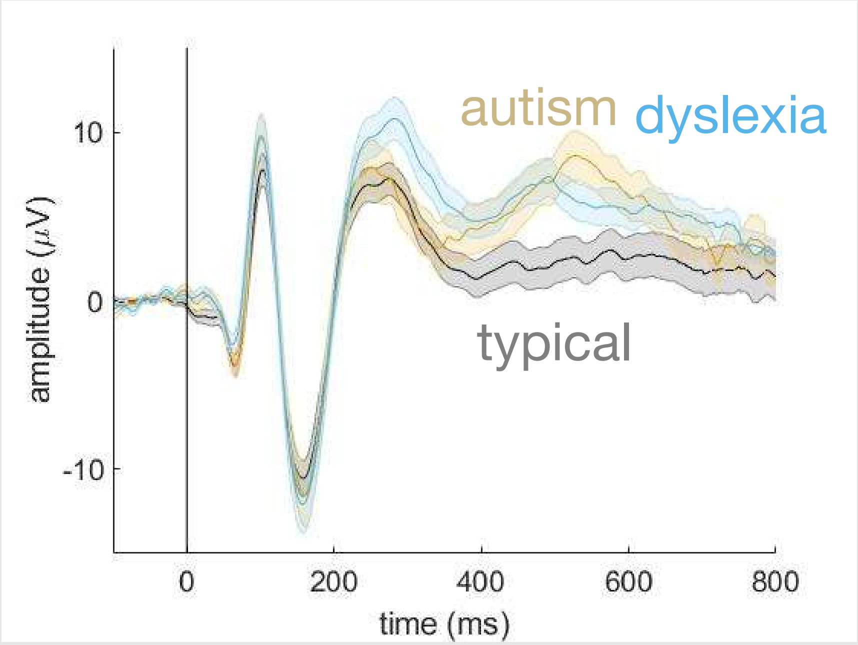
EEG – visual processing

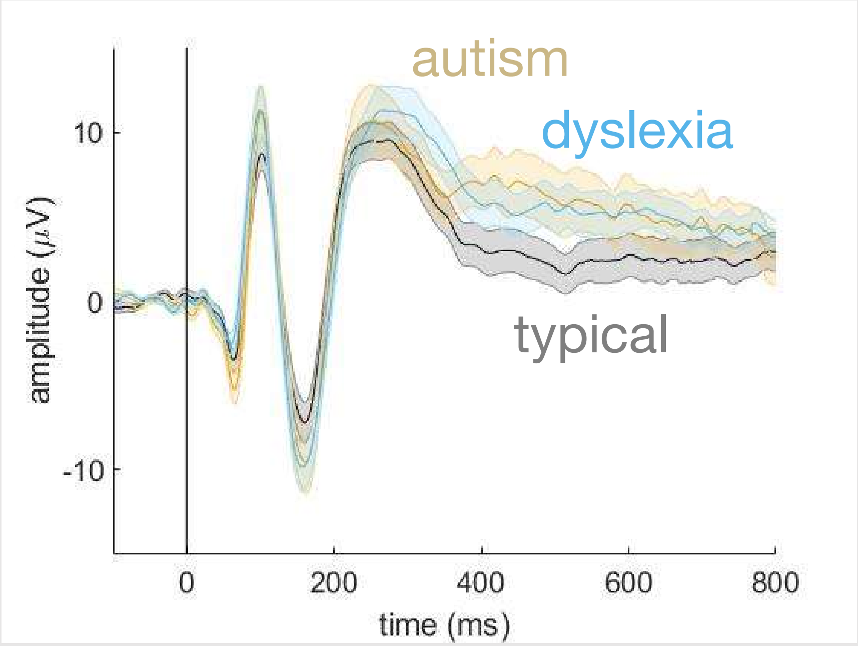


motion coherence task

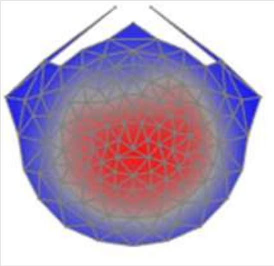


motion integration task

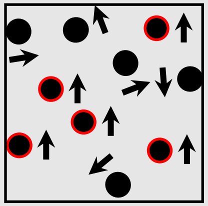




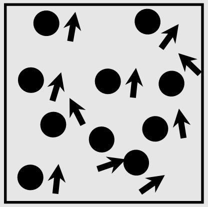
Group differences at later timepoints – and only in the motion coherence task – reflecting difficulties filtering out visual noise for both autistic and dyslexic children?



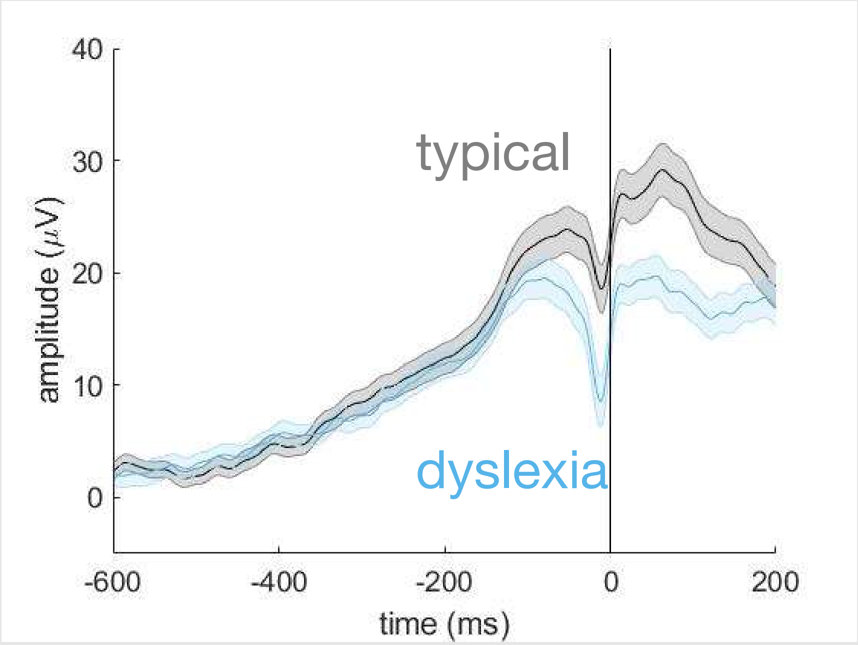
EEG – decision-making

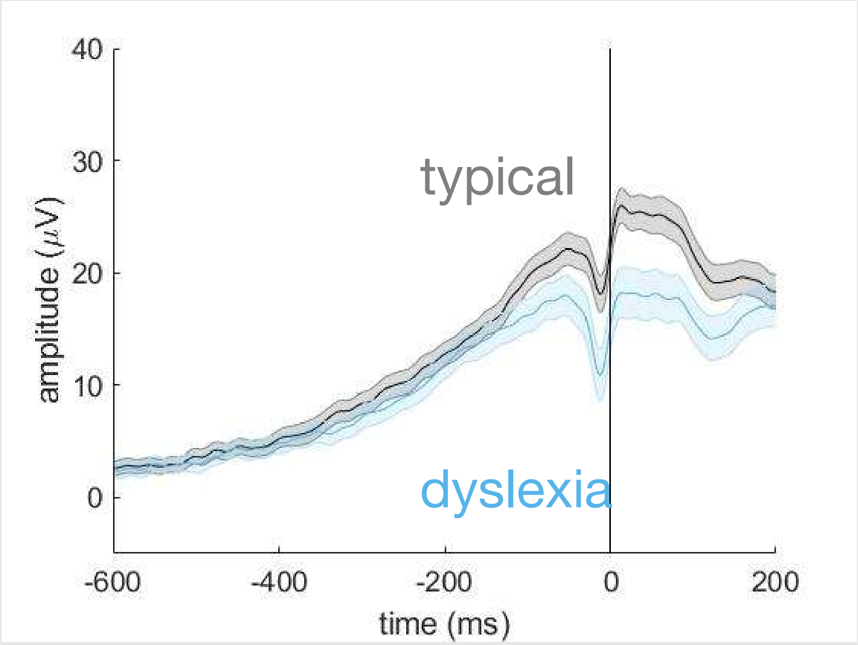


motion coherence task

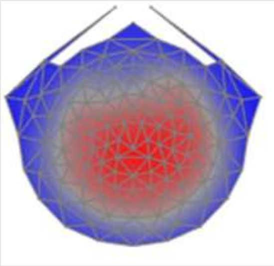


motion integration task

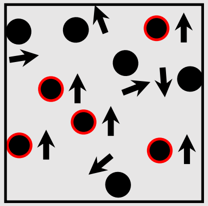




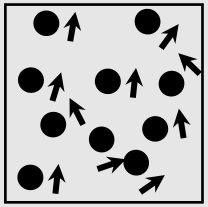
Group differences in brain activity for both tasks around the time of the response. Relates to mathematical model



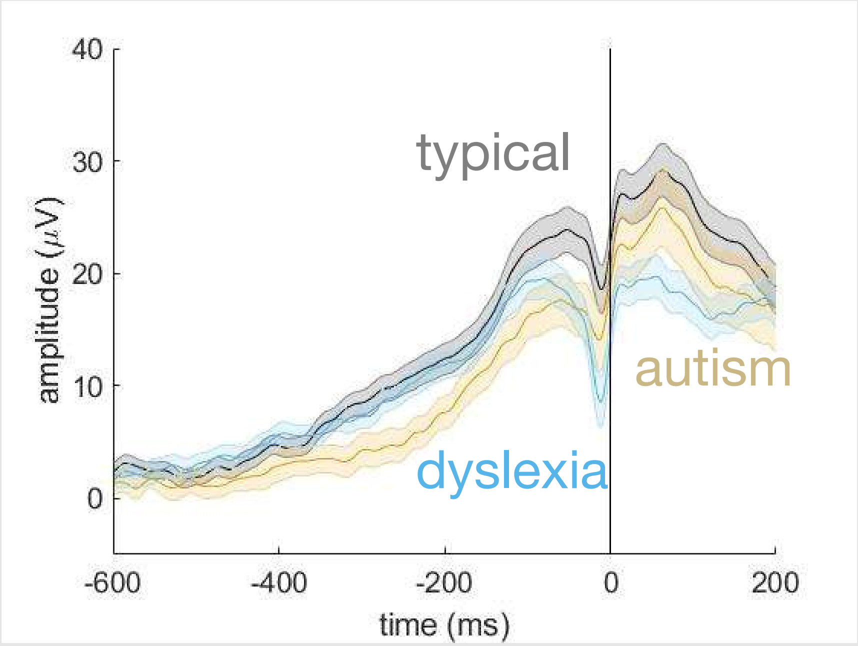
EEG – decision-making

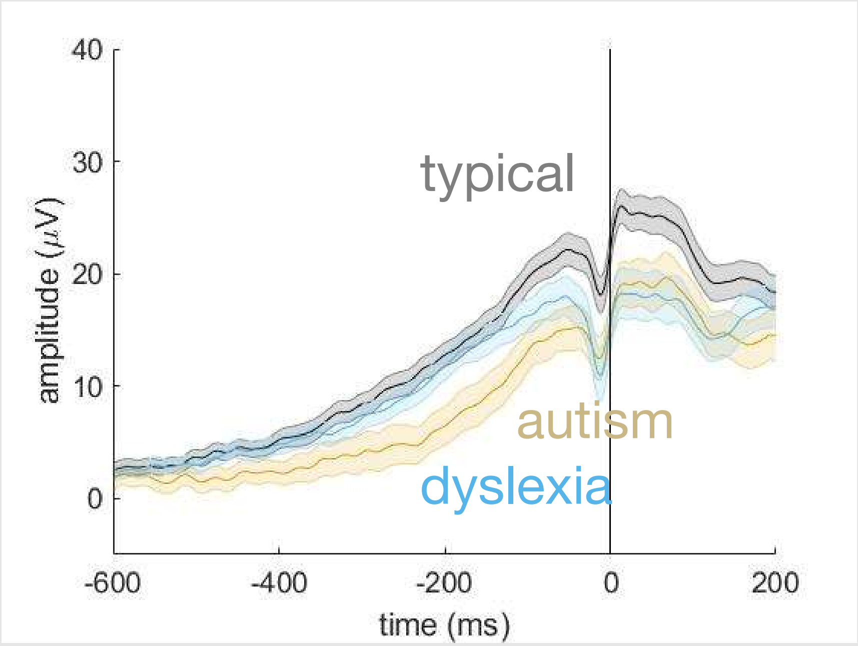


motion coherence task



motion integration task





Also differences in autism group around the time of response

Summary of dyslexia findings

- Dyslexic children are slightly slower and make slightly more errors than typically developing children
- The mathematical model suggests that this is because dyslexic children are less sensitive to motion information
- Dyslexic children also differ from typical children in their brain activity
- Early responses to motion information are unaffected, but differences emerge in later processing stages linked to ignoring visual noise, making decisions and responses

Comparing dyslexia and autism

- Both similarities and differences between autistic and dyslexic children
- Suggests that there are areas of overlap in these two developmental conditions, but also areas of divergence
- Important for understanding the role atypical visual processing plays in these two conditions
- Still work to be done on understanding variability within a condition

Summary

- Visual processing is atypical in dyslexic children e.g., reduced sensitivity to visual motion information
- Dyslexic children pick up motion information more slowly, and have difficulties ignoring visual noise
- We find neural markers of these differences in EEG

Implications and future research

- Not just reading affected in dyslexia – differences in visual processing in non-reading tasks
- Visual processing differences may not be causal… but still potentially important
- Helps us understand how the brain develops differently in children with dyslexia
- Does this difference in picking up information extend to other tasks?
- How do other skills (e.g., processing speed, cognitive ability) relate to decision-making and reading difficulties?
- Can we train decision-making to improve reading ability?

Implications and future research

[How moving dots are helping us learn more about dyslexia in children – new research (theconversation.com)](https://theconversation.com)

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Research priorities

- Lack of research into what the dyslexia community want researched
- Current research may therefore not align with the dyslexia community's priorities
- Currently, UK research predominantly focuses on biology, brain and cognition
- Focus groups with dyslexia community – need more research in other areas
- Survey to be launched in coming months

Q&A

Thanks to the participants, families, schools and organisations who took part

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wellcome