Beyond the label: Understanding why some kids struggle in school

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Debunking a few myths....

“What do you know about the brain?” If you ask someone this question, you are most likely to get one of the following answers: “The right hemisphere of the brain is for emotion and creativity. In contrast, logic lies in the left hemisphere.” Someone else might answer: “We only use of 10% of our brains!” These statements are common misconceptions about brain mechanisms, which are taken for granted in today’s society. Many such myths have evolved around the functioning of the brain. In order to classify them, the OECD coined the term "Neuromyths".

OECD Website
The brain, cognition and learning

Top 5:

• 5) We only use x% of our brains

• 4) Short bursts of co-ordinated activity can improve the communication between the two halves of the brain

• 3) Pressing on different parts of the body can enhance specific patterns of brain activity

• 2) Individual’s brains are predisposed to learn in different ways, and will learn best when information is delivered in the preferred style

• 1) Differences in hemispheric dominance can help explain differences in learning style
Treatments for educational difficulties: an example

More from Dorothy Bishop
https://www.slideshare.net/deevybishop/the-dore-programme-evaluation

For more information
https://www.badscience.net/2006/11/the-miracle-cure-for-dyslexia/
How does the intervention work?

• Based on a series of balancing and motor exercises developed by Wynford Dore to help his daughter, who had dyslexia

• The programme includes exercises for around 10 minutes, twice a day, assessed every 6 weeks

• Example exercises:
  • Standing on a cushion on one leg and throwing a beanbag from one hand to another for one minute
  • Balancing on a wobble board
  • Hopping on one leg in a large circle, clockwise then anticlockwise
    • (Examples only: full details confidential because it is commercially sensitive)

• The idea is that these exercises will improve cerebellar function... and thus cure dyslexia
What was the evidence that this works?

A group of children were selected using a dyslexia screening tool and then put through the Dore Programme

Dore (2006): The results are “stunning”
- Reading age increased by 3x
- Comprehension age increased by 5x
- Writing increased by ‘an extraordinary’ 17x


Why might this be?
Practice effect, maturation, regression to the mean
So what about the control group?

Data from the ‘dyslexia screening tool’
- Intervention – mean score fell from 0.74 to 0.34
- Control group – mean score fell from 0.72 to 0.44

*i.e. everyone improves... even if not treated*

*Nb. This measure includes bead threading and posture*

“Social scientists incorrectly estimate the effect of ameliorative interventions... and snake-oil peddlers earn a healthy living all because our intuition fails when trying to comprehend regression to toward the mean” Campbell and Kenny, 1999

Image courtesy of Dorothy Bishop
https://www.slideshare.net/deeyvibishop/the-dore-programme-evaluation

For more information
https://www.badscience.net/2006/11/the-miracle-cure-for-dyslexia/
Is this an isolated case?

No...

Raising Attainment: STEP Physical Literacy

What is STEP?
STEP has been described as “the most innovative intervention for raising achievement levels in children whose academic performance is in the lower quartile of the classroom”.

It is a unique programme that enhances the traditional interventions that we already offer in our schools such as numeracy, literacy, behaviour and
Why are these ‘treatments’ so popular?

• Families and children are vulnerable

• For example, the cost of the Dore Programme was £1500 to £2000
  “Surely it is a price worth paying in the attempt to transform the life of your child so that they are able to enjoy school, to develop social skills, to develop good sporting skills, to have good prospects in life?”
  Dore (2006)

• There is no regulation of education interventions... and great demand from families

• Policy makers – e.g. MPs – tend not to have the scientific literacy needed to critically evaluate ‘treatments’ before they endorse them

• Widespread misunderstanding of the nature of diagnoses of developmental disorders or learning difficulties
How do you study the cognitive and neural mechanisms in developmental disorders or learning difficulties?

1. Choose a diagnostic group – e.g. dyslexia, ADHD
2. Choose some matched controls
3. Compare the groups

But…..

These diagnostic groups lack specificity within the diagnostic groups

These diagnostic groups lack sensitivity – these cognitive problems are likely shared across multiple groups,

Result: White matter correlates of ADHD

This is a real problem: interventions are pitched at diagnostic labels... but these labels don’t do a good job of capturing cognitive difficulties
CALM: the Centre for Attention, Learning and Memory

With the help of speech and language therapists, SENCos, paediatricians, specialist teachers, ADHD nurses, educational psychologists, clinical psychologists, occupational therapists... we recruited hundreds of struggling learners.

We had a lot of fun along the way!
CALM: the Centre for Attention, Learning and Memory

**REFERRALS**

- Education n=572 (199)
  - CAMHS & Paediatrics n=304 (81)
  - SLT n=38 (14)

**ASSESSMENTS**

- Children referred n=914 (294)
  - No shows: n=24 (6)
- Children assessed by December 2018 n=812 (258)
  - Waiting to be assessed: n=0 (1)
  - Assessed but data excluded n=7 (2):
    - Non-native English speakers n=3 (2)
    - Refused to complete majority of tests n=3 (0)
    - Pre-existing neurological condition n=1 (0)

**ANALYSIS**

Current sample for analysis n=805 (256)
- Education: n=504 (172)
- CAMHS & Paediatrics: n=267 (71)
- SLT: n=34 (13)
### Diagnosis

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>N (female)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADD</td>
<td>14 (8)</td>
</tr>
<tr>
<td>ADHD</td>
<td>183 (40)</td>
</tr>
<tr>
<td>ADHD under assessment</td>
<td>56 (16)</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>1 (0)</td>
</tr>
<tr>
<td>Dyslexia</td>
<td>47 (15)</td>
</tr>
<tr>
<td>Dyspraxia</td>
<td>21 (7)</td>
</tr>
<tr>
<td>Dysgraphia</td>
<td>1 (0)</td>
</tr>
<tr>
<td>Dyscalculia</td>
<td>2 (2)</td>
</tr>
<tr>
<td>FASD</td>
<td>6 (4)</td>
</tr>
<tr>
<td>Generalised/global delay</td>
<td>10 (5)</td>
</tr>
<tr>
<td>Depression</td>
<td>3 (3)</td>
</tr>
<tr>
<td>Anxiety (inc. social anxiety)</td>
<td>9 (4)</td>
</tr>
<tr>
<td>Autism</td>
<td>57 (7)</td>
</tr>
<tr>
<td>PDA</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Tourettes</td>
<td>5 (1)</td>
</tr>
<tr>
<td>DAMP</td>
<td>4 (1)</td>
</tr>
<tr>
<td>OCD</td>
<td>5 (4)</td>
</tr>
<tr>
<td>Sensory processing disorder</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Language disorder (inc. SLI)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Conduct disorder</td>
<td>1 (0)</td>
</tr>
<tr>
<td>ODD</td>
<td>3 (1)</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Anorexia</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Speech &amp; language therapy</td>
<td>160 (51)</td>
</tr>
<tr>
<td><strong>No diagnosis</strong></td>
<td><strong>484 (165)</strong></td>
</tr>
</tbody>
</table>

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**CALM: the Centre for Attention, Learning and Memory**

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**Gender Distribution**

- **Total participants**: 319 female, 90 male

**Age Distribution**

- 5-6 years: 1 female, 2 female
- 7-8 years: 6 female, 62 male
- 9-10 years: 90 female, 126 male
- 11-12 years: 125 female, 154 male
- 13+ years: 4 female, 11 male

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**Diagnosis Distribution by Gender**

- **ADD**: 3 female, 11 male
- **ADHD**: 14 female, 29 male
- **ADHD under assessment**: 5 female, 29 male
- **Hyperactivity**: 1 female, 0 male
- **Dyslexia**: 47 female, 15 male
- **Dyspraxia**: 21 female, 7 male
- **Dysgraphia**: 1 female, 0 male
- **Dyscalculia**: 2 female, 2 male
- **FASD**: 6 female, 4 male
- **Generalised/global delay**: 10 female, 5 male
- **Depression**: 3 female, 3 male
- **Anxiety (inc. social anxiety)**: 9 female, 4 male
- **Autism**: 57 female, 7 male
- **PDA**: 1 female, 1 male
- **Tourettes**: 5 female, 1 male
- **DAMP**: 4 female, 1 male
- **OCD**: 5 female, 4 male
- **Sensory processing disorder**: 3 female, 1 male
- **Language disorder (inc. SLI)**: 2 female, 1 male
- **Conduct disorder**: 1 female, 0 male
- **ODD**: 3 female, 1 male
- **Epilepsy**: 4 female, 2 male
- **Anorexia**: 1 female, 1 male
- **Speech & language therapy**: 160 female, 51 male
Can we use the data to tell us what the different routes are to being a struggling learner?
CALM: the Centre for Attention, Learning and Memory

Rather than analysing data according to diagnostic boundaries, or cut-offs, we wanted to make as few assumptions as possible.

We analysed the data using machine learning – a simple artificial neural net.
Does the machine learning learn the categories we know about?

Referral reason or diagnosis is not a good predictor of a child’s cognitive difficulties
So what did the machine learning ...learn?

One way is to carve the map into different chunks

Within the map there are four profiles:

i) Wide-spread deficits
ii) Spatial STM/WM problems
iii) Age-appropriate scores
iv) Phonological problems
So what did the machine learning ...learn?

Does this generalise to other data?

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Group 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Widespread difficulties”</td>
<td>“Poor working memory”</td>
<td>“Age-appropriate”</td>
<td>“Poor phono”</td>
</tr>
</tbody>
</table>

**Reading**
- Bottom ~5%
- Bottom ~15%
- Bottom ~15%
- Bottom ~15%

**Spelling**
- Bottom ~5%
- Bottom ~15%
- Age-appropriate
- Age-appropriate

**Maths**
- Bottom ~5%
- Bottom ~15%
- Age-appropriate
- Bottom ~15%

**Behaviour**
- Poor communication skills
- Age-appropriate communication
- Poor communication skills
Why do some children struggle to learn?

Interim Summary:

• We collected a rich dataset from a large group of struggling learners

• Their difficulties do not correspond well to any diagnoses they had

• Within the data there are children with:
  • i) Widespread cognitive difficulties
  • ii) Spatial STM / WM difficulties
  • iii) Age-appropriate cognitive skills
  • iv) Phonological difficulties

• These groupings corresponded closely to educational attainment and communication skills
What about the brain?

- We tend to think that different bits of brain do different things – and therefore a particular learning difficulty results from ‘damage’ to a different bit of brain

- But this is highly unlikely to be true
  - Most of these studies are too small
  - They use methods that only find peaks
  - They are all case-control designs (remember what I told you about those)
  - And they usually don’t replicate
What about the brain?

We can measure grey matter thickness, the curvature (gyrification) and the depth of the sulci.
Can we use machine learning to combine datasets?
Can we predict a child’s cognitive profile from their brain morphology?

Yes – structural brain data make accurate predictions about a child’s cognitive profile
Can we predict a child’s cognitive profile from their brain morphology?

So, what are the neural correlates of different profiles?

In short, there is no ‘core brain deficit’ corresponding to a specific cognitive profile.
Can we predict a child’s cognitive profile from their brain morphology?

Why? Because the developing brain is not like an adult brain.

It is a complex network.
Beyond the label: Understanding why some kids struggle in school

• Misconceptions about the brain are very common

• Alongside other factors, this can fuel ‘treatments’ for learning difficulties that have no good evidence base

• We recruited a large sample of struggling learners – using machine learning we identified different profiles of difficulty across children, and these generalise to communication skills and educational attainment

• The nature of their cognitive difficulties does not correspond well with any diagnosis or referral reason

• These difficulties can be strongly predicted by brain structure. But there are many ‘routes’ to having a particular cognitive difficulty
Remapping the cognitive and neural profiles of children who struggle at school

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