Dyscalculia
6-14 years
What do we know already about dyscalculia?
Numeracy skills are affected by:

- Poor number awareness
- Sequencing difficulties
- Visual perceptual difficulties
- Spatial problems
- Language difficulties
- Poor active working memory
- Anxiety, emotional problems
- Epilepsy, medical conditions
- Low IQ
- Dyscalculia

Source: inclusion4all
Diagnosis

DSM = Specific Learning Disorder
“A neurodevelopmental disorder of biological origin manifested in learning difficulties and problems in acquiring academic skills markedly below age level and manifested in the early school years, lasting for at least 6 months; not attributed to intellectual disabilities, developmental disorders, or neurological or motor disorders.”

315.0 With impairment in reading.
315.1 With impairment in mathematics
315.2 With impairment in written expression

Severity: Mild, Moderate, Severe
So what is dyscalculia?

Spectrum disorder

Neurological difference

- Inappropriate/hyperactivity activity in parietal and frontal lobes area of the brain
- Difference in visual processing areas of brain
- Inappropriate task modulation in multiple brain areas
Recent research

(Rosenberg-Lee et al, 2015)

- DD: More activity in intraparietal areas
- DD: More inter connectivity between areas
- TD: more activity in frontal lobes
Recent research

(Rosenberg-Lee et al, 2015)

- Addition is as accurate as typically developing children
- Subtraction is more problematic
Recent research

(Rosenberg-Lee et al, 2015)

- **DD:** No difference in time it takes to correctly answer addition and subtraction
- **TD:** much quicker at solving addition problems
“Both localized processing deficits in multiple brain areas as well as the coordination between multiple brain circuits are impaired in DD.”

(Rosenberg-Lee et al, 2015)
Recent research

(Park and Brannon, 2013)
When students work with symbols, such as numbers, they are using a different area of the brain than when they work with visual and spatial information, such as an array of dots.
Mathematics learning and performance was optimized when the two areas of the brain were communicating.
Who has dyscalculia?

3% - 6%
International influences
Three areas of difficulty

**Number sense**
- Delay learning to count
- Difficulty counting accurately
- Difficulty understanding (language of) quantity
- Inefficient strategies for calculation – rounding, estimating, visualising

**Processing number symbols**
- Difficulty linking symbols to quantity
- Difficulty with calculation, especially subtraction

**Executive Functioning**
- Working memory – number facts, mental calculation
- Speed of processing (visual) information
- Ignoring irrelevant information
- Attention
Symptoms

Number sense difficulties

• Difficulty subitising
• Over-reliance on finger counting
• Poor estimation skills
• Counting objects is inaccurate
• Difficulty counting backwards
• Problems ‘Rounding’ numbers
• Difficulty decomposing numbers
• Inaccurate subtraction
• Poor sense of place value
Subitising
Number sense

Sense of:

- how big the answer will be
- how to simplify a calculation by changing numbers without changing the answer
- an answer that is completely wrong
Numicon

Visualising numbers
Sloping number line

The sloping number line
‘Maths Explained’
Steve Chin
Estimation

1) ‘Right’, ‘nearly right’ or ‘a long way from right’?

2) Positivity towards trial and error (class culture)
Place value

Take a set of cards.

Put yourselves ascending into numerical order.

What skills did you use?
Place value

“... a poor understanding of the place-value system of numbers is a common phenomenon. This poor understanding will have far-reaching implications for children learning mathematics.”

The Routledge International Handbook of Dyscalculia and Mathematical Learning Difficulties by Steve Chin, 2014
Support ideas

How would you support place value?

Re-write horizontal calculations into vertical form
Re-write vertical calculations into horizontal form!
One way of recording
Use squared paper
Line up paper before the lesson
Use Dienes blocks/Base Ten throughout KS2
Have model of methodology on table
Use calculator for checking
Resources

Numicon
Cuisenaire
Dienes
Base 10 blocks
Tally marks
Arrays

www.addacus.co.uk
Symptoms

Processing number symbols difficulties

- Poor memorisation of the number line
- Slow to move from practical equipment to symbols
- Money (size of coins not representative of value)
- Poor concept of Zero
- Poor commutativity \((7+5 = 5+7)\)
- Writes 61 for ‘sixteen’ and other teen numbers
- Cannot remember number bonds and multiplication facts
- Over-dependence on fingers and practical apparatus in simple calculations
Number Symbols

Where numbers are on the number line
Which numbers come before and after
Which numbers are ‘more’ and ‘less’
Relationship to 5, to 10, to 100, to 1000
# Progression

<table>
<thead>
<tr>
<th></th>
<th><img src="image1.png" alt="Apples" /></th>
<th><img src="image2.png" alt="Apples" /></th>
<th><img src="image3.png" alt="Apples" /></th>
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</thead>
<tbody>
<tr>
<td><strong>Real objects</strong></td>
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<tr>
<td><strong>Pictures of objects</strong></td>
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<td><img src="image3.png" alt="Apple" /></td>
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<tr>
<td><strong>Counters/cubes</strong></td>
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<tr>
<td><strong>Numeral chart</strong></td>
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<td><img src="image2.png" alt="Chart" /></td>
<td><img src="image3.png" alt="Chart" /></td>
</tr>
<tr>
<td><strong>Number line</strong></td>
<td>0 1 2 3</td>
<td>0 1 2 3</td>
<td>0 1 2 3</td>
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</tbody>
</table>
Numerals

Learn Telugu numerals ...
Learn numerals in Telugu
Numerals test

What did you learn?
Calculation test

3 + 0 = 0 + 3 = 3 - 0 =
2 + 2 = 2 + 2 = 2 - 2 =
5 + 2 = 2 + 5 = 5 - 2 =
8 - 0 = 8 - 3 = 8 - 5 =
9 - 1 = 9 - 3 = 9 - 5 =
6 - 2 = 6 - 9 = 6 + 9 =

What did you learn?
Support ideas for number symbols

How would you support number symbols?

- Daily practice in short bursts
- Regular practice with practical apparatus
- Have number lines/squares always available
- Use consistent colours on numberlines (multiples of 5 and 10)
- Use consistent mathematical language
- Use consistent symbols (1, 1, 1)
- Extra time for calculations
Symptoms

Executive Functioning

• Patterns
• Arrangement of objects
• Rote learning: addition facts, times tables
• Time/direction
• Organisation of written work
• Forgets the question in mental maths
• Can only hold 2 or 3 numbers in memory
• Trouble with multi-step (mental) calculations
• Attention to task
• Tiredness
Executive Functions

Higher-Level Executive Functions:
- Reasoning
- Problem-Solving
- Planning & Monitoring

Fluid Intelligence

Cognitive Flexibility

Working Memory
- Verbal
- Visual-spatial

Inhibitory Control
- Interference Control
- Cognitive Inhibition
- Selective or Focused Attention
- Inhibition at the level of: Thoughts, Attention
- Response Inhibition
  - Behavior
by Helen Claus

9 year old

Next step: work on columns
Support for Executive Functioning

- Reinforce and praise use of concrete materials
- Minimise copying from board
- Always lay materials out in the same way
  - Box the biggest number in addition $79+135$
- Always write calculations in same way
- Use practical apparatus
- Encourage drawing
- No mixed problems
- Highlight key words
- Talk through steps as they are done
- First 3 examples supported
- Sit with more advanced group

Model, support, independent
Strategies
**9x Tables Trick**

Put down the finger you are multiplying by.

Count the fingers on either side.

There's your answer!

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Times Tables on Hands

9x4 = 36
Anxiety and Fear of Failure

“The experience of failure is a consequence of the inherently judgmental nature of arithmetic. For example, the answer for $8 \times 7$ is 56.

Giving an answer of 54 is rarely judged empathetically as, “That was close. Well done.”

The “54” answer generates the response, “Wrong.”

(Steve Chin: Beliefs, Anxiety, and Avoiding Failure in Mathematics, 2012)
"NO, NO, NO WRONG AGAIN!"
We don’t have to wait for a diagnosis to start interventions
Key Teaching Strategies

- Start from the beginning and build up skills
- Effective communication – simple, consistent vocabulary
- Teach one method and stick with it
- Practice little and often
- Share methodology with parents and tutors
- Reduce copying from board
- Take away time pressures
- Reduction of anxiety

Model, support, independent
Thank you!