The brain, dyscalculia and learning difficulties

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My background

- BSc, University of Auckland (Psychology)
- PhD, University of Oregon (Cognitive neuroscience)
  - Major: Numerical & spatial cognition
  - Minor: Math learning disabilities (special education)
- Postdoctoral fellowship, INSERM U562, Paris
  - Development & testing of remediation software for maths learning disabilities (dyscalculia)
- Research fellow, University of Auckland
  - Brain bases of maths and reading learning disabilities
- Lecturer, University of Canterbury
  - Teaching/research on educational neuroscience, dyscalculia
Educational neuroscience

Application of cognitive neuroscience findings to education / teaching.

- Interest from public, teachers (grassroots)
- Developments in neuroscience
- Political push for “evidence based” education

- 1995 onwards: “Brain-based learning” industry
- 2000 onwards, academic response
New brain imaging methods

In the last 20 years, the field of cognitive neuroscience has developed non-invasive methods for studying the brain in action, in adults and now children.

Electroencephalography (EEG)

Functional magnetic resonance imaging (fMRI)
Fig. 1. An illustration of several different noninvasive tools currently being used to study human brain development, learning and plasticity. From top left to right to bottom are images of an MRI, a child in a MRI simulator, and DNA samples collected from cheek swabs, images from a fMRI study and DTI images, respectively.
Brain areas active in reading in skilled readers are speech areas. These areas are less active in dyslexic vs. normal reading children. Activity increases with phonological awareness training.

e.g. Temple et al. 2003
Debunking neuromyths

If it’s in the brain – it can’t be changed

Nothing could be more wrong!

- The brain is the basis of all learning
- Brain function and even structure is highly “plastic”, especially at a young age
- The mild impairments associated with learning disabilities are nothing like the brain damage caused by stroke/lesion
Other neuromyths

- Learning does not always involve the brain
- We only use 10% of our brain
- There are left and right brain learners
- There are different sensory “learning styles”

Avoiding neuromyths

- Check your source is an authority... qualifications? Recommended by other authorities?
- Don’t assume cost or popularity means it’s correct.
- Inform yourself (see next slide)
- Avoid: David Sousa, BrainGym, Eric Jensen
Berninger, V. W. & Richards, T. L. Brain literacy for educators and psychologists.
Tokunama-Espinosa, T. The new science of teaching and learning.

See: http://amzn.com/w/24DIN2W7E2RVP (My Amazon list)
Numerical cognition

• Study of representation of number in the brain

• Methods: Animals, infants, cross-cultural linguistics, brain imaging, cognitive psychology

• Good introductory books:
  - Stanislas Dehaene
Dyscalculia

- Severe difficulty in mathematics, not explained by general cognitive difficulties or educational opportunities
- Also called “Mathematics Disorder” (DSM-IV), or “mathematical learning disabilities”
- Prevalence: around 6% (same as dyslexia!)
- Has genetic component (runs in families)
- Understudied compared to dyslexia

Difficulties seen in dyscalculia

Delay in acquisition of:
- Counting, including finger counting
- Addition strategies (counting on vs. counting all)
- Memorization of number facts (e.g. times tables)


Difficulties with word problems
- Although may be linked to dyslexia

2 + 5 = ?

Counting all
“1..2...
1...2...3...4..5..
1...2...3...4...5...6...7”

Counting on
“2...3...4...5...6...7”

Counting on (max)
“5...6...7”
Likely other difficulties

Difficulty with:

- Decomposing numbers (e.g. recognizing that 10 is made up of 4 and 6)
- Understanding place value
- Learning/understanding multi-step calculation procedures and problem solving

Anxiety about or negative attitude towards maths
Co-occurring difficulties

Both verbal and non-verbal:

- Dyslexia (40%)
- ADHD (30%)
- Dyspraxia
- Spatial difficulties

Why is there such a high association between these disorders?? What is the implication for remediation?
Consequences in children

Bevan & Butterworth (1997) – Focus group study

Focus group 1

*Child 5:* *It makes me feel left out, sometimes.*
*Child 2:* Yeah.
*Child 5:* *When I like—when I don’t know something, I wish that I was like a clever person and I blame it on myself—*
*Child 4:* *I would cry and I wish I was at home with my mum and it would be—I won’t have to do any maths.*
Consequences in children

Bevan & Butterworth (1997) – Focus group study

Focus group 2

Moderator: How does it make people feel in a math lesson when they lose track?
Child 1: Horrible.

Moderator: Horrible? . . . Why’s that?
Child 1: I don’t know.

Child 3 (whispers): He does know.

Moderator: Just a guess.
Child 1: You feel stupid.
Consequences in children

Bevan & Butterworth (1997) – Focus group study

More able children, of course, are well aware of this and often tease or stigmatize DD classmates:

Child 1: She’s like—she’s like all upset and miserable, and she don’t like being teased.

Child 4: Yeah, and then she goes hide in the corner—nobody knows where she is and she’s crying there.
Consequences in adults

- Blocked from certain professions (lower salary)
- Difficulty managing money
- Difficulty understanding statistics/numbers (influence on decision making)
- Low self-esteem, anxiety, avoidance

“I have always had difficulty with simple addition and subtraction since young, always still have to ‘count on my fingers quickly’ e.g. 5+7 without anyone knowing. Sometimes I feel very embarrassed! Especially under pressure I just panic.”
Consequences in adults

“I struggled through school with maths to the point the teachers gave up on me. I can only count on my fingers or with a calculator. I can't count out change, no matter how small and often get flustered with any tasks involving numbers. Despite trying hard I could never remember my 'times tables'. Division etc just bewildered me totally. English was one of my best subjects at school.”

“I have no trouble whatsoever reading or writing, understanding literary concepts and theories etc., but spend an hour sitting in the bank trying to work out how much money is in my cheque account! Last year I returned to University, attempting to avoid any papers containing mathematics, but hidden in nearly everything are formulas and calculations.”
Consequences in adults

University of Auckland study with Prof. Karen Waldie.

Adults with dyscalculia have basic number processing impairments:

- Slower and less accurate on their times tables
- Slower and less accurate subtracting 1-digit numbers
- Slower to indicate the larger of two 1-digit numbers
- Slower counting up to 8
- Slower to “subitise” – quickly recognise quantities of 1-3 objects

This is independent of whether they have dyslexia or not, and is specific to processing numbers.
Welcome

4-6% of the World population are dyscalculic. Dyscalculia has been approved by WHO and DSM for decades, but most people have no idea that this exists. Because of that, very few people are getting the help they need to succeed in life. The help dyscalculics need simply doesn’t exist. And it’s the same thing all over the world - from Thailand to Australia.

We need to change that. We need to spread the word.

The Dyscalculia Forum is an international community for everyone and anyone interested in dyscalculia. You can find information, facts, hundreds of articles and much more, but this is mainly a community to be used by YOU. The forum is free to join, free to use, free to read and free of advertising of any kind. The forum is not part of any sort of organisation - it’s simply maintained and owned by people who are interested in dyscalculia. You are more than welcome to email us if you have suggestions, questions or comments.
Mathematical cognition

- Study of how the brain does maths
- Methods: Animals, infants, cross-cultural linguistics, brain imaging, cognitive psychology
- Good introductory books:

  - Stanislas Dehaene
  - Brian Butterworth
Mathematics is componential

- Non-verbal
  - number, approximation, comparison
- Verbal
  - number facts (multiplication, addition)
- Logical
  - problem solving, higher maths
- Spatial
  - geometry? Number line?
Non-verbal bases of number

- Number is not “constructed” or dependent on symbolic thought as Piaget claimed
- We can perceive and operate on non-symbolic quantities from infancy
- Animals can also add, subtract and compare quantities!
- Makes evolutionary sense
Approximate number: Demonstration

Which side has more dots?
Ratio = 0.5
Faster, more accurate

Ratio = 0.79
Slower, less accurate
Ratio = 0.5
Dots: faster, more accurate
Digits: the same!!

Ratio = 0.79
Dots: slower, less accurate
Digits: the same!!
The distance effect

Speed and accuracy depend on how close the two numbers are together.
Found in adults and children, with dots AND number symbols.
E.g. see Brannon (2003) for a review
Approximate number, or “number sense”

- Non-verbal
- Non-symbolic
- Present in animals / human infants
- Still accessed in skilled adults
- Used for representation and operations
- Predictive of success in maths

Next: Has a specific brain basis
Number sense in adults

Using number sense activates the intraparietal sulcus (IPS):
(This same area is involved in thinking about space.)

Tasks that activate this region:
• Comparison of numbers
• Subtraction
• Approximation
• Estimation
• Non-symbolic tasks

Automatically activated by viewing numbers

Number sense in children

Neural correlates the same as in adults.

Cantlon, Brannon, Carter & Pelphrey 2006

Non symbolic tasks

fMRI in 4 year olds
Causes of dyscalculia

"Access" hypothesis: Deficit in link between number sense and symbols
(Rouselle & Nöel, 2007)

"Core deficit" hypothesis: Deficit in number sense (Butterworth, 1999; Gersten & Chard, 1999; Wilson & Dehaene, 2007)

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Brain bases of dyscalculia

Dyscalculic children - less grey matter in IPS (Rotzer et al., 2008)

Dyscalculic adults born pre-term – less gray matter in IPS (Isaacs, Edmonds & Lucas, 2001)

Dyscalculic children – less activation in IPS during magnitude tasks (Kucian et al., 2006)

Cognitive capacities in dyscalculia

- Difficulty representing quantity (“number sense”).
  - Slow to compare numbers (Landerl et al., 2004)
  - Slow to enumerate 1-3 objects (“subitizing”) (Reeve et al., in press)

- Number symbols processed less automatically
  - Number stroop task (Rouselle & Nöel, 2007; Rubinsten & Henik 2005)

- Mental number line slow to develop
Lower number “acuity”

Piazza et al. (2010) Cognition
Mental number line task

“Put a mark where you think 64 goes”

Siegler & Booth, 2004
Mental number line development

Individual differences on this task correlate with maths achievement scores.

Siegler & Booth, 2004
Mental number line in dyscalculia

Wilson, Krinzinger, Nuerk, Dehaene & Willmes, in prep

10-year olds with dyscalculia
Mathematics is componential

• Non-verbal
  – number, approximation, comparison

• Verbal
  – number facts (multiplication, addition)

• Logical
  – problem solving, higher maths

• Spatial
  – geometry? Number line?
Angular gyrus (green) involved in “verbal” aspects of mathematics such as multiplication, and retrieval of arithmetic facts.

- Numerical comparison (1 digit)
- Exact subtraction > Comparison
- Exact subtraction > Multiplication
- Approximate addition
- Numerosity estimation
- Numerical distance effect (1 digits)
- Number subliminal perception
- Complex > Simple addition
- Numerical distance effect (2 digits)
- Multiplication > Comparison
- Multiplication > Subtraction
- Exact > Approximate calculation
- Subtraction ∩ Phoneme detection
- Simple addition > Complex addition

Adapted from Dehaene et al. 2003
Angular gyrus increases activation with “drill” type training, with practice, and with development. Function: linking non-symbolic to symbolic representations?

e.g. Ischebeck et al. (2007)
Training by drill increases AG activation
Subtypes of dyscalculia?

- **Number sense / number sense access**
  - Everything affected except counting, fact retrieval
  - May have difficulty with non-symbolic tasks
- **Verbal**
  - Difficulty with counting, fact retrieval, word problems
  - Associated with dyslexia?
- **Executive**
  - Difficulty with fact retrieval, use of strategy/procedure
  - Associated with ADHD??
- **Spatial**
  - Difficulty with subitizing, apprehension of non-symbolic quantity… mental number line?

Wilson & Dehaene (2007)
Dyscalculia identification

Ideally, assessment should be carried out by a qualified professional, e.g.:

- Educational psychologist
  - Private practices
  - Ministry of Ed (Moderate Needs)
- RTLB, RTLit, MST (Also Ministry of Ed)
- SPELD (NZQA trained assessors)
- School / tertiary learning centre staff
Identification procedure

Test for:
- Mathematics level (standardised test)
- Profile of performance in different components
- IQ (rule out general difficulties)
- Dyslexia, ADHD, dyspraxia if suspected

Interview parent and child to rule out other possible causes of maths difficulties, and to establish risk factors.
Diagnostic criteria

Difficulties are developmental. Difficulties are severe.

- Maths score 2 years below age level
- OR in an adult at a low level (e.g. <25 %tile) and/or discrepant (e.g. 1.5 SD) with IQ

General cognitive ability intact
- e.g. IQ >= 80

No other reasonable explanation for difficulties.

→ Presumed to be dyscalculia
Questions to ask

Other possible reasons for difficulties

- What is Ranjit’s first language? Doe he speak any languages other than English? Have you ever lived overseas?
- Has Jenny experienced difficulties with maths since the beginning of school? How did she do in primary school? Do you remember what her school reports were like for maths? Was there anything in particular she had difficulty with?
- Has Tom missed any schooling for any reason, e.g. moving, illness?
- Have you been happy with the maths teachers Moana has had over the years? Has Moana? Have there been any issues?
- Is there anything that has happened in your home life in the past or recently which you think could have had an impact on Amy’s learning?
- How do you think Tyler’s motivation for learning in general is? Is it different for different subjects?
## Assessment options

<table>
<thead>
<tr>
<th>Test Name</th>
<th>NZ norms</th>
<th>Age range</th>
<th>Little reading required</th>
<th>Range of maths</th>
<th>Cost</th>
<th>Admin time</th>
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<tbody>
<tr>
<td><strong>PAT</strong></td>
<td>✓✓</td>
<td>9 - 15 yrs</td>
<td>✓ Too much!</td>
<td>✓ ✓</td>
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<tr>
<td>Numeracy project</td>
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<td>5 - 14 yrs</td>
<td>✓ ✓</td>
<td>✓ limited</td>
<td>None</td>
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<tr>
<td><strong>KeyMaths 3</strong> <em>(Aus, NZ edition)</em></td>
<td>✓ (AU)</td>
<td>4.5 - 21 yrs</td>
<td>✓ ✓</td>
<td>✓ ✓ Comprehensive</td>
<td>$835 min Pearson</td>
<td>30 – 90 mins</td>
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<tr>
<td>Woodcock Johnson III <em>(Aus, NZ edition)</em></td>
<td>✓ (AU)</td>
<td>2+ yrs</td>
<td>✓ ~ (but verbal memory)</td>
<td>✓</td>
<td>$1643 min NZCER</td>
<td>15 mins ?</td>
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<tr>
<td><strong>Wide Range Achievement Test 4</strong></td>
<td>✗ US</td>
<td>5+</td>
<td>✓ ✓</td>
<td>✓ ✓ (has basics, but short)</td>
<td>$614 NZCER</td>
<td>15 – 20 mins</td>
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<tr>
<td>Dyscalculia Screener</td>
<td>✗ UK</td>
<td>6 - 14</td>
<td>✓ ✓</td>
<td>✓ ✓ (for a screener)</td>
<td>$720 NZCER</td>
<td>30 mins</td>
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</table>
KeyMaths 3

- Revised AUS/NZ edition; fit to syllabus, converted norms
- Basic concepts
  - Numeration, algebra, geometry, measurement, data analysis, probability
- Operations
  - Mental computation & estimation, Addition & subtraction, multiplication & division,
- Applications
  - Foundations of problem solving, applied problem solving
- Links to remediation material (designed for response to intervention approach)
Dyscalculia Screener (nferNelson)

Brian Butterworth, University College London
www.mathematicalbrain.com

Computerised, for use in schools
– Number stroop
– Subitizing / Counting
– Mental arithmetic

Administration time: 30 minutes
Advantages: Precise measures including reaction time, standardised, fast
Disadvantages: Assumes dyscalculia caused by core deficit in number sense
Why profile?

- Maths is componential and sequential
- Possible subtypes of dyscalculia
- Allows an individualised approach

- Where are the main difficulties / “holes”?
- Where to start, what to cover, what can be built on.
Which components to profile?

- Counting (important building block)
- Multiplication, addition fact recall (verbal memory)
- Subtraction, addition calculation (larger problems for which facts are not known)
- Number sense
  - Symbolic number comparison
  - Non-symbolic comparison, addition
  - Estimation (e.g. number line, verbal)
- Place value
Quantitative profiling tests

Ideally: Measurements of response time as well as accuracy. Separate breakdowns for different operations and components

- KeyMaths 3 (4.5-21 yrs)
- TEMA-3 (3-8 yrs)
- CMAT (7-19 yrs)
Qualitative profile

The Dyscalculia Assessment
Jame Emerson & Patricia Babtie
Assessment Piagetian style, with no norms, or numerical scores.

Covers:

- Number sense
- Counting
- Calculation
- Place value
- Multiplication & division
- Word problems
- Formal written numeracy
4. The Dyscalculia Assessment

Summary Maths Profile

<table>
<thead>
<tr>
<th>Number Sense and Counting</th>
<th>Calculation</th>
<th>Place Value</th>
<th>Multiplication and Division</th>
<th>Word Problems</th>
<th>Formal Written Numeracy</th>
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<td>Addition +1, +2</td>
<td>Principle of exchange</td>
<td>Multiplication</td>
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<td>10 plus a single digit/Tens plus</td>
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<td>two more +2</td>
<td>10 + n</td>
<td>x5</td>
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<td>Subtract −1, −2</td>
<td>tens plus n (e.g. 20 + n)</td>
<td>x10</td>
<td>multiplication</td>
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<td>up to 10</td>
<td>one less −1</td>
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<td>more than 10</td>
<td>two less −2</td>
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<td>Dot patterns 1–6</td>
<td>Bridging</td>
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<td>units + units (e.g. 8 + 5)</td>
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<td>in 10s</td>
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<td>two-digit numbers (TU)</td>
<td>addition (e.g. 47 + ? = 50)</td>
<td>Subtraction strategies</td>
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<td>doubles</td>
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<td>larger numbers</td>
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<td>counting on (shopkeeper’s</td>
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<td>two-digit numbers (TU)</td>
<td>addition (e.g. 30 + ? = 100)</td>
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<td>method)</td>
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<td>larger numbers</td>
<td>subtraction (e.g. 100 – 80 = ?)</td>
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</table>
Is there a best intervention?

- Those shown to be successful include many components and tasks.
- Focus on number sense likely to be key.
- Also important to problem-solve and fit the intervention to the child/individual.
- The remediation should include the task the child needs to improve on! (e.g. training motor skills such as balance unlikely to generalise to maths... )
What age is the child?

- **Primary school** – focus on number sense
  - UK books good examples of techniques to use
  - Concrete – Representational – Abstract sequence

- **Late primary/Intermediate** – previous + number facts (bonds to make 10, x tables)
  - Direct Instruction a good example

- **Intermediate / Secondary** – previous + strategy instruction
  - Basically teaching kids metacognition for maths.
Individual intervention

- Focus on understanding (esp. quantity)
- Drilling of facts only useful up to a point
- Use concrete materials
- Start at an easy level (success important!)
- Provide lots of practice
- Reduce need for memorisation
Inclusive education strategies

- Give children their own set of work, at their level
- Allow extra time
- Use written **and** verbal instructions and questions
- Extra scaffolding, especially for multi-step procedures
- Reduce opportunity for comparison with peers
Remediation workbooks

Overcoming difficulties with number by Ronit Bird (2009).

Cost of each around £20 from www.amazon.co.uk
Remediation books

Dyslexia, Dyspraxia and Mathematics by Dorian Yeo. (2003).
The dyscalculia assessment by Jane Emerson and Patricia Babtie. (2010).
Number track game

Materials needed

Tens-structured ‘caterpillar’ tracks representing 20, 30 or even 40. Each player requires his or her own track. The track circles should be just large enough to contain individual counters or ones. The tracks must be drawn underneath each other in one-to-one correspondence (see diagram below), as this allows pupils to compare quantities. A photocopiable template is included at the rear of this book, page 116; it may need to be enlarged to A3.

Counters (one uniform colour).

A 1–3 spinner or numbered 1–6 dice, depending on the age of the dyscalculic pupil.

How to play

Players take turns to spin or roll a number, and take the quantity of counters indicated. Each time, the player places the quantity of counters ‘earned’ on his or her own track.

The aim of the game is to be the first player to cover the length of his or her caterpillar track.

For example, the diagram below illustrates the progress part-way through a basic track game, played by two players.


Player A has 13 counters

Player B has 22 counters

While playing, pupils are encouraged to:

- ‘say’ the number represented by their running total quantities, using the decade structures as a guide;
- compare their own quantities with those of their competitors;
- note how close or distant individual quantities are to the decade numbers that they lie between.
Dot pattern card war
Clear the deck

<table>
<thead>
<tr>
<th>1</th>
<th>9</th>
<th>6</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>
Teaching bridging to ten

What to do first

Example: $9 + 4 = ?$

Teachers ask pupils to place nine counters on the track.

Teachers ask pupils to say how many counters are needed to reach ten, from nine.

Next, teachers ask pupils to use counters in the second colour to build the dot pattern of four below the track.

Teachers explain to pupils that they will be using the tens to help them to figure out the ‘nine plus four’ problem. Teachers write down $9 + 4 = _. Teachers ask pupils to take one counter from the pattern of four to ‘make’ ten.

Teachers ask pupils to think about and predict what the answer to the $9 + 4$ problem would be. Pupils are asked to place the rest of the counters on the track to ‘check’ their answers.

Following this, teachers ask pupils to use an emptier number line to record the way that they ‘thought to ten’. First, ask pupils to show how they would figure out $9 + 4$. 
Intervention packages: High end

E.g. KeyMath 3 has package designed to fit with assessment.

If you buy the ASSIST software, exercises automatically recommended.

Includes lessons, worksheets, assessments, progress profiles etc.

But expensive!

$540 software

$860 – 1400 intervention
Software

To Market, To Market
by Learning in Motion

The Number Race
by myself and Stan Dehaene

Bubble Reef
by ICDC

Number Shark
by White Space

Knowsley Woods
by ICDC
The Number Race

http://www.thenumberrace.com

Adaptive game to remediate/teach early number sense

- Non-profit model
  ("open source" = free to obtain, copy, distribute, modify)
- Programmed by myself

Wilson et al. 2007a,b

Languages:
Research based instructional principles

- **Enhance number sense**
  - intensive number comparison (e.g. largest of 3, 9?)
  - speed deadline
  - link between number and space

- **Cement non-symbolic symbolic links**
  - repeated association of non-symbolic & symbolic numbers
  - encourage increasing reliance on symbols

- **Conceptualise and automatise arithmetic**
  - concrete representations of operations
  - speed deadline

- **Maximize motivation**
  - positive reinforcement
  - difficulty adaptation
  - entertaining format (game!)
The Number Race

What is The Number Race?
It is a fun computer game that lets you play with numbers, while training basic concepts of number and arithmetic:

- Number formats: concrete sets, digits, and number words
- Counting: practice with numbers 1-40
- Addition and subtraction in the range 1-10

Learn how to play, or how the game works

Who would benefit from playing?
The Number Race is primarily designed for children aged 4 to 8.
Children who are making their first steps with numbers will learn the basic concepts of number and arithmetic. Older children, who are already familiar with numbers, will build their fluency in arithmetic and in mapping numbers to quantities (number sense).
The game is especially designed to address mathematical learning disabilities (dyscalculia), by strengthening the brain circuits for representing and manipulating numbers.

Who created The Number Race?
INSERM-CEA Cognitive Neuroimaging Unit, a world-leading research institute in mathematical cognition.

The Number Race focuses on small numbers. For more advanced children consider using The Number Catcher.
Number race: Current verdict

Pluses
- Clear improvements in number comparison and number fluency
- Good potential as part of a preventative intervention

Minuses
- Modest improvements; not a "magic bullet"
- Generalisation limited in short term
- Scope of software limited (only small part of curriculum)
- Kids get bored after a while (need more content)

Needed
- More generalisation testing, esp. longitudinal
- Test in dyscalculic kids 4-5 yrs
- Develop similar adaptive game modules for other math areas
What is The Number Catcher?
It is a fun, fast-paced computer game that lets you play with numbers, while training basic concepts of number and arithmetic:
- Basic calculation skills: addition and subtraction
- Number formats: concrete sets, digits, and number words
- The base 10 principle and the logic of multi-digit numbers

Learn how to play, or how the game works

Who created The Number Catcher?
INSERM-CEA Cognitive Neuroimaging Unit, a world-leading research institute in mathematical cognition.

Who would benefit from playing?
The Number Catcher is primarily designed for children aged 5 to 10 but its higher levels can be fun for adults too!

Children who are making their first steps with numbers will learn the basic concepts of number and arithmetic. Older children, who are already familiar with numbers, will build their fluency in arithmetic.

The game is especially designed to address mathematical learning disabilities (dyscalculia), by strengthening the brain circuits for representing and manipulating numbers.

The Number Catcher focuses on two-digit numbers. For children who make their first steps with numbers, consider using our more basic game The Number Race.
Dyscalculia, or mathematical learning disabilities, is a specific learning disability which affects around 6% of the population. Individuals with dyscalculia are not unintelligent, but struggle to learn mathematics, despite having an adequate learning environment at home and at school. Dyscalculia is assumed to be due to a difference in brain function.

Dyscalculia affects individuals over their life span. Children with dyscalculia fall behind early in primary school, and may develop anxiety or a strong dislike of maths. In secondary school they are likely to struggle to pass maths and science courses and find their career options reduced. In adult life, they may earn less, and have difficulties managing their everyday finances.
References


Barth, H., La Mont, K., Lipton, J., & Spelke, E. S. (2005). Abstract number and arithmetic in preschool children. *PNAS, 102*(39), 14116-14121.


References cntd.


