

Stanford Math Brain



The Stanford MathBrain Project: Year 6

This has been an exciting sixth year for the Stanford MathBrain Project, led by Dr. Vinod Menon! In this newsletter, we would like to share some of the discoveries made possible by your participation. Please note that we are interested in discovering general trends and we encourage parents not to interpret the findings as an indication of their child's ability. This newsletter provides an overview of ongoing studies and points to useful links and reading materials that provide additional information about our research.

Additional details including scientific publications are available online at <http://mathbrain.stanford.edu>.

Our research is funded by the National Institute of Child and Human Development and the National Science Foundation.

Current Studies

The cognitive and brain imaging study for which we are currently recruiting is the **Math FUNDamentals study**. This study is currently seeking **2nd and 3rd graders** who are interested in participating in number sense training and are willing to return for two follow-up visits in **3rd/4th grade** and **5th/6th grade**.

The project has two goals: In typically developing children the goal is to examine the behavioral and neural bases of mathematical learning. In children with math difficulties, the goal is to assess the neural changes that occur in the brain as a child goes through math training. Long term development will be assessed by neuropsychological testing and brain scans in the same children in 3rd/4th grade and 5th/6th grade.

Stanford MathBrain Project:

Dedicated to improving our knowledge of math learning in typically developing children and children with mathematical disabilities



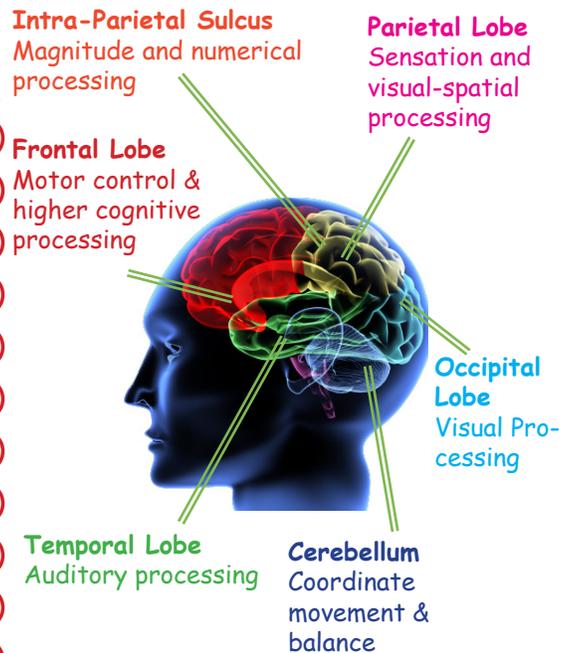
Contact Us: (650) 736-0128 | smp@med.stanford.edu | <http://mathbrain.stanford.edu>

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Brain Differences in Children Who Do and Don't Know the Answer to Arithmetic Problems by Heart

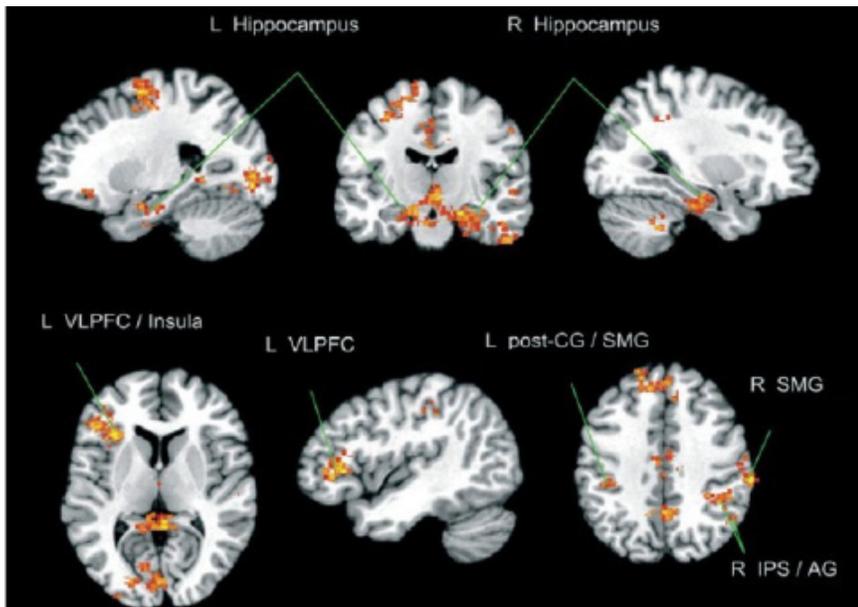
During early elementary school, children's strategies for solving arithmetic problems shift from counting to retrieving answers. Learning to retrieve the correct answer from memory is an important developmental milestone. Recently, we compared math performance and brain activity between children who retrieve answers from memory ("retrievers") versus those who counted ("counters"). Retrievers were more accurate and faster at solving addition problems compared to counters. Several regions of the brain, including the hippocampus and the lateral prefrontal and posterior parietal cortex, were found to differ in activity patterns between retrievers and counters (see figure below). The brain area called the hippocampus is well-known for its role in memory formation. The lateral prefrontal cortex refers to the front part of the brain underneath the forehead above the eyebrows. This region is important for the most complex and high-level information processing such as monitoring cognitive activities and allocating mental resources for important tasks. The posterior parietal cortex is the back and upper side part of the brain which plays an important role in mathematical cognition. Our results demonstrate that retrieval and counting strategies during early learning are characterized by distinct patterns of activity in a distributed network of brain regions involved in math and purposeful memory retrieval. (Published in Developmental Science, 2011).

The Human Brain



SMP By The Numbers...

| | |
|--------------------------|--------------|
| Brain Scans Complete | 244 |
| # Children Returning | Over 75 |
| Age Range | 7 - 14 Years |
| # of Girls to Boys | 121 to 139 |
| # of Schools Represented | Over 54 |

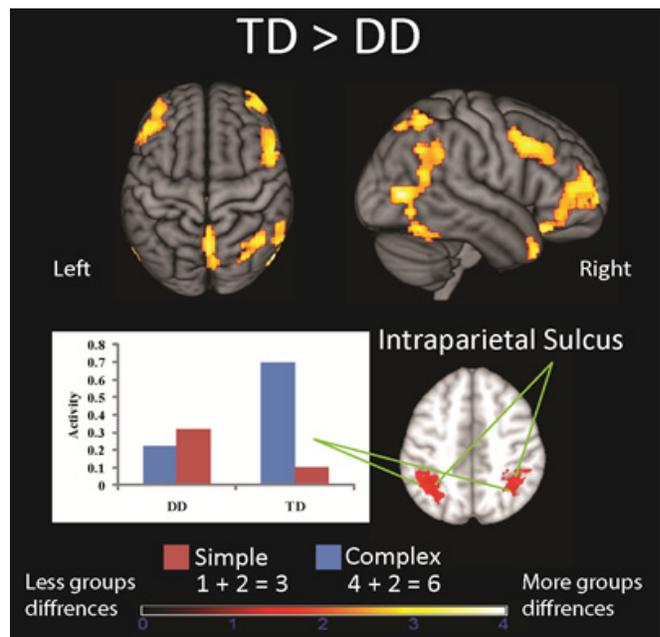


How Do Children's Brains Respond Differently When They Have Difficulties with Math?

Elementary School Acknowledgements

We recently examined brain activity in 7-9 year old typically developing children (TD) and children with developmental dyscalculia (DD), which is a disorder of numerical and mathematical abilities in children with normal intelligence and reading ability. Usually, children do not need to calculate to solve simple arithmetic problems like $1+2$, but instead just remember the answer. However, children with DD calculate to find the solution to even simple arithmetic problems and have difficulty committing the answers to memory. To learn more about these different approaches to solving arithmetic problems, we scanned the brains of children as they solved Complex (e.g. $4+5=9$) and Simple (e.g. $4+1=5$) addition problems. We found that children activate areas in the parietal, frontal, and visual cortices, which are involved in spatial reasoning, abstract reasoning, and vision, respectively. TD children, however, had greater activity in these regions while they were solving Complex problems compared to Simple problems. In contrast, children with DD did not have greater activation of these regions when solving Complex problems compared to Simple problems. Instead, brain regions had similar activations patterns no matter if the problem was Simple or Complex. The figure on the right displays the differences in activation in a part of the brain known to be involved in arithmetic problem solving called the intraparietal sulcus. TD had greater activation during Complex versus Simple problems, whereas DD children had similar activation for both Simple and Complex problems. (Published in *Developmental Cognitive Neuroscience*, 2011)

- | | |
|-------------------------------|--------------------------|
| Alamo | Meyerholz |
| Alex Anderson | Mission Valley |
| All Souls | Miraloma |
| Argonne | Monta Loma |
| Baldwin | Montclair |
| Briarwood | Monte Verde |
| Brittan Acres | Oakridge |
| Bubb | Ohlone |
| Bullis Charter Canyon | Parkview |
| Carl Munck | Redwood Christian |
| Castro | Robert Louis Stevenson |
| Charles Armstrong | Roosevelt |
| Cherry Chase | Sakamoto |
| Cumberland | The San Francisco School |
| Dianne Feinstein | San Miguel |
| Don Callejon | Santa Teresa |
| East Palo Alto Charter School | Sherman Oaks |
| Edith Landels | Simonds |
| Ellis | Slonaker |
| Frost | St. Lawrence |
| George Miner | St. Martins |
| Glider | St. Pius |
| Hacienda | St. Simon Parish |
| Hayes | Stipe |
| Huff | Stobridge |
| Juana Briones | Sutter |
| Kensington Hilltop | Theuerkauf |
| Lakewood | Thurgood Marshall |
| Laurelwood | Trinity |
| Ledesma | Vinci Park |
| Los Alamitos | Washington Open |
| Manzanita SEED | Westwood |



Puzzles and Games!

1

Try to solve these rebus puzzles.
What are the pictures saying?

A

B

C

2

Fill the squares so that the sums are correct on the right side and on the bottom.

| | | |
|---|---|---|
| | | 4 |
| | | 1 |
| 3 | 2 | |

4

Can you kick the soccer ball and score a goal? Use each hint to write a word that is only one letter different than the word above it.

B A L L

The opposite of short _ _ _ _

The hind part of an animal _ _ _ _

Put to sea _ _ _ _

Dirt _ _ _ _

Spiral _ _ _ _

Dark mineral used for fuel _ _ _ _

G O A L



F M J L H M V E
M K M J M J M
R M J D W L F H ?

3

Decode Mike the Monkey's message to you!

- Change all of the Ms to As.
- Change all of the Js to Ns.
- Change all of the Ls to Is.
- Change all of the Fs to Cs.
- Change the R to an S.
- Change the K to a B.



Online Math Adventures

Visit these sites for more fun and games!

Cool Math Games:

<http://www.coolmath-games.com/>

Primary Games:

<http://www.primarygames.com/math.htm>

Math Playground:

<http://www.mathplayground.com/games.html>

4. ball, tall, tail, sail, soil, coil, coal, goal

3. Can I have a banana sandwich?

| | | | |
|---|---|---|---|
| 3 | 2 | | |
| 1 | 0 | 1 | 1 |
| 4 | 2 | 2 | 2 |

or

| | | | |
|---|---|---|---|
| 3 | 2 | | |
| 1 | 0 | 1 | 1 |
| 4 | 1 | 3 | 2 |

1c. Head over heels in love

1b. Pair of pants

1a. Big bad wolf

Solutions