PROCESSING SPEED AND DYSLEXIA

"I'm still slow at reading but I've learned to adjust...while you will have dyslexia for the rest of your life, you can dart between the raindrops to get where you want to go. It will not hold you back." - Steven Spielberg

WHAT IS PROCESSING SPEED?

Processing speed generally refers to the speed required to take in information, do cognitive work, and respond.

For dyslexic children and adults, processing speeds can vary dramatically depending on the types of stimuli, types of mental work, and types of responses expected.

PROCESSING SPEED CHANGES AND CHANGES OVER TIME

In the setting of dyslexia, processing speeds for different tasks also vary dramatically with age. Typical "late-blooming" children may be much slower than same age peers in early grade school, but then catch up over the years as practice, learning, and maturity narrow the gap.

Most parents and teachers are likely to hear about a student's "Processing Speed" in the context of formal testing for "specific learning disabilities." Common IQ tests have a "Processing Speed Index" which often may qualify students for extra time on classroom and standardized tests.

SLOW PROCESSING SPEED IN DYSLEXIA IS SPECIFIC AND NOT GLOBAL

The important thing to be aware of in the context of dyslexia is that slow processing speed is SPECIFIC and not global.

Dr. Sally Shaywitz of Yale University has talked about the paradox of dyslexia being slow reading and fast thinking. Much of the underestimation of dyslexic students comes from a failure to understand this paradox. It's also why dyslexia can be so frustrating.

On a practical level, dyslexic students need extended time accommodations to read (and often re-read) question prompts and text passages on tests, often extra time to organize and express their thoughts down on paper. Slowness occurs in the process of getting information in and getting information out, but fund of knowledge, grasp of concepts, interpretation, and synthesis are on par or even better than typical non-dyslexic peers.

This paradox between some aspects of processing and thinking ability in general is why dyslexic students who are orally tested may be able to demonstrate their knowledge much better than timed tests may show. It also accounts for why average or above average IQ has been part of a formal diagnosis of dyslexia.

Students who have a low IQ and are poor readers are not dyslexic, by definition. They maybe be poor readers, but in this case, low reading may reflect more general brain factors that affect learning and the brain in general.

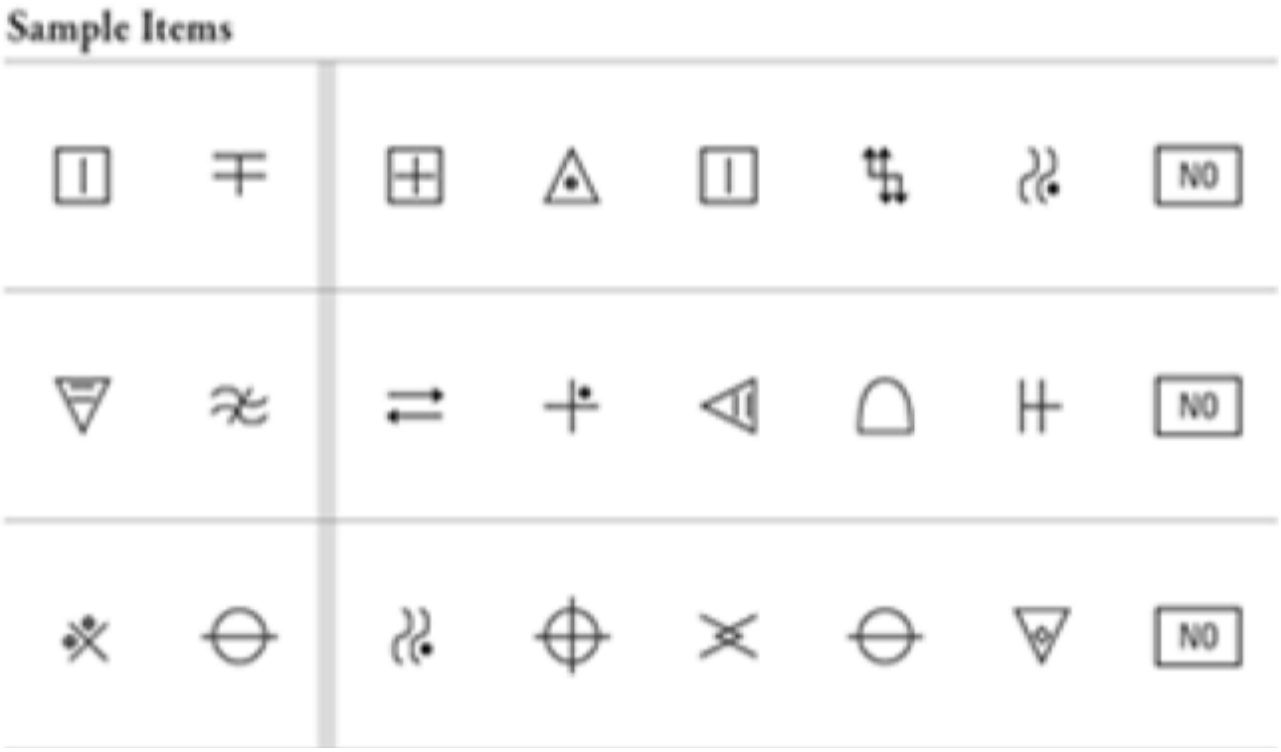
UNDERSTANDING THE PROCESSING SPEED INDEX

If you or your student has had comprehensive testing for dyslexia, chances are that they had a Processing Speed Index determined as part of their formal testing.

PROCESSING SPEED

Of the four composite scores that make up the Wechsler IQ tests the PSI or Processing Speed Index is not uncommonly the lowest among dyslexic students of any age. None of the subtests in the PSI involve reading. What they do test, though, is an ability to scan columns of similar appearing symbols and find identical ones, and copy unique symbols under timed conditions.

Here is an example that the test company provides about the test:



The idea for these questions is to find look for exact copies of the symbols on the left in the same row. If there are no duplicates, then test takers are to mark "No."

The other subtest that makes up the Processing Speed Index is "Coding." For this test, test-takers are to copy similary simple symbols in the order that they are printed.

For parents and students, the point to realize about such scores is that "slow processing speed" in this context has nothing to do with problem solving, higher order thinking, or creativity. It's simply a measure (and comparison with other students of the same age or grade) of visual registration and selection and symbol copying.

The processing speed tests on the WISC-V are good tests for picking up common problems that dyslexic students have, but get far too little attention in general from educational and even dyslexia advocates. It's a crucial test for many students with goals of graduating with a college degree, and also those who want to complete high school and technical certifications and licensure. Having a slow processing speed qualifies individuals for extended time accommodations - most easily 1.5 x extra time, but occasionally 2x-extra time, depending on the severity of processing speed impairment.

Although this processing speed test is helpful, it also does not look at other aspects of processing that may be affected in dyslexic students; testing professionals should be aware that there are wide variations that may exist between students. Ideally, taking a good history and observing a student's performance directly can tailor the choice of tests to particular students. In our practice, it was common to test over two days and use a variety of assessment tools.

REMOTE TESTING FOR DYSLEXIA: ESPECIALLY IN REGARD TO PROCESSING SPEED

Given the pandemic and second COVID wave, testing for dyslexia has become more complicated. The American Psychological Association has broadened professionals' ability to perform remote testing, but some limitations still exist in terms of what assessments can be performed virtually. The pros of remote testing are that risk of infection to the testing professional or student are eliminated, the negatives are that some confounding factors can be introduced into the testing session and not all of the standard subtests are available.

For example, the WISC-V Intelligence test is a common test use for IQ testing, but as the testing company, Pearson, points out, norms were determined for the test under face-to-face testing conditions and not remote testing.

PROCESSING SPEED

From **Pearson**:

"If a professional facilitator is not used, Block Design is not feasible for telepractice. Omitting Block Design impacts subtest selection and the approach to deriving composite scores."

Pearson does suggest that another subtest, Visual Puzzles can be substituted for Block Design, thereby allowing an estimation of full scale IQ, but even with this substitution, this means that the VisualSpatial Index, Nonverbal Intelligence, and General Ability Index or GAI cannot be estimated.

For gifted students with dyslexia, the GAI is the greatest loss. Often the GAI is needed to assess giftedness when great discrepancies are seen in IQ subtest scores (typical pattern for dyslexic students). The problem with estimating intelligence without the GAI, is that processing speed and working memory can lower estimations of intelligence and gifted dyslexics can fail to qualify for gifted programs.

Pearson again:

"If Block Design is omitted and response booklets are not used, subtest selection and the approach to composite scores are impacted further because no Processing Speed subtest is available."

All this information may be more technical than necessary for the majority of parents and teachers, but what the information points out is that care needs to be taken in the decision to undergo remote testing via teletherapy and testing of gifted dyslexic students is best done by professionals who are experienced assessing dyslexic students. There are other tests that can make estimates of processing speed or other aspects of performance in school or standardized tests that would merit accommodations; when remote testing puts limits on certain tests, professionals with access to a variety of tools can make appropriate additions or substitutions.

PROCESSING SPEED DURING THE PANDEMIC

What are the practical implications for students with slow processing speed whether or not they have formal testing?

Parents and teachers working with dyslexic students should recognize that in almost all cases, their processing speeds will be lower than their non-dyslexic peers. In the early grades, some decreased workload accommodations should be considered so that students have manageable assignments and realistic goals. In pre-pandemic times and in-person schooling, most students who needed extra time for in-classroom tests could finish them after school. Now during the pandemic, there are likely fewer tests, more projects and at-home work assigned. If your student needs to have less homework assigned, be prepared to advocate or help your student self-advocate on this point.

The goal is not to avoid necessary school work, but rather to have realistic work expectations and not to so overburden students that they become anxious, sleep-deprived and give up all together.

Changes in education because of the pandemic often increases screen time and reading and writing demands, while disrupting routines, reducing or in some cases eliminating personal feedback and support. If there is a time to exercise flexibility and understanding, this has got to be the time!

Older students may have a harder time getting quantity of work reduced, but reasonable requests should be considered. For instance, if students are able to maintain a certain performance on tests, they may be able to request decreases (1/2 or 1/3) in the quantity of problems completed for math homework. Students should give as full explanations as possible to their teachers why the work requires so much time. For example, "I'd like to request fewer homework problems for each chapter. Because it takes me longer to re-read and check my work, I am spending x hours on a problem set and I'm finding the assignments impossible to finish. Working more problems doesn't seem to help my understanding. I seem to learn better if I have fewer problems to work through and I understand completely why certain steps are done."

If such an explanation is given to a teacher, at least there is a hope that there will be a trial period of doing fewer homework problems.

An all-too-common situation for dyslexic middle and high school students is that they may perform well on tests, but get marked down because their homework isn't complete. What these situations show is misplaced priorities on work that isn't necessary for conceptual understanding.

PROCESSING SPEED - THE BIG PICTURE - AUTOMATICITY AND FLUENCY

If you've been told that your student has slow processing speed, the next questions that come to mind are: what can be done about it and will it improve?

In the setting of dyslexia, the good news is that processing speed will improve, and as to how to improve it, the answer depends on what individual factors are involved for a particular student.

From the book, WISC-V Assessment and Interpretation, **here's** a more detailed description about what processing speed can include:

"Processing speed is the ability to identify, discriminate, integrate, make a decision about information, and to respond to visual and verbal information. Response processes for speeded tests are typically motoric (e.g., written response, check a response, etc.) or oral (e.g., saying an object's name, reading numbers or letters aloud). Processing speed measures provide an estimation of how efficiently a child can perform basic, overlearned tasks or tasks that require processing of novel information. These tests usually do not assess higher-level thinking; however, they frequently require some degree of simple decision-making. Some anxious children may perform slowly on such tasks because of a lack of confidence or certainty in decision-making.

Generally, performance on these tests reflects how well (speed and accuracy) the examinee can perform a specific procedure (e.g., simple math calculation, naming, visual identification, etc.), which can indicate the automaticity of that process, accessibility to that information, efficiency of early stages of information processing (e.g., visual or auditory discrimination), and speed of decision-making."

All of these components of processing speed are what burden students in the early grades. Visual discrimination, decision making, motor responses, and everything in-between contribute to why students are slow, especially in the early grades. Training of many skill types contributes to improved processing speed - but training and education take time.

At the beginning of their education, what many students need is a little bit of everything - visual work, error checking, decision-making, structured literacy to improve decoding and reading automaticity and fluency. Students also need some gentle pressure to do the things that are difficult to do and don't come naturally. So often we see if a dyslexic student has a non-dyslexic sibling or best friend, they get in the habit of deferring to their strong sib or friend so that over time, they get much less practice speaking, reading aloud, answering questions, or making decision....exactly what we don't want to happen!

Parents, teachers, and tutors need to take the big picture with students with slow processing speed. Students speed up, but a lot of groundwork is necessary because so many subskills are difficult if not impossible to learn to the point of automaticity.

All sorts of research studies have shown that training can improve speed and accuracy of tasks, but especially for dyslexic students, they may only really come into their own with complex tasks in their 20's. The late bloom is inconvenient, but it does happen. For many, the challenge is contenting oneself with small goals and successes, working on subskills and using technology to support until all the skills really come fully online.

Understanding Processing Speed and Dyslexia [Premium]

by Fernette Eide | Accommodations, Dyspraxia, Math, Memory, Music, Premium, Premium Content, Reading, Strategies, VIsual, Writing | 2 comments

When families come together to discuss test scores, no group of scores surprises them as much as "Processing Speed."

Processing Speed scores on psychometric exams might mean Coding and Symbol Search scores on the WISC intelligence exams or Visual Matching and Paired Cancellation on the Woodcock Johnson.

Processing Speed scores on these subtests are typically lower for dyslexic students, but on other tasks like Decision Making and in real life, these students may be quite quick and even quicker than their peers at various tasks such as insight-based problem solving or situational awareness (helpful for athletics, for instance).

Understanding the true significance of Processing Speed Difference in Dyslexia, then is important not only for recognizing when accommodations may be appropriate school, but also for identifying opportunities for strength development and even promising career disciplines.

Processing Speed Misconceptions

Misconception: "It means I'm just slow."

Perhaps the most common misconception we've heard about Processing Speed from individuals with dyslexia is "It means that I'm just slow." No it doesn't. The

processing speed issue are NOT global. Furthermore, there is a great deal of individual variation on why people's speeds are slow on these subtests – and these can also change a great deal over time.

2. Misconception 2: "I'll always be slow."

Children speed up a great deal in Processing Speed tasks such as Coding. It is not uncommon for us to see the gap narrow significantly as children get older, but some tasks, like copying letters or novel symbols, can persist into adulthood. As mentioned previously, slower speeds don't occur for all tasks.

Why Are Certain Tasks Slower in Dyslexia?

Visual – One of the most difficult tasks for dyslexic people on the Woodock-Johnson Cognitive Abilities task is Visual Matching…matching identical numbers in a line of visual look-alikes. For instance, find two of the same number in the following line:

113 131 311 313 113

Dyslexic people have more trouble with this task (especially when the numbers are all crowded together with little whitespace).

Developmental optometrists may be helpful in checking out the treatable issues are acontributing to the problem, but otherwise other helpful strategies could include: reducing the number of problems on a page (more whitespace), covering up lines of numbers with a piece of paper, reading glasses that are slightly magnifying, and font changes (increase size, character spacing).

If your eyes skip 'inside' of strings of numbers, then tapping numbers or saying them to yourself might make sure that you've registered or copied each number correctly, but it will also add to overall processing time needed for a given task.

Attention, Executive Function, and Working Memory –

Attention issues can definitely affect processing speed by pulling away focus, but attention can also be involved wit switching between different tasks or juggling different types of information. Some people need extra time for reading because they need to re-read certain passages in order to truly comprehend them. Others may get distracted by outside information after they have read it, so they may have thought they read something, but actually it was other thoughts that were put down in their place (for instance, misread test questions – "I thought it had said this…")

Strong visual learners may have strong associations with what they read and as a group seem to have a higher incidence of these 'false memories'.

Extra time may also be needed to organize ideas for an essay, or break down the task of writing into smaller steps (e.g. brainstorm, sequence, organizer words, check spelling and punctuation).

Time Perception – Numerous studies have identified difficulties in time perception among dyslexic children and adults (1, 2). Difficulties in time perception can cause trouble discerning the correct pronunciation or certain words as well as difficulty estimating time to get work done, and time management on homework and tests as well as other activities.

When time perception significant impacts phonological awareness and learning, then sound perception exercises or training may be of benefit (3,4). Multisensory methods like clapping out sounds and exaggerating gaps between sounds might help some of these children perceive, then master tricky blends and complex words.

For organization, external supports like timers can help children perceive the passage of time. Visual timers like the Time Timer sold through Amazon can help students grasp the passage of time by seeing how fast or slow the red section of the time disappears.

Emotional Overload –

This test made me feel . . .

"*Nervous because I am afraid I will not finish, or make a mistake.*" – 4th grader

Research studies have shown that even very young children are susceptible to test anxiety. One huge culprit is the timed test. When researchers asked what students were saying to themselves after an anxiety-provoking test, much of it was completely unhelpful negative self-talk such as ("I can't do these" "I'm so stupid" etc. etc.). What worse is that negative self-talk during a difficult exam or assignment also compromised their working memory further making more

difficult to do the task at hand. High levels of anxiety over a subject (like math, reading, or writing) can hijack student's focus and concentration causing them to make omissions or other mistakes (read more about Math Anxiety here).
For some students, just learning that they can have extra time can reduce anxiety. Additional classroom strategies for helping students with anxiety are listed HERE.

Information Retrieval –

Another factor that can affect processing speed is the speed of information

retrieval. Sometimes the slowness in calling a word to mind ('tip of the tongue') is due to some of the sound-filing differences related to dyslexia itself. In other cases it may be due to differences in how words are filed in brain (for instance, in multiple places and in different connotations) or because information was filed primarily nonverbally as an experience or visual image. If information was filed nonverbally from the start, it will have to be converted to words before being spoken. Individuals who primarily think in words (there are some who don't experience visual images at all) will have an easier time retrieving verbal information than their nonverbal counterparts.
In general, the speed of information or word retrieval improves as children mature into adults. If a person is tired though or juggling lots of bits of information through working memory, the difficulty with finding words will likely return.

Writing by Hand –

Difficulty making the movements of letter writing automatic contributes significantly to the slower processing speeds of students writing by hand vs. typing. This slowness with symbol writing also impacts science and mathematics.

The standard accommodation (besides extra time) is to allow keyboarding and / or software programs that to help with getting information down on paper.

What Processing Speed is Quicker for Dyslexics?
There is much less research into tests where dyslexics children and adults outperform their non-dyslexic peers, but looking at the peak patterns of peak-and-valley results of neuropsychological testing show that strengths can be seen in verbal and nonverbal problem solving and reasoning. On the Woodcock Johnson Cognitive Abilities Test, where dyslexic individuals typically score below average on Visual Matching, we often see Decision Making at or above average. The important thing to recognize about Processing Speed and Dyslexia is that it's more often the clerical skills that are the slowest (copying from the board, writing to dictation). The tasks that are quick or quicker for dyslexics tend to be higher order thinking tasks like complex problem solving or divergent thinking…so all good things.

Processing Speed & Writing [PREMIUM]

by Dyslexic Advantage Team | Dysgraphia, dyslexia, Premium, Premium Content, Strategies, Teaching, Writing | 0 comments

Question: I know my son's processing speed is slow from his testing, but how slow should his speed on something like writing take? My son has slow processing speed, dyslexia, dysgraphia and a loose attention control system

– but how long should it take him to write a 5 pargraph academic paper… after which the paper still need revisions? It takes him hours to complete assignments.

This is a great question…but of course the answer depends on a lot of individual factors regarding your student. When essay or paper writing take so long, it's good to try to troubleshoot ways to make the process quicker. If the delay occurs at the beginning, before any 'writing' occurs, then maybe he doesn't have a template in which to organize his ideas or choose the direction of his essay.

TIPS FOR PROCESSING SPEED AND WRITING

Talk First

Because dyslexic minds often can see a paper and issue from multiple perspectives, the choosing of one side – and the organization of the central thesis of the paper can be harder than for other peers. Talking the big picture of the assignment can often be helpful (this can be done with a parent, peer, or tutor). What is your gut first reaction from the question prompt? What don't you believe? (sometimes this approach breaks the ice).

MindMap or List Key Ideas

Committing to an idea or course of the assignment might save time at a start of the whole process. Writing down these big picture ideas can also hold space and focus ideas for later. Anything that doesn't relate to the central idea should be thrown out – or at least saved in a different area.

Use a Simple Template

Using a simple template like one from Step Up to Writing can help writing seem more like filling in the blanks than writing. 1. The position or statement I am making. 2,3,4. Examples that support #1 (give the reasons, a detail, fact, or quote from an expert or text), and 5. Implications of the statement or position – effect on the world, some group, or me.

Look to See if a Student is Getting Bogged Down by Word Finding, Spelling, or Grammar

If the writing is still a painful process, see if you can figure out if the challenge is coming up with the correct word or spelling. Many dyslexics have told us that because of working memory issues, they have to get their ideas down onto paper first, without thinking about the spelling or grammar.
If word finding and spelling are still quite difficult, you might think about investing in software such as Don Johnson Co-Writer. A goal in middle school and beyond is to provide students with all the tools they need that can help them work independently.

Dyslexic students who are slow with writing are not like other students who have more global slow processing issues. It's usually certain specific tasks that are holding up the works – not slowness at everything they do. If you can troubleshoot the blockages – you may be surprised how quickly the rest of the writing goes.

Teaching Math – No Need for Speed

by Fernette Eide | Education, Math, Social and Emotional | 0 comments

"What do teachers need to know about teaching math? Strategy over speed, and math thinking over rote memorization." – Stanford Professor Dr Jo Boaler

Check out Jo's tips from her new article, Speed and Time Pressure Block Working Memory (below).

"I was always deeply uncertain about my own intellectual capacity; I thought I was unintelligent. And it is true that I was, and still am, rather slow. I need time to seize things because I always need to understand them fully. Towards the end of the eleventh grade, I secretly thought of myself as stupid. I worried about this for a long time.

I'm still just as slow . . . . At the end of the eleventh grade, I took the measure of the situation, and came to the conclusion that rapidity doesn't have a precise relation to intelligence. What is important is to deeply understand things and their relations to each other. This is where intelligence lies. The fact of being quick or slow isn't really relevant."

– Laurent Schwartz, Field Medalist, One of the Great Mathematicians of All Time

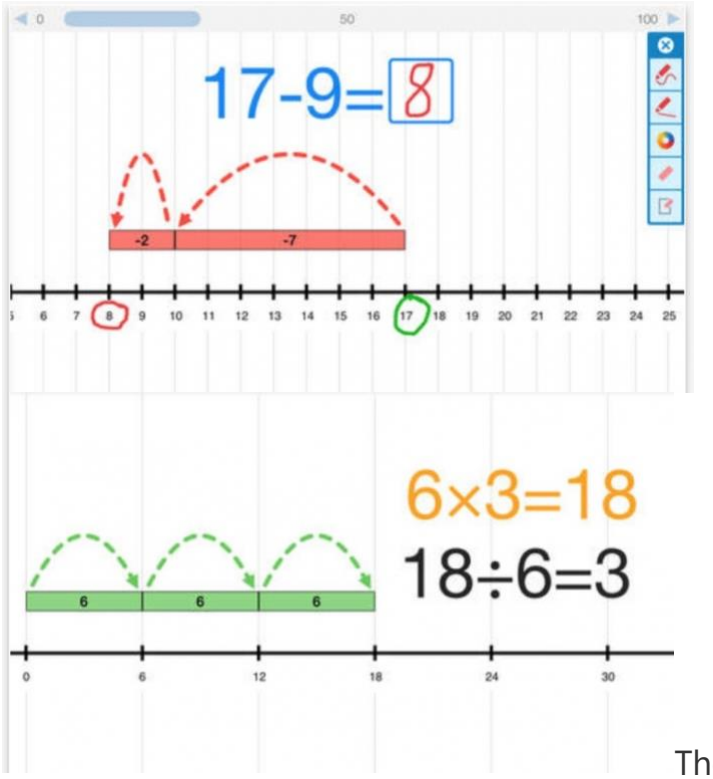
"When I ask them what led to their math aversion, many talk about timed tests in second or third grade as the major turning point when they decided that math was not for them."

– Dr. Jo Boaler, Stanford

What Not to Do: Timed Tests in the Early Grades, Over-Emphasis on Rote Math

What To Do: Teach Strategy Rather than Rote Memorization, Call Attention to Interesting Math Patterns, Introduce Visual Math

Here are another visual math resource to look at. It's the free Number Line app from the Math Learning Center. It's available for iPad, Windows, and the Web! Check out some of the Math Center's other apps too!



The issue about timed tests and strategy for teaching is especially keen for dyslexic students, many of whom have slow processing (especially in the early grades), rote memory challenges, and timed retrieval difficulties.

Big thanks to Dr Jo Boaler from
In the video below, check out Dr Boaler's webinar for Dyslexic Advantage. She talked about mindset and math anxiety. It's quite striking to us that they found that children as young as 5 years could develop math anxiety.

Speed and Time Pressure Blocks Working Memory

by Jo Boaler

Stanford Professor of Mathematics Education, Online Course Experimenter, Co-Founder of Youcubed, author of the new book: Mathematical Mindsets.

For about one-third of students, the onset of timed testing is the beginning of math anxiety (Boaler, 2014a, 2015). Sian Beilock and her colleagues studied people's brains through MRI imaging and found that math facts are held in the working memory section of the brain (Beilock, 2011). But when students are stressed, such as when they are taking math questions under time pressure, the working memory becomes blocked, and students cannot access math facts they know (Beilock, 2011 Ramirez, et al, 2013). As students realize they cannot perform well on timed tests, they start to develop anxiety and their mathematical confidence wears away. The blocking of the working memory and associated anxiety is particularly common among higher-achieving students and girls (Ramirez et al, 2013; Boaler, 2015). Conservative estimates suggest that at least a third of students experience extreme stress related to timed tests, and these are not students from any particular achievement group or economic background. When we put students through this anxiety-provoking experience, they distance themselves from mathematics.

Math anxiety has now been recorded in students as young as five, and timed tests are a major cause of this debilitating, often lifelong condition (Ramirez, et al, 2013).
In my classes at Stanford University, I encounter many undergraduates who have been traumatized by their math experiences, even though they are among the highest-achieving students in the country. When I ask them what led to their math aversion, many talk about timed tests in second or third grade as the major turning point when they decided that math was not for them. Some of the students, especially women, talk about the need to understand deeply, a very worthwhile goal, (see Boaler, 2014b) and being made to feel that deep understanding was not valued or offered when timed tests became a part of math class. Students may have been doing other, more valuable work in their mathematics classes, focusing on sense making and understanding, but timed tests evoke such strong emotions that

students often come to believe that being fast with math facts is the essence of mathematics. This is extremely unfortunate. We see the outcome of the misguided school emphasis on memorization and testing in the numbers of students dropping out of mathematics and the low numbers of women and people of color in math-based college majors. As long as we keep putting students under pressure to recall facts at speed we will not erase the widespread anxiety and dislike of mathematics that pervades the United States (Silva & White, 2013).

So how do students learn math facts?

Youcubed's paper "Fluency without Fear", includes the evidence on math facts and the brain and a range of activities that teachers and parents can use to teach number sense and enable important brain connections.

The best way to learn math facts is to offer conceptual mathematical activities that help students learn and understand number relationships. Brain researchers studied students learning math facts in two ways. One approach was through strategies; for example, working out 17 × 8 by thinking about 17 × 10 (170) and subtracting 17 × 2 (34); the other strategy was memorization of the facts (17 × 8 = 136). They found that those who learn through strategies achieved "superior performance" over those who memorized. Strategy Users solved test questions at the same speed as memorizers and showed a better ability to transfer their knowledge to new problems. The brain researchers concluded that automaticity should be reached through understanding of number relationships, achieved through thinking about number strategies (Delazer et al., 2005).

Strategy users solved test questions at the same speed as memorizers and showed a better

ability to transfer their knowledge to new problems.

In another important study, researchers found that the most powerful learning occurs when we use different areas of the brain (Park & Brannon, 2013). Some parts of the brain handle symbolic information; others handle visual and spatial information. Researchers found that mathematics learning and performance are optimized when different areas of the brain are communicating (Park & Brannon, 2013). Researchers also found that when students were working on math fact questions, the most successful students were those who exhibited the strongest connections between different areas of the brain. The implications of this finding are extremely important for mathematics learning, as they tell us that learning the formal abstract mathematics that makes up a lot of the school curriculum is enhanced when students are using visual and intuitive mathematical thinking. See visual post for more on ways to encourage visual math.

What is Mathematics?

A serious problem we face in math education is that people believe that mathematics is all about calculating and that the best mathematics thinkers are those who calculate the fastest. Some people believe something even worse— you have to be *fast* at math to be *good* at math.

Yet mathematicians, whom we could think of as the most capable math people, are often slow with math. I work with many mathematicians, and they are simply not fast math thinkers. I don't say this to be disrespectful to mathematicians; they are slow because they think carefully and deeply about mathematics. Laurent Schwartz won the Fields Medal in mathematics and was one of the greatest mathematicians of his time. When he was in school, he was one of the slowest math thinkers in his class. In his autobiography, *A Mathematician Grappling with His Century* (2001), Schwartz reflects on his school days and how he felt "stupid" because his school valued fast thinking, but he thought slowly and deeply:

I was always deeply uncertain about my own intellectual capacity; I thought I was unintelligent. And it is true that I was, and still am, rather slow. I need time to seize things because I always need to understand them fully. Towards the end of the eleventh grade, I secretly thought of myself as stupid. I worried about this for a long time.

I'm still just as slow . . . . At the end of the eleventh grade, I took the measure of the situation, and came to the conclusion that rapidity doesn't have a precise relation to intelligence. What is important is to deeply understand things and their relations to each other. This is where intelligence lies. The fact of being quick or slow isn't really relevant. (Schwartz, 2001)

Keith Devlin is a Stanford mathematician, and NPR's Math Guy. Keith also talks about being slow with math, and the misconceptions that arise when we focus on competition math, such as Olympiads because:

"Competition mathematics is in many respects a very different activity than the professional mathematics that most of us in the business pursue. For one thing, competition math requires speed, whereas many good mathematicians are slow thinkers. (I certainly am.)" Devlin in http://devlinsangle.blogspot.com/

Maryam Mirzakani is a mathematician at Stanford who recently won the Fields Medal, the

world's top prize in mathematics. Maryam is an amazing woman who studies hyperbolic surfaces and who recently produced what has been called "the theory of the decade." In news articles on her work she is shown sketching ideas on large pieces of paper on her kitchen table, as her work is almost entirely visual.

When we look at mathematics in the world and the mathematics used by mathematicians, we see a creative, visual, connected, and living subject. Yet school students often see mathematics as a dead subject—hundreds of methods and procedures to memorize that they will never use, hundreds of answers to questions that they have never asked. When people are asked about how mathematics is used in the world, they usually think of numbers and calculations—of working out mortgages or sale prices—but mathematical thinking is so much more. Mathematics is at the center of thinking about how to spend the day, how many events and jobs can fit into the day, what size of space can be used to fit equipment or turn a car around, how likely events are to happen, knowing how tweets are amplified and how many

people they reach. The world respects people who can calculate quickly, but the fact is, some people can be very fast with numbers and not be able to do great things with them, and others, who are very slow and make many mistakes, go on to do something amazing with mathematics. The powerful thinkers in today's world are not those who can calculate fast, as used to be true; fast calculations are now fully automated, routine, and uninspiring. (see Boaler, 2013) The powerful thinkers are those who make connections, think logically, and apply the breadth and depth of mathematics to a variety of problems.

This article contains excerpts from Jo Boaler's new book, Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages and Innovative Teaching

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