Neuroplasticity:

Speech Workouts To Reshape Neural Pathways

Remap Your Cortex, And Improve Fluency

David Stones

CSA Conference, Toronto, 2018

"Neurons that wire together fire together…"

AGENDA

1. A Few Words of Introduction

2. Our Neuroplasticity Workshop:
   - Workshop goals and genesis
   - Our agenda and info package
   - Disclaimers
   - This is **OUR** workshop: Speak Up!

3. My Personal Stuttering Journey

4. What Is Neuroplasticity

5. How Neuroplasticity Applies To Stuttering:
   - A parable
   - The stuttering brain
   - Harnessing the power of neuroplasticity

6. Ten Fundamentals Of Rewiring Your Brain

7. Tips For Better Speech Performance And Fluency

8. Fluency Shaping Practice List

9. Questions and Discussion

10. Wrap-Up: 10:a.m.

(2)

Neural Plasticity Workshop Goals:

1. To learn more about the theory, the concept and the practice of neuroplasticity

2. To explore how neuroplasticity applies to stuttering and how people who stutter might harness the magic of the brain to improve speech fluency

3. To review best practices and practical exercises leading to improved speech fluency and possible rewiring of our neural pathways

My Worshop Disclaimers:

1. I'm not a neuro scientist, brain surgeon, psychiatrist or medical doctor.

2. I'm not a speech language pathologist (SLP).....The advice and guidance of your SLP has to come first.

3. Not all therapeutic interventions will necessarily affect PWS in the same way. Benefits may be lesser or greater, depending on many factors.

3

9 Recommended Books on Neuroplasticity

If you're interested in learning more and you have more than 20 minutes or so to dedicate to it, you might enjoy one of these books on the subject:

- *The Brain's Way of Healing: Remarkable Discoveries and Recoveries from the Frontiers of Neuroplasticity* by Norman Doidge (**Amazon**)
- *Neuroplasticity (MIT Press Essential Knowledge Series)* by Moheb Costandi (**Amazon**)
- *Switch on Your Brain: The Key to Peak Happiness, Thinking, and Health* by Dr. Caroline Leaf (**Amazon**)
- *The Power of Neuroplasticity* by Shad Helmstetter (**Amazon**)
- *The Stress-Proof Brain: Master Your Emotional Response to Stress Using Mindfulness & Neuroplasticity* by Melanie Greenberg (**Amazon**)
- *The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science* by Norman Doidge (**Amazon**)
- *My Stroke of Insight: A Brain Scientist's Personal Journey* by Jill Bolte Taylor (**Amazon**)
- *The Mind and the Brain: Neuroplasticity and the Power of Mental Force* by Jeffrey M. Schwartz and Sharon Begley (**Amazon**)
- *Breaking the Habit of Being Yourself: How to Lose Your Mind and Create a New One* by Dr. Joe Dispenza (**Amazon**)

Neuroplasticity and the Brain That Changes Itself

By: Laurie Bartels

I first discovered Norman Doidge's book, **The Brain That Changes Itself**, in a May, 2007 review in the New York Times. Intrigued, but caught up in myriad end-of-school-year responsibilities, the book was put out of my mind until later that summer, when our schools learning specialist emailed to say she had just finished a fascinating book. The Brain That Changes Itself: Stores of Personal Triumph from the Frontiers of Brain Science, is a compelling collection of tales about the amazing abilities of the brain to rewire, readjust and relearn after having a slice of itself rendered dysfunctional. The first seven chapters captivated me for their personal stories; the final four chapters for the science and philosophy.

Part of what makes Doidge's writing so accessible is he tells stories, and his stories just happen to incorporate brain science. As a result, his book is easy to digest. The neuroscience behind Doidge's book involves neuroplasticity, which is the brain's ability to rewire itself. This means that the brain is our intelligence is not something fixed in concrete but rather a changing, learning entity. On the face of it, this concept should not sound unusual, for it is what happens to individuals all the time as we go about the learning process, from infancy onwards.

What separates the stories in this book from daily learning is that the brains in question have been damaged in some form or other. Each tale is inspirational in that the individuals are able to overcome substantial, life-altering events, such as severe illness and stroke, in part thanks to the research of visionary scientists and doctors who developed methods and tools to facilitate neuroplasticity.

Neuroplasticity

The catchy phrase behind neuroplasticity is *"neurons that fire together wire together"*. The idea is that when two events (neurons firing) occur in the brain at the same time, the events (neurons) become associated with one another, and the neuronal connections (wiring) become stronger.

For many years, it was thought that each area of the brain had its own responsibilities; in other words, certain functions were localized or hardwired to certain brain areas. If something is hardwired then it is fixed and not capable of change.

However, while certain areas of the brain do tend to be responsible for specific functions, since the

brain is plastic, areas overlap and even can co-opt one another's functions. Initial maps drawn of our mental system turn out to be not as static as originally thought. If one pathway gets blocked, the brain is very good at finding alternative pathways.

As with any pathway, the more a particular path is used, the more ingrained it becomes, and pathways near one another become associated with each other. If a path is underutilized, over time it will be co-opted by other pathways that are branching out and need more space.

Hence, plasticity can be summed up in a few succinct statements all from chapter three Redesigning the brain:

- Neurons that fire together wire together.

- Neurons that wire apart fire apart. This is also stated as Neurons out of sync fail to link.

- Use it or lose it.

The Scientists

Doidge includes stories of the neuroscientists, among them Paul Bach-y-Rita, who pioneered the idea of *"polysensory".* Polysensory refers to the sensory areas of the brain, which rather than only processing information from just the senses that normally report to those areas, are actually able to process information from any of the senses.

Michael Merzenich, a developer of the cochlear implant and founder of Posit Science, is another of the scientists noted by Doidge. Merzenich says that *"You cannot have plasticity in isolation — an absolute impossibility. (and Doidge continues) His experiments have shown that if one brain system changes, those systems connected to it change as well.*

Following on his heels is Edward Taub, who established constraint induced therapy, an alternative therapy for individuals felled by stroke. Taub's research supported Merzenich's findings that *"when a brain map is not used, the brain can reorganize itself so that another mental function takes over that processing space.*

Alvaro Pascual-Leone's experiments began with looking at what happens in the minds of those who read Braille, and transitioned to looking at how *"our thoughts can change the material structure of our brains.* His goal was "to test whether mental practice and imagination in fact lead to physical changes. This is, indeed, what happens when athletes use visualization to help prepare for sports trials.

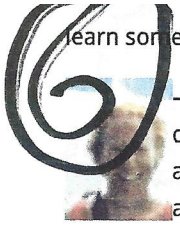
In the last quarter of Doidge"s book, which is equally interesting for the clarification of theories, he discusses the work of Eric Kandel, Sigmund Freud, Santiago Ramy Cajal, Jordan Grafman, and several other scientists who are exploring neuroplasticity.

My Take-Aways

I see plasticity and metacognition as closely entwined. This combination of knowing that intelligence is not fixed and thus you can change it, and knowing how you learn, is immensely positive and powerful, and has huge implications for students of any age. I translate this to students who struggle with learning issues, and aging adults who fear their brains will fade. I also think it is important for teachers to understand the concept of brain plasticity, as a means for no longer pigeon holing students.

Of course, we take away from an authors writing what we want or need to learn. As a provider of professional development to faculty, the final lesson I take from Doidge's book is the power of multifaceted professional development to foster neuroplasticity in adults, and therefore enhance their creativity. I take the message that most of us have the ability to break out of habits and to

learn something new, and each time we do this, it strengthens our ability to do it the next time!



– **Laurie Bartels** writes the Neurons Firing blog to create for herself the "the graduate course I'd love to take if it existed as a program". She is the K-8 Computer Coordinator and Technology Training Coordinator at Rye Country Day School in Rye, New York. She is also the organizer of Digital Wave annual summer professional development, and a frequent attendee of Learning & The Brain conferences.

For more on brain plasticity and learning:

- Brain Plasticity: How learning changes your brain
- Neuroscience Interview Series: interviews with over 15 brain scientists on how to direct the property of neuroplasticity.

Categories: Cognitive Neuroscience, Education & Lifelong Learning, Health & Wellness

Tags: Alvaro-Pascual-Leone, brain, Brain-Plasticity, brain-science, Brain-That-Changes-Itself, cochlear-implant, Edward-Taub, intelligence, Learning, metacognition, Michael-Merzenich, Neurons, Neurons-that-fire-together-wire-together, neuroplasticity, Norman-Doidge, pathways, Posit-Science, rewire, schools, Use-It-or-Lose-It

About SharpBrains

As seen in ***The New York Times, The Wall Street Journal, BBC News, CNN, Reuters*** and more, SharpBrains is an independent market research firm tracking health and performance applications of brain science.

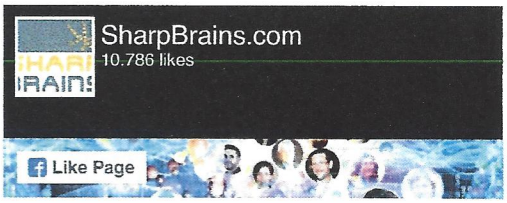
Follow us and Engage via...

facebook

twitter

LinkedIn

RSS Feed



Be the first of your friends to like this

Top Articles on Neuroplasticity and Brain Health Innovation

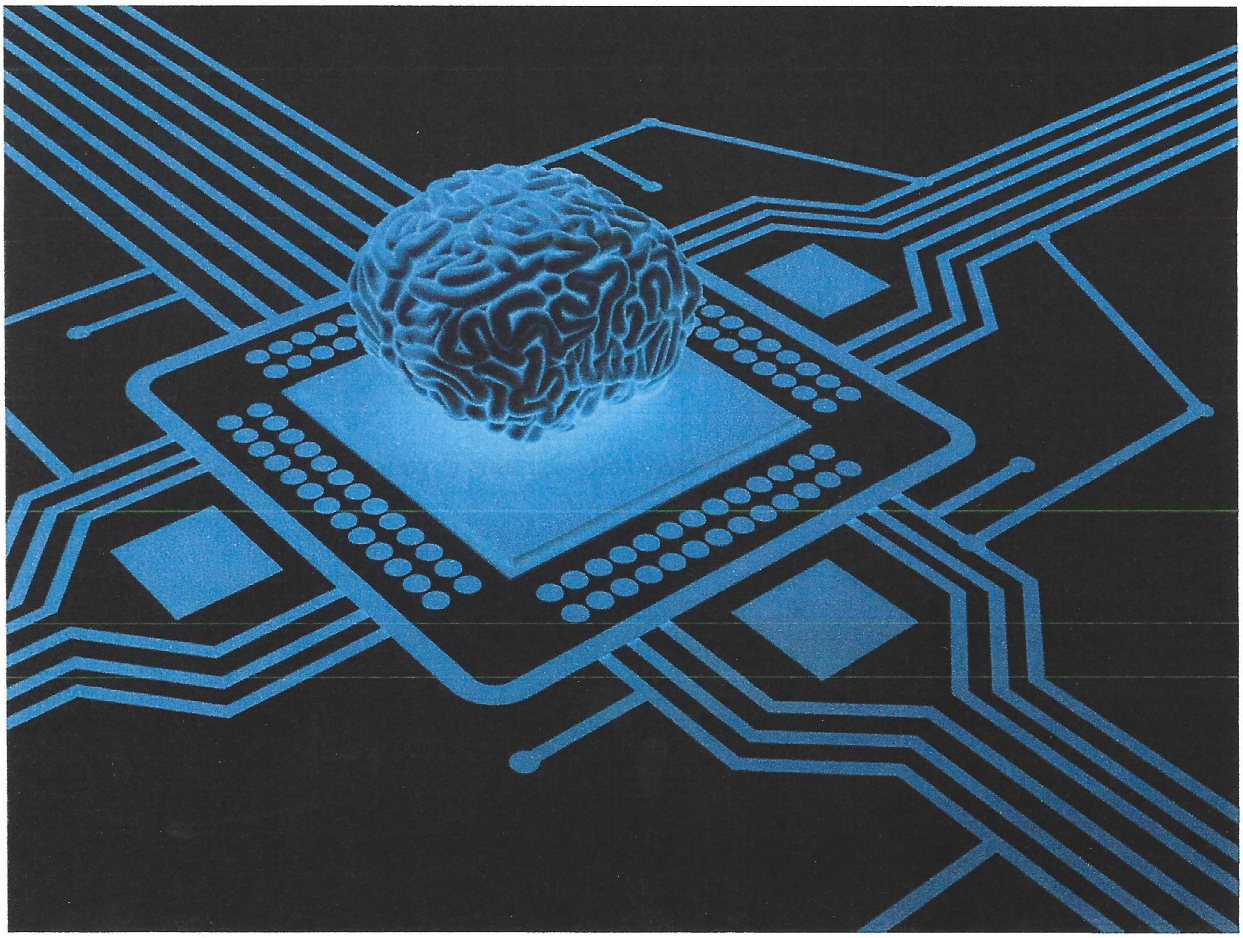
1. Five reasons the future of brain enhancement is digital, pervasive and (hopefully) bright
2. Can you grow your hippocampus? Yes. Here's how, and why it matters
3. To harness neuroplasticity, start with enthusiasm
4. 10 neurotechnologies about to transform brain enhancement and brain health
5. What Educators and Parents Should Know About Neuroplasticity and Dance
6. The Ten Habits of Highly Effective Brains

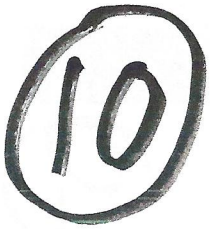
8. How learning changes your brain
9. Why you turn down the radio when you're lost
9. Can brain training work? Yes, if it meets these 5 conditions
10. What are cognitive abilities and how to boost them?
11. 8 Tips To Remember What You Read
12. Solving the Brain Fitness Puzzle Is the Key to Self-Empowered Aging
13. Six tips to build resilience and prevent brain-damaging stress
14. 20 Must-Know Facts to Harness Neuroplasticity and Improve Brain Health
15. Top Brain Teasers, Games and Illusions, for Teens and Adults of Any Age

Search for anything brain-related in our article archives

The Best Brain Possible *With Debbie Hampton*
Information and Inspiration For Anyone With a Brain

Ten Fundamentals Of Rewiring Your Brain





Neuroplasticity has become a buzzword in psychology and scientific circles, as well as outside of them, promising that you can "rewire" your brain to improve everything from health and mental well-being to quality of life. There's a lot of conflicting, misleading, and erroneous information out there.

So, exactly how does it work?

What Is Neuroplasticity

Just in case you've managed to miss all the hype, neuroplasticity is an umbrella term referring to the ability of your brain to reorganize itself, both physically and functionally, throughout your life due to your environment, behavior, thinking, and emotions. The concept of neuroplasticity is not new and mentions of a malleable brain go all of the way back to the 1800s, but with the relatively recent capability to visually "see" into the brain allowed by functional magnetic resonance imaging (fMRI), science has confirmed this incredible morphing ability of the brain beyond a doubt.

The concept of a changing brain has replaced the formerly held belief that the adult brain was pretty much a physiologically static organ or hard-wired, after critical developmental periods in childhood. While it's true that your brain is much more plastic during the early years and capacity declines with age, plasticity happens all throughout your life.

For a thorough explanation of how plasticity physically happens in your brain, see blog: **Masterpiece Or Mess**.

How Neuroplasticity Shows Up In Your Life

Neuroplasticity makes your brain extremely resilient and is the process by which all permanent learning takes place in your brain, such as playing a musical instrument or mastering a different language. Neuroplasticity also enables people to recover from stroke, injury, and birth abnormalities, improve symptoms of autism, ADD and ADHD, learning disabilities and other brain deficits, pull out of depression and addictions, and reverse obsessive-compulsive patterns. (Read more: **You're Not**

Stuck With The Brain You're Born With)

Neuroplasticity has far-reaching implications and possibilities for almost every aspect of human life and culture from education to medicine. Its limits are not yet known. However, this same characteristic, which makes your brain amazingly resilient, also makes it vulnerable to outside and internal, usually unconscious, influences. In his book **The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science**, Norman Doidge calls this the "plastic paradox." (Read more: **Your Plastic Brain: The Good, The Bad, and The Ugly**)

I know the power of neuroplasticity first hand, as I devised and performed my own homegrown, experience-dependent neuroplasticity-based exercises for years to recover from a brain injury, the result of a suicide attempt. Additionally, through extensive **cognitive behavioral therapy**, **meditation**, and **mindfulness** practices, all of which encourage neuroplastic change, I overcame depression, anxiety, and totally revamped my mental health and life.

But it was because of neuroplastic change that I became entrenched in depressive, anxious, obsessive, and over-reactive patterns in the first place.

Ten Fundamentals Of Neuroplasticity

Science has confirmed that you CAN access neuroplasticity for positive change in your own life in many ways, but it's not quite as easy as some of the neuro-hype would have you believe. In the article, **Neuroplasticity: can you rewire your brain?**, Dr. Sarah McKay, neuroscientist, says:

> *Plasticity dials back 'ON' in adulthood when specific conditions that enable or trigger plasticity are met. 'What recent research has shown is that under the right circumstances, the power of brain plasticity can help adults minds grow. Although certain brain*

machinery tends to decline with age, there are steps people can take to tap into plasticity and reinvigorate that machinery,' explains Merzenich. These circumstances include focused attention, determination, hard work and maintaining overall brain health.

In his book, **Soft-Wired: How the New Science of Brain Plasticity Can Change Your Life**, Dr. Michael Merzenich (which Dr. McKay cites above), a leading pioneer in brain plasticity research and co-founder of Posit Science, lists ten core principles necessary for the remodeling of your brain to take place:

1. Change is mostly limited to those situations in which the brain is in the mood for it.

> If you are alert, on the ball, engaged, motivated, ready for action, the brain releases the neurochemicals necessary to enable brain change. When disengaged, inattentive, distracted, or doing something without thinking that requires no real effort, your neuroplastic switches are "off."

2. The harder you try, the more you're motivated, the more alert you are, and the better (or worse) the potential outcome, the bigger the brain change.

> If you're intensely focused on the task and really trying to master something for an important reason, the change experienced will be greater.

3. What actually changes in the brain are the strengths of the connections of neurons that are engaged together, moment by moment, in time.

> The more something is practiced, the more connections are changed and made to include all elements of the experience (sensory info, movement, cognitive patterns). You can think of it like a "master controller" being formed for that particular behavior which allows it to be performed with remarkable facility and reliability over time.

4. Learning-driven changes in connections increase cell-to-cell cooperation which

is crucial for increasing reliability.

Merzenich explains this by asking you to imagine the sound of a football stadium full of fans all clapping at random versus the same people clapping in unison. He explains, "The more powerfully coordinated your [nerve cell] teams are, the more powerful and more reliable their behavioral productions."

5. The brain also strengthens its connections between teams of neurons representing separate moments of successive things that reliably occur in serial time.

This allows your brain to predict what happens next and have a continuous "associative flow." Without this ability, your stream of consciousness would be reduced to "a series of separate, stagnating puddles," explains Merzenich.

6. Initial changes are temporary.

Your brain first records the change, then determines whether it should make the change permanent or not. It only becomes permanent if your brain judges the experience to be fascinating or novel enough or if the behavioral outcome is important, good or bad.

7. The brain is changed by internal mental rehearsal in the same ways and involving precisely the same processes that control changes achieved through interactions with the external world.

According to Merzenich, "You don't have to move an inch to drive positive plastic change in your brain. Your internal representations of things recalled from memory work just fine for progressive brain plasticity-based learning." See blog: **Two Primary Ways to Drive Brain Neuroplasticity**.

8. Memory guides and controls most learning.

As you learn a new skill, your brain takes note of and remembers the good attempts,

while discarding the not-so-good trys. Then, it recalls the last good pass, makes incremental adjustments, and progressively improves.

9. Every movement of learning provides a moment of opportunity for the brain to stabilize – and reduce the disruptive power of – potentially interfering backgrounds or "noise."

Each time your brain strengthens a connection to advance your mastery of a skill, it also weakens other connections of neurons that weren't used at that precise moment. This negative plastic brain change erases some of the irrelevant or interfering activity in the brain.

10. Brain plasticity is a two-way street; it is just as easy to generate negative changes as it is positive ones.

You have a "use it or lose it" brain. It's almost as easy to drive changes that impair memory and physical and mental abilities as it is to improve these things. Merzenich says that older people are absolute masters at encouraging plastic brain change in the wrong direction. See blog: **Are You Unknowingly Contributing To Your Brain's Decline?**

RELATED POSTS



15

PUBLIC RELEASE: 30-MAY-2018

UTSA researchers study stuttering and develop technology to enhance brain function

Grant will be used to develop brain-computer interface (BCI) technology to train people how to optimize brain functions

UNIVERSITY OF TEXAS AT SAN ANTONIO

A team of researchers at The University of Texas at San Antonio (UTSA) received a two-year, $387,000 grant, from the National Institutes of Health (NIH), to develop technology that will identify brain activity patterns that contribute to stuttering and use that technology to train people how to optimize brain functions.

Edward Golob, a psychology professor and principal investigator of the grant, is teaming up with Kay Robbins, a professor in the UTSA Department of Computer Science, Jeffrey Mock, an assistant professor of research at UTSA, and Farzan Irani, an assistant professor of communication disorders at Texas State University, to study persistent developmental stuttering (PDS).

According to the National Institute on Deafness and Other Communication Disorders, stuttering affects roughly three million Americans of all ages.

With this grant, the research team of professors and their doctoral and undergraduate students, will create brain-computer interface (BCI) technology with the goal to reduce how often participants stutter.

The study's participants will have sensors on their heads that are connected to a computer system. The sensors will read what the brain is doing in real-time and will be used to identify brain activity patterns associated with successful and stuttered speech in each person.

After identifying brain states associated with a participant's best performance, researchers train the brain to get into that state more often, with the hopes that their stuttering rate will be reduced.

"We are studying how to get the most out of the brain that you have," said Golob, whose research expertise includes cognitive neuroscience with a focus on perception, attention and memory in the auditory system. "This general approach could be developed into a powerful tool for rehabilitation and therapy for neurological and psychiatric disorders including stroke, Alzheimer's disease and traumatic brain injuries."

Golob works alongside Mock, graduate and undergraduate students in his Cognitive Neuroscience Lab. In the lab, research is conducted on aspects of hearing, such as determining where a sound is coming from in space, allocating spatial attention and understanding how perception is influenced by memory and actions. Through their work, the researchers are striving to understand the cognitive and neurobiological differences that accompany normal aging as well as neurodegenerative disease.

Golob is part of the Brain Health Consortium, a world-class research enterprise at UTSA comprised of 40 of the nation's leading brain health researchers. These researchers leverage their expertise in neurodegenerative disease, brain circuits and electrical signaling, traumatic brain injury, regenerative medicine, stem cell

therapies, medicinal chemistry, neuroinflammation, drug design and psychology to collaborate on complex, large-scale research projects that will produce a greater understanding of the brain's complexity and the factors that cause its decline.

16

###

Media Contact

Kara Soria
kara.soria@utsa.edu
210-458-7495

@utsa

http://www.utsa.edu

OXFORD ACADEMIC

BRAIN

A JOURNAL OF NEUROLOGY

Facilitating fluency in adults who stutter

Jennifer T Crinion

Brain, Volume 141, Issue 4, 1 April 2018, Pages 944–946, https://doi.org/10.1093/brain/awy075
Published: 27 March 2018

This scientific commentary refers to 'Transcranial direct current stimulation over left inferior frontal cortex improves speech fluency in adults who stutter', by Chesters *et al.* (doi:10.1093/brain/awy011).

Being able to speak fluently is something most of us take for granted. However, for the estimated 70 million people worldwide with persistent developmental stuttering, speaking is a tense struggle to get words out. This can result in avoidance of speaking in some or many situations, with fear and anticipation of stammering affecting personal interactions, education and employment prospects (Boyle, 2015). As such, stuttering is not simply a speech difficulty but a serious communication problem. For children, behavioural interventions can work (Nye *et al.*, 2013). However, for the 1% of cases where stuttering

persists to adulthood, changing the way speech is produced to maintain speech fluency is a particular challenge and there is a need for novel interventions (Howell, 2011). In this issue of *Brain*, Chesters and co-workers examine whether application of transcranial direct current stimulation (tDCS) concurrent with fluency training can improve speech fluency in people who stutter (Chesters *et al.*, 2018).

In a double-blind randomized controlled trial, 30 people who stutter underwent fluency training while receiving either anodal tDCS delivered over the left frontal cortices for 5 days (1 mA for 20 min/day), or sham stimulation. Outcomes were measured in terms of changes to stuttering severity both 1 and 6 weeks post-therapy. The behavioural intervention increased fluency immediately in all participants but only the people who stutter who received anodal tDCS maintained speech gains at both follow-up testing points. These results provide new insights into neuroplasticity in people who stutter in response to intervention, but at the same time raise a number of questions relating to (i) how to understand the behavioural consequences of tDCS; (ii) what role the left frontal cortices have in speech fluency; and (iii) how applicable these findings are to the goal of treating stuttering.

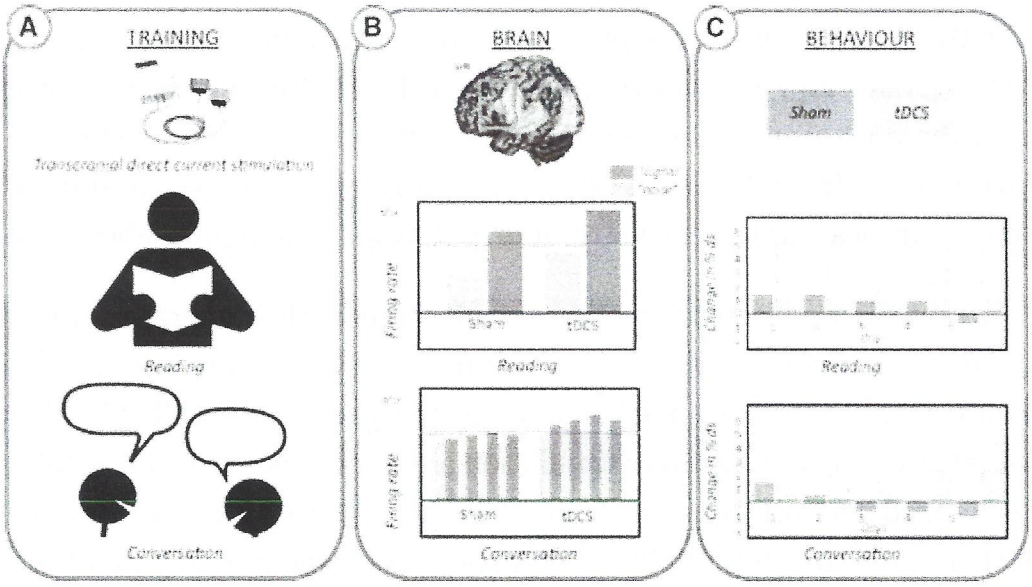
First, the speech changes observed by Chesters *et al.* took the form of reductions of disfluencies across two speaking tasks, reading and conversation 1 week post-therapy. In the reading task only, these reductions were maintained 6 weeks later. The authors interpret their results as evidence that speech samples taken during reading tasks provide a more sensitive measure of disfluency. This is certainly one potential account.

Yet we are still left with the question as to why the decreases in disfluency during the 5 days of intervention were greater during reading than conversation tasks only for the anodal tDCS group. From a methodological perspective, the behavioural invention was composed of two tasks: choral speech, which involved reading passages in unison with a live and then a recorded voice, and metronome-timed speech during cartoon narrations and conversations on random topics. Based on their intervention design, this means that Chesters *et al.* paired what one presumes is half their anodal tDCS dose with reading tasks that mirrored the reading outcome measures. It is not clear how long anodal tDCS was paired with the metronome conversation task. It has been suggested that anodal tDCS may induce facilitation when the task is well-trained or familiar, but such facilitation is not present during performance of a novel task (Dockery *et al.*, 2009). This may go some way towards explaining why Chesters *et al.* found a difference in outcomes between their two tasks.

TDCS itself cannot induce an over-threshold depolarization of neurons directly but can modulate the firing rate of the stimulated brain area. It will only induce the firing of neurons that are near threshold, which means that neurons not influenced by the task are less likely

to discharge. In Chesters *et al.*'s well-practiced reading aloud task, the signal-to-noise rati within the neural network is already above threshold. With anodal tDCS, the neural noise induced by stimulation is reduced so that the task input signal emerges clearly from the noise, thereby facilitating processing (Miniussi *et al.*, 2013). This is evocative of Hebbian-like plasticity mechanisms. The combination of anodal tDCS with reading fluency is similar to co-activation of a specific network modulating ongoing long-term potentiation—like changes that outlast the stimulation, leading to consolidation of changes in reading fluency performance. In their less-trained conversation task the context is different: the variability of the task likely meant variability of synaptic input function, meaning there was more background noise in the system and little consolidation of the neural networks. In this case, anodal tDCS would not help task performance as it would increase both the signal and the noise in the system, both being close to threshold. In this sense, anodal tDCS would not perturb the neural system supporting the conversation task's behavioural processes nor lead to (long-term) conversation fluency change. In sum, tDCS requires ongoing learning in order to promote or modify plasticity to prime the behavioural system and produce corresponding specific effects in the cognitive system.

Figure 1



View large Download slide

Effects of behavioural interventions plus anodal or sham tDCS at brain and behavioural levels in persistent developmental stuttering. (**A**) Training. *Top*: Photo of a standard tDCS kit that is paired with behavioural interventions. The speech fluency intervention used by Chesters *et al.* involved delivering tDCS (sham or anodal) concurrently with choral (reading based) and metronome-timed (including conversation) speech tasks. Speech fluency during reading and conversation tasks was then assessed after each day of intervention ($n = 5$) and at 1 and 6 weeks post-intervention. (**B**) Brain systems level. *Top:* Region-specific speech effects are illustrated relative to the location of the stimulating electrode. Yellow = left hemisphere

BOLD response, overlaid on a canonical brain for the contrast 'speaking relative to rest' in a functional MRI study of healthy subjects. Green box indicates the approximate edge of the electrode (35 cm^2) placed over the left frontal cortex. *Middle and bottom:* Illustrations of the possible neural response for reading and conversation tasks in the left frontal cortices underneath the stimulating electrode. Those neurons that respond according to the task-goal are displayed as target signal (red), all other sources of activity that are not associated with the final task-goal are defined as neuronal noise (grey). Plots show the interaction between target signal and noise when subjects read aloud (*top*), or engage in a conversation (*bottom*). The threshold represents the minimum signal intensity for neurons to contribute to the final speech task. The tDCS plots represent possible effects of anodal stimulation on the neurons that fire in response to the task demands. A pattern can be seen in the interaction between the task state and tDCS-induced activity. (**C**) Behavioural after-effects of anodal tDCS (yellow) versus sham (blue). The final behavioural outcome each day is likely dependent on the final neuronal patterns as shown in **B** schematic plots. *Middle:* Reading performance. *Bottom*: Conversation performance. The bars indicate the mean change in percentage of disfluencies (ds), where a high number indicates more fluent speech.

Second, what can we conclude about the role of left inferior frontal cortices in speech fluency in people who stutter? Chesters *et al.* proposed that this is a key brain region to support fluent speech on the basis of previous functional and structural imaging studies in people who stutter showing it to be structurally anomalous (Watkins *et al.*, 2008) or functionally underactivated (Budde *et al.*, 2014). They targeted this region using a tDCS montage with the reference electrode placed over the right supra-orbital cortex and the anode electrode (standard 7 × 5 cm size) placed over the left inferior frontal cortices also encompassing the ventral sensorimotor and premotor cortices. Thence extensive brain areas (not just inferior frontal cortices) were stimulated by Chesters *et al.* and the current flow between electrodes was widely distributed, potentially including subcortical structures.

Complex behaviours like speech production recruit large-scale bilateral neural systems. TDCS may, therefore, modulate task-related connectivity of regions distant to the stimulation site as well as task-related areas beneath the electrodes. This implies that the net behavioural effects evolving after stimulation are likely based on a remodelling of the whole task-engaged network; specifically, in the case of speech fluency, the behavioural effects reflect complex and potentially bilateral network interactions rather than changes in a single left frontal speech region. Indeed, Neef and colleagues' combined functional MRI-diffusion tensor imaging data suggest that right fronto-temporal networks play a compensatory role as a fluency-enhancing mechanism in people who stutter (Neef *et al.*, 2018). While Lu and colleagues found increased functional activation in left ventral inferior frontal cortices and insula on a reading task after a 7-day behavioural intervention (also reading-based) for stuttering (Lu *et al.*, 2017). Their data combined with Chesters *et al.*'s reading data suggest that customizing tDCS to the task-induced neural activation during training is likely to increase specificity of effects. Nonetheless, the spatial resolution of tDCS

is very low. Whether and how reduction in disfluencies induced by anodal tDCS placed over left frontal cortices paired with fluency interventions relates to the connection strength of co-activated (hypo and hyper) bilateral frontal regions to other brain areas remains an open question. In people who stutter, left inferior frontal cortices may be neither the only nor the optimal site for neuromodulation to affect speech fluency intervention outcomes.

At present, there are no universally-accepted methods or 'gold standards' for the treatment of people who stutter against which new or experimental interventions can be compared and no clear criteria to assess treatment efficacy. While clinically meaningful outcome measures have not been established, most therapists, clinicians, and researchers in the field would probably agree that a treatment should be considered effective if: (i) subjects show significant improvement in trained tasks compared to untrained tasks; (ii) these behavioural effects persist beyond the training period; and (iii) any improvement in fluency-based measures generalizes to real-world contexts. Chesters *et al.* have shown that anodal tDCS paired with a fluency intervention was safe and well-tolerated in a sham-controlled study in 30 people who stutter. The group who had anodal tDCS paired with their training significantly improved speech fluency compared to those who received the fluency intervention alone. The fluency gains were maintained for up to 6 weeks after therapy on reading-based tasks that were arguably trained more during the tDCS intervention. The results were not only statistically significant but the standardized effect sizes were large using Cohen's *d*. Given the small sample size and the low dose of intervention (5 days), these results are promising. That the participants did not report a significant improvement in their functional speech skills is perhaps not surprising. This may be because the outcome measure used, OASES (Yaruss and Quesal, 2006), focuses on the psychosocial impact of stuttering and as such is ill-equipped to detect increased speech fluency, or because increased speech fluency during reading may have little applicability in daily life.

In the search for more effective and longer-lasting interventions, combining training and brain stimulation seems reasonable. The appeal of tDCS is its portable, inexpensive, safe and relatively simple set-up. The challenge for the treatment of people who stutter is to take a clinically effective stuttering intervention, understand its neural mechanism of action and, from these data, identify a candidate site for neuromodulation. Only then will tDCS have the potential—not as a complete therapy in itself but as an adjunct to effective behavioural interventions—to improve therapeutic outcomes.

Funding

J.C. is supported by a Wellcome Trust Senior Research Fellowship in Clinical Science

(100261/Z/14/Z).

22

References

Boyle MP . Relationships between psychosocial factors and quality of life for adults who stutter. *Am J Speech Lang Pathol* 2015; 24: 1–12.

Google Scholar CrossRef PubMed

Budde KS , Barron DS, Fox PT. Stuttering, induced fluency, and natural fluency: a hierarchical series of activation likelihood estimation meta-analyses. *Brain Lang* 2014; 139: 99–107.

Google Scholar CrossRef PubMed

Chesters J , Mottonen R, Watkins K. Transcranial direct current stimulation over left inferior frontal cortex improves speech fluency in adults who stutter. *Brain* 2018; 141: 1161–71.

Google Scholar CrossRef PubMed

Dockery CA , Hueckel-Weng R, Birbaumer N, Plewnia C. Enhancement of planning ability by transcranial direct current stimulation. *J Neurosc* 2009; 29: 7271–7.

Google Scholar CrossRef

Howell P . *Recovery from stuttering* . New York, NY: Psychology Press; 2011. p. 1–390.

Lu CM , Zheng LF, Long Y, Yan Q, Ding GS, Liu L, et al. Reorganization of brain function after a short-term behavioral intervention for stuttering. *Brain Lang* 2017; 168: 12–22.

Google Scholar CrossRef PubMed

Miniussi C , Harris JA, Ruzzoli M. Modelling non-invasive brain stimulation in cognitive neuroscience. *Neurosci Biobehav Rev* 2013; 37: 1702–12.

Google Scholar CrossRef PubMed

Neef NE , Anwander A, Butfering C, Schmidt-Samoa C, Friederici AD, Paulus W, et al. Structural connectivity of right frontal hyperactive areas scales with stuttering severity. *Brain* 2018; 141: 191–204.

Google Scholar CrossRef PubMed

Nye C , Vanryckeghem M, Schwartz JB, Herder C, Turner HMIII, Howard C. Behavioral stuttering

interventions for children and adolescents: a systematic review and meta-analysis. *J Speech Lang Hear Res* 2013; 56: 921–32.
Google Scholar CrossRef PubMed

Watkins KE , Smith SM, Davis S, Howell P. Structural and functional abnormalities of the motor system in developmental stuttering. *Brain* 2008; 131 (Pt 1): 50–9.

Yaruss JS , Quesal RW. Overall Assessment of the Speaker's Experience of Stuttering (OASES): documenting multiple outcomes in stuttering treatment. *J Fluency Disord* 2006; 31: 90–115.
Google Scholar CrossRef PubMed

23

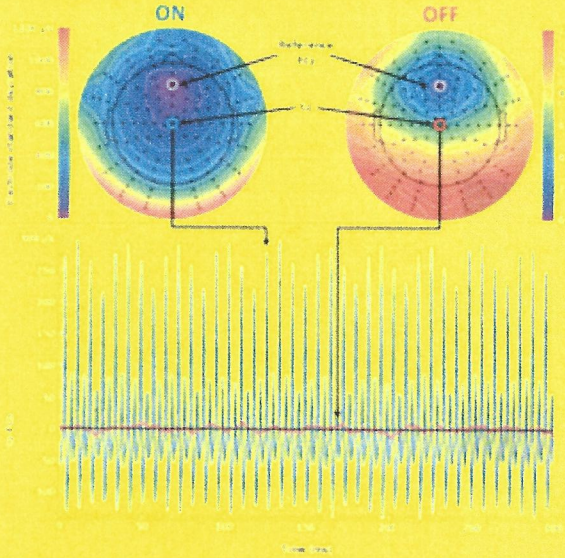
Issue Section: Scientific Commentaries

24

CLINICAL NEUROPHYSIOLOGY

OFFICIAL JOURNAL OF THE INTERNATIONAL FEDERATION OF CLINICAL NEUROPHYSIOLOGY

Example of EEG signal
with and without DBS of the STN



ISSN 1388-2457

ELSEVIER

Clinical Neurophysiology
Volume : 129
Issue : 10
October 01, 2018
Previous Download Issue Next

CLINICAL NEUROPHYSIOLOGY

Imaging of the recovery from stuttering reveals spontaneous neuroplasticity

C. Kell
,
C.A. Kell
,
K. von Kriegstein
,
K. Neumann
,
A.L. Giraud

https://doi.org/10.1016/j.clinph.2006.11.135

Background: People who stutter (PWS) overactivate a right-hemispheric network during speech production when compared with controls Brown et al., 2005. After fluency-shaping therapy, these overactivations shift to the left hemisphere as a result of cortical plasticity [De Nil et al., 2003]. A subset of PWS can recover from stuttering even without therapy. To identify the network reflecting 'ideal' compensation and help to orientate future stuttering therapies, we studied the functional substrates of overt speech in this group compared with normal controls and PWS before and after therapy.

26

You must be logged in to purchase this article.

Purchase a subscription to gain access to this and all other articles in this journal.

Claim access to a subscription (current subscribers and society members)

Institutional access

Visit ScienceDirect to see if you have access through your institution.

View PDF
View Full Text
NEXT ARTICLE
The human subthalamic nucleus is activated earlier during internally paced single and sequential movements compared to externally paced movements

CLINICAL NEUROPHYSIOLOGY

Current Issue Articles in Press

2014

Intensive stuttering therapy based on neuroplasticity and motor learning principles: treatment efficacy for adults who stutter

Daniel Shubert
Western Washington University

28

INTENSIVE STUTTERING THERAPY BASED ON NEUROPLASTICITY AND MOTOR LEARNING PRINCIPLES: TREATMENT EFFICACY FOR ADULTS WHO STUTTER

By

Daniel Shubert

Accepted in Partial Completion
Of the Requirements for the Degree
Masters of Arts

Kathleen L. Kitto, Dean of the Graduate School

ADVISORY COMMITTEE

Chair, Dr. Barbara Mathers-Schmidt

Dr. Michael Fraas

Dr. Kimberly Peters

Yarrow Pospisil

29

MASTER'S THESIS

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Western Washington University, I grant to Western Washington University the non-exclusive royalty-free right to archive, reproduce, distribute, and display the thesis in any and all forms, including electronic format, via any digital library mechanisms maintained by WWU.

I represent and warrant this is my original work, and does not infringe or violate any rights of others. I warrant that I have obtained written permissions from the owner of any third party copyrighted material included in these files.

I acknowledge that I retain ownership rights to the copyright of this work, including but not limited to the right to use all or part of this work in future works, such as articles or books.

Library users are granted permission for individual, research and non-commercial reproduction of this work for educational purposes only. Any further digital posting of this document requires specific permission from the author.

Any copying or publication of this thesis for commercial purposes, or for financial gain, is not allowed without my written permission.

Daniel Shubert
May 16th, 2014

INTENSIVE STUTTERING THERAPY BASED ON NEUROPLASTICITY AND MOTOR LEARNING PRINCIPLES: TREATMENT EFFICACY FOR ADULTS WHO STUTTER

A Thesis
Presented to
The Faculty of
Western Washington University

In Partial Fulfillment
Of the Requirement for the Degree
Master of Arts

by
Daniel Shubert
June 2014

Abstract

This study examined the efficacy of an intensive stuttering therapy program that was highly structured and based on neuroplasticity and the principles of motor learning. Treatment sessions were conducted in person and through Skype 4 days a week for a total of 8 weeks. Speech samples were collected throughout the study during Skype testing sessions and through self-recordings by the participants. These samples were analyzed for percent stuttered syllables and naturalness rating. Outcome measures also included a series of self-ratings by the participants and the completion of selected sections of the Overall Assessment of the Speaker's Experience of Stuttering (OASES). Results indicated that the participants' levels of disfluency and self-ratings improved throughout the course of the study. Individual differences in response to treatment are discussed.

Table of Contents

Abstract.....iv

List of Figures.....vi

List of Tables.....vii

Introduction.....1

Method.....11

Results.....20

Discussion.....38

Conclusion.....48

Bibliography.....49

Appendix A: Testing Protocol.....54

Appendix B: Topics List.....56

Appendix C: Sample Home Practice Sheets.....57

Appendix D: Sample Lesson Plans.....61

Appendix E: Instructions for Use of Self-Recording Device.....65

Appendix F: Communication Partner Consent Form.....66

Appendix G: Informed Consent Form.....67

Appendix H: Initial Treatment Calendar.....69

List of Figures

Figure 1 - Participant A: %SS in Skype Monologues and Conversations.....21

Figure 2 - Participant A: Naturalness Rating in Skype Monologues and Conversations.....22

Figure 3 - Participant A: %SS in Self-Recordings.....22

Figure 4 - Participant A: Naturalness Rating in Self-Recordings.....23

Figure 5 - Participant B: %SS in Skype Monologues and Conversations.....24

Figure 6 - Participant B: Naturalness Rating in Skype Monologues and Conversations.....26

Figure 7 - Participant B: %SS in Self-Recordings.....27

Figure 8 - Participant B: Naturalness Rating in Self-Recordings.....28

Figure 9 - Participant A: Overall Speech Satisfaction.....29

Figure 10 - Participant A: Anxiety Rating.....29

Figure 11 - Participant A: Stuttering Severity Rating.....30

Figure 12 - Participant B: Overall Speech Satisfaction Rating.....31

Figure 13 - Participant B: Anxiety Rating.....31

Figure 14 - Participant B: Stuttering Severity Rating.....32

Figure 15 - Participant A: Reactions to Your Stuttering: Part B Rating.....33

Figure 16 - Participant A: Communication in Daily Situations Rating.....33

Figure 17 - Participant A: Quality of Life Rating.....34

Figure 18 - Participant B: Reactions to Your Stuttering: Part B Score.....35

Figure 19 - Participant B: Communications in Daily Situations Rating.....35

Figure 20 - Participant B: Quality of Life Rating.....36

(34)

List of Tables

Table 1 - Participant A: Average %SS in Skype Monologues and Conversations.....21

Table 2 - Participant A: Average %SS in Self-Recordings.....23

Table 3 - Participant B: Average %SS in Skype Monologues and Conversations.....25

Table 4 - Participant B: Average %SS in Self-Recordings.....27

experience, she liked therapy occurring for 50-minutes each weekday, she thought treatment was useful and based on what she needed, and she liked the way that target complexity built up over time. Her major complaint about treatment had to do with the testing that was required for the study and the repetitiveness of practicing the functional phrases. An SSI-4 was completed during the exit interview and the client produced speech both in conversation and reading aloud with less than .3% SS and no physical concomitants which places her below the "very mild" severity rating on the SSI.

Discussion

The purpose of this study was to examine the efficacy of intensive stuttering therapy that incorporates telepractice and what is known about motor learning and neuroplasticity. Outcome measures were used to assess the disfluency levels and quality of life of two adults who stutter. The data revealed an overall decrease in average %SS in self-recordings by the conclusion of the second treatment phase and an improvement in scores on the OASES. High variability of individual data points was noted throughout the study. This was likely related to the difficulty in obtaining consistently representative data for individuals who stutter due to the myriad of factors that contribute to when and how disfluencies occur. This variability of data points decreased as the study progressed which further demonstrated the efficacy of the treatment program. The exit interviews at the conclusion of the study suggest that the participants believe the therapy administered was beneficial and resulted in improvement in their fluency.

Data for %SS and naturalness for Participant A was drastically different between the Skype testing and the self-recordings. The %SS during both the monologue and conversation tasks over Skype remained relatively low throughout the study. This is most likely related to the fact that Participant A had received previous therapy as an adult and was able to switch into the

the participant to change the rating and therefore they remained relatively consistent throughout most of the study.

One last small limitation may have been the technical difficulties experienced using telepractice. There were some interruptions during Skype testing and during treatment related to internet connection issues. These interruptions may have had an effect on the research participants' performance and on the ability of the research assistants to accurately score the recorded samples.

Conclusion

The results of this study suggest that intensive stuttering therapy conducted using telepractice that focuses on implementing what is known about principles of motor relearning and neuroplasticity can be beneficial for individuals who stutter. Individuals with strong emotional responses to their stuttering and avoidance behaviors may benefit more from a program that also implements treatment that targets emotional reactions specifically. Stuttering therapy needs to be highly individualized to each client's needs and a program such as the one conducted in this study may be more successful when incorporated into a broader treatment plan. The use of telepractice can help to make treatment more available to clients with difficult schedules or who live in areas without stuttering specialists nearby. Continued research investigating motor relearning and neuroplasticity in relation to speech needs to be conducted in order to guide clinical practice that incorporates principles based on speech-specific evidence.

Appendix C: Sample Home Practice Sheets

Week 5: Home Practice Activities 1/14-1/17

Tuesday (1/14/2014): **Completed**

Individual:

- Practice functional phrases with easy speech: 3x ____
- Practice reading out loud with easy speech: 5 min ____

Social:

- Use easy speech in all low-challenge conversations ____
- Use easy speech for first 2-3 sentences of moderate-challenge conversation: 3x ____
- Self-generated home activity:

Wednesday (1/15/2014):

Individual:

- Practice functional phrases with easy speech: 3x ____
- Practice reading out loud with easy speech: 5 min ____

Social:

- Use easy speech in all low-challenge conversations ____
- Use easy speech for first 2-3 sentences of moderate-challenge conversation: 3x ____
- Self-generated home activity:

Thursday (1/16/2014):

Individual:

- Practice functional phrases with easy speech: 3x ____
- Practice reading out loud with easy speech: 5 min ____

Social:

- Use easy speech in all low-challenge conversations ____
- Use easy speech for 3 minute moderate-challenge conversation: 3x ____
- Self-generated home activity:

Friday (1/17/2014):

Individual

- Practice functional phrases with easy speech: 3x ____
- Practice reading out loud with easy speech: 5 min ____

Social:

- Use easy speech in all low-challenge conversations ____
- Use easy speech for 3 minute moderate-challenge conversation: 3x ____

(38)

- Self-generated home activity:

Weekend:

Individual:

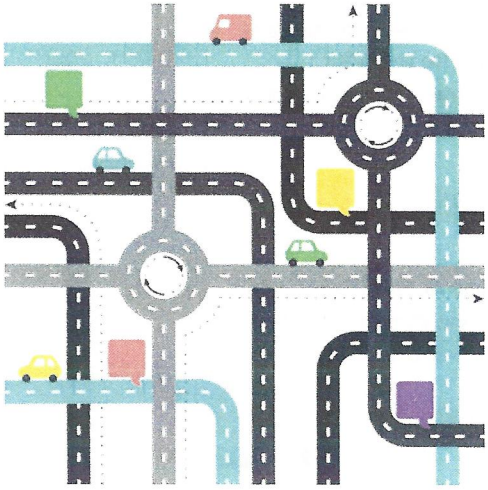
- Practice all functional phrases aloud using easy speech (3x) ____
- Read aloud using easy speech for (3 min) ____

Social:

- Self-recording of conversation in high-challenge situation (5 min; 2x) ____
- Use easy speech in all low-challenge conversations ____
- Use easy speech for first 2-3 sentences of high-challenge conversation: 1x ____
- Self-generated home activity:

Stuttering and Brain Pathways

Category: Research
Published: Tuesday, 20 February 2018 02:29
Written by Lisa Wilder



This is a review of the article: "Structural connectivity of right frontal hyperactive areas scaled with stuttering severity". from *BRAIN: a journal of Neurology*, 2018 issue 141, pages 191-204. (Authors listed at end of article)

Imagine you are driving a car. It seems to be a good fast car, and you're happily driving down the highway. But when you slightly decrease your foot on the gas in order to slow down, the car stops entirely! If you try to make a ninety-degree right turn onto another road, no matter how far right you turn the steering wheel, the car will only turn twenty degrees, or ten degrees, or maybe won't turn at all! Sounds like a bad dream, doesn't it?

Brain scanning

Modern medical technology, such as PET and MRI scanning, allows doctors to peer inside peoples' working brains, allowing for advanced insight into what causes, and could potentially help, conditions like stuttering. The research paper studied here builds on previous research that examined brain anomalies, in both structure and function, of people who stutter compared to those who do not. Research such as this can lead to greater understanding of the specific neural pathways that contribute to stuttering, and potentially lead to treatment such as electric brain stimulation which is already being tested.

An automatic function

Speech is such an automatic thing it is difficult to analyze. The fact is, speaking involves a very complex set of movements and extensive neural activity. Like driving a car, it is a "stop and go" activity, involving both the initiation and the inhibition of movement, and switching to different types of movement. In the case of speech, this is changing from one sound to the next, and stopping and starting breath and sound between words and thoughts. Our brains activate different neural pathways for "starting" as opposed to "stopping".

Overactive connections

It is already known that one significant way stuttering brains differ from non-stuttering brains is a higher degree of right hemisphere activity during speech. Neural pathways in the left hemisphere have been observed to be degenerated, and the extent of this degeneration correlates with the degree of stuttering severity. Some neural connections, mainly on the right side, are overactive. While increased connection strength can sound like a good thing, it can be a negative if it is putting a rapid fine-tuned sequence of actions off balance.

> Speech is a "stop and go" activity, involving both the initiation and the inhibition of movement

The *basal ganglia* is a region of the brain situated in the base of the frontal region. Activity between elements of this region via neural pathways is what controls our movement and the motor activity that produces speech. One neural pathway within this region connects to a part called the *subthalamic nucleus*. This nucleus controls selection of the specific motor activity and

Articles Categories

- All Latest Article
- Personal Storie
- Research
- Book Reviews
- Personal Comm
- News Archives

Become a Member!

Support the Canadia Association by beco Get updates and rec upcoming monthly n

Fill out the Members

inhibits the activity of those certain muscles.

One of the main findings of the study is the overactivity in the connection strength of the *subthalamic nucleus*. This overactivity suggests an "overly active global response suppression mechanism" in stuttering. It is suggested that this part, due to being overactive, goes haywire and, like the car that can stop but not slow down, causes global inhibition in the entire system rather than a specific inhibitory response. This overactive inhibitory response is part of what causes blocks and involuntary prolongation and repetition that characterizes stuttering.

Anticipation of stuttering

The research found differences in the brains of people who stutter not related to speech behaviour. Areas associated with motor imagery, imitation and action observation, memory control, task switching, cognitive flexibility were also overactivated compared to non-stutterers. The researchers link these neural circuits to "proactive inhibition", such as the anticipation of stuttering that causes coping and avoidance behaviours in people who stutter. This research is "the first to bring such a brain-behaviour relationship" into awareness.

Participants

This is a solid research paper that has the benefit of a good sample size: 31 adults who stutter and 34 controls who do not stutter participated in the study. The adults who stutter completed the OASES (Overall Assessment of the Speakers Experience of Stuttering) questionnaire to determine the impact of stuttering on their lives. As well, the SSI-4 (Stuttering Severity Instrument) showed that fifteen participants showed "very mild" to "mild" stuttering, seven were "mild", two were "moderate", two "severe" and two "very severe". They were all right handed and were not taking speech therapy at the time of the research. Three different types of MRI (magnetic resonance imaging) were used in the study for brain scanning, including types of imaging that specifically determine the strength of neural tracts and white matter connecting tissue.

Authors: Neef NE, Anwander A, Bütfering C, Schmidt-Samoa C, Friederici AD, Paulus W, Sommer M. From: Department of Neuropsychology, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany. 2Department of Clinical Neurophysiology, University Medical Center Göttingen, Göttingen, Germany. 3Department of Cognitive Neurology, University Medical Center Göttingen, Germany.

› Prev

› Next

CONTACT INFORMATION

Canadian Stuttering Association

1-866-840-2905 or 416-840-5169 (Toronto)
csa-info@stutter.ca

PO Box 20056
Carrville PO
Concord ON L4K 0C8

RECENT NEWS

- Don't give up!
- Stuttering, history and popular culture
- If you are talking to someone who stutters
- A Boy and a Jaguar: the life of Alan Rabinowitz

THE STUTTERING FOUNDATION
Since 1947 A Nonprofit Organization Helping Those Who Stutter

Can stuttering be cured through the induction of plastic change in the brain?

- Parents of Preschoolers
- Parents of School-Age Children
- Just for Kids
- Teens
- Adults
- Teachers
- Speech-Language Pathologists
- Physicians
- Employers

Kathleen Henriksen, M.D.
Emergency Room, Ullevål University Hospital, 0407 Oslo, Norway

Eirik Solheim M.D.
Sørlandet Hospital, 4809 Arendal, Norway

Hilda Sønsterud
Speech and Language Pathologist, Oslo, Norway

Greg Jablonski, M.D., Ph.D.
Senior Ear Surgeon
Department of Ear Nose and Throat , ØPO-klinikken,
Rikshospitalet University Hospital and University of Oslo
N-0027 Oslo, Norway

Espen Dietrichs, M.D., Ph.D.
Professor of Neurology, Head of Department

Department of Neurology
Center for Clinical Neuroscience
Rikshospitalet University Hospital and University of Oslo
N-0027 Oslo, Norway

This is the English translation of an article published October 2007 issue of *Norsk Tidskrift for Logopedi*.

It is well established that some stutters can experience spontaneous improvement in fluency when speaking in chorus or with song, a so called choral effect. We are of the belief that if technical intervention against stuttering or moderated speech is initiated while the brain is still plastic, before the age of 7 years, it may be possible to induce persistent fluency as the brain re-modulates to circumvent dysfunctional nerve tracts. This hypothesis is based on the brains significant potential for plastic change and logical deduction from the empirical treatment of astigmatism.

Background

The estimated prevalence for stuttering in the adult population is between 0.7 to 1%. Stuttering can be a significant social handicap. Traditionally it has been diagnosed and treated by speech pathologists and psychologists. Stuttering is a complex neuro-motor speech disorder often with a genetic predisposition. Essential stuttering is often characterized by blocks with full stops of air and sound, repetition of sounds or prolongation of syllables. The consensus has defined stuttering as a percentage of dysfluency per one hundred words, 5% representing a mild stutter while 12% or more is considered a sever condition. (Guitar 2006) By essential stuttering we mean that stuttering is the fundamental dysfunction and not that it is a symptom of another illness.

It has been known since ancient times that physical manipulation while stuttering can affect stuttering frequency. It is written that as a boy Demosthenes (384-322) cured himself of stuttering by speaking with pebbles in his mouth. In the 1960's it was discovered that a portion of the stuttering population experienced remission when they were exposed to Delayed Auditory Feedback (DAF). Subsequently, there have been many devices developed that deliver DAF therapy. We will refer to this as technical intervention. Technical intervention encompasses fitting the patient with a device that provides an echo of the patient's own voice with a delay between 50 to 200 ms. In an effort to avoid resistance development over time the frequency of the patient's own voice is also adjusted up or down, from +/- 1000Hz to 500Hz. This is referred to as Frequency Altered Feedback (FAF). What percent of patients respond to the effect of DAF/FAF is not yet properly documented. However, DAF/FAF has been used and is being used for stuttering therapy.

Existing Hypotheses

Foundas (2004) is of the opinion that people who stutter have an auditory perception defect. She has postulated that the manipulation of the hearing signal with DAF/FAF can influence the degree of fluency amongst some patients that stutter: 'The auditory system, at least at the level of auditory input, is involved in both of these fluency inducing conditions. Thus there may be a defect at the level of auditory processing that is at least partially reversed with these procedures.' (Foundas et al, 2004, s.1640)

Van Riper described stuttering as a consequence of a dis-synchronization of sequential motor speech movements (Guitar 2006). Can this be a consequence of an auditory perception defect or a dysfunction of the basal ganglia?

In 1991, G. Goldberg proposed a hypothesis which crudely simplified states there exist two routes which can be used for initiating motor activity. The dual system is composed of a medial tract, which includes the basal ganglia , and a lateral tract, which includes the cerebellum. The lateral tract encompasses the premotor cerebal cortex, cerebellum, and the connections between them. According to the hypothesis, the lateral tract is activated during conscious coordinated movement. Activation of this lateral tract can be helpful in reducing symptoms which are caused by a dysfunction in the medial tract, basal ganglia for example with Parkinson's disease. (Goldberg,1991) Alm (2004) has further hypothesized about the etiology of stuttering: ' The core dysfunction in stuttering is suggested to be impaired ability of the basal ganglia to produce timing cues for the initiation of the next motor segment in speech.' (Alm, 2004, s.325)

According to Foundas (2004) and Alm (2004) one can induce the brain to shift tracts by changing the auditory feedback. A large portion of the relationship between the different structures and their role in the pathogenesis of stuttering is still unknown. Nevertheless, it seems reasonable to use Goldberg's hypothesis (1991) on lateral versus medial tracts as a working model for stuttering. (Alm 2004) If that the error does indeed occur in the medial tract / basal ganglia, by activating the lateral coordinated tract, one can bypass the "faulty circuit." In such a system, it would seem reasonable to observe more fluent speech, thus establishing the basis for understanding the therapeutic effects of choral reading and auditory feedback (DAF/FAF). By fluent speech we mean speech production that is even, rhythmic and not strained (Lind 2004).

Radiology

Some degree of support for Alm's theory can be found in a recent functional Magnetic Resonance Imaging (fMRI) study done on 16 adult stutterers. Images were taken before and after Kassel Stuttering Therapy

(Giraud et al, 2007). Before treatment, the patients had increased activity in a portion of the basal ganglia (nucleus caudatus), while after successful treatment this activity was no longer present.

With the help of Positron Emission Tomography (PET) technology, support has been found for a number of etiological hypotheses of stuttering:

- Lack of development of left hemisphere dominance.

- Hyperactivity of the right hemisphere.

- Deactivation of the frontal-temporal system implicated in speech production.

- Hyperactivity of motor systems.

The hyperactivity was shown to be significantly reduced with the use of choral speech. In addition , there was a corresponding reactivation of the deactivated frontal-temporal systems. (Fox et al, 1996).

Considering that a PET scan is a picture of metabolic activity over elapsed time, we consider the functional findings of the type given above to be poorly suited for understanding the etiology of stuttering. The time that it takes from the time the dysfunction occurs until supplementary mechanisms are activated is so short that it is likely impossible with today's technology to expose the actual instant of dysfunction. The question then being; Which of the observed changes represent the point of error and which represent the brains secondary compensation mechanisms?

Dr. Chang (Schonfeld , 2007) has observed in both stuttering children and adults a reduction in white substance in areas that connect the frontal motor-speech region and the language understanding region. Dr. Chang expressed the following thoughts in Ped News (January 2007, s.34):

'Adults who stutter show the same tract abnormalities as do children, but also show asymmetry in gray-matter volume, suggesting that the gray-matter finding in adults reflect neuroplastic changes secondary to a lifetime of stuttering.'

This must be considered a significant find in that it represents an introduction of the brains plastic change in the pathology of stuttering .

Can therapy induce plastic change?

Under clinical testing of a DAF/FAF device, Henriksen and Solheim observed a technically induced spontaneous remission in a sever stuttering patient. The testing was conducted under controlled conditions at Rikshospital in Oslo Norway on November 4, 2003. Under great academic skepticism we ask; can such a remission in some cases be permanent?

In the last few years we have learned that the brain has enormous potential for plastic change throughout life, both as a result of normal learning and restitution after injury (see Dietrichs, 2007 for overview). Nevertheless it is in the first few years of life that the brain has its greatest potential for plastic change. During these years all of the important nerve tracts are being fully developed and those that are not in use are being gradually degraded. This re-modulation process is used in clinical medicine, for example in the treatment of children with astigmatism. Treatment involves a period of alternating patching of the aligned and nonaligned eyes, thus training the child to use both eyes. It is recommended this be done prior to age 7 for optimal effect. If this is not done, the brain will often suppress the vision and degrade the optic tract of the crossed eye potentially resulting in blindness.

Based on current knowledge of the brains enormous potential for plastic change and logical deduction from the empirical treatment of astigmatism, Henriksen and Solheim have developed the following hypothesis: If technical intervention against stuttering is initiated while the brain is in its most plastic phase (prior to age 7) it may be possible to induce a persistent fluency even after the device is removed. They have further theorized that technical intervention with DAF/FAF works by blocking the dysfunctional medial motor tract while activating the lateral tract. In doing so the dysfunctional tracts would be degradated during treatment. This in theory could result in a permanent fluency mediated by the lateral system.

A parallel hypothesis could be presented for evaluating the Lidcombe program's effect. An important element in the program involves the parents active participation in intervention. The parents are instructed to give direct feedback to the child (within very specific guidelines and procedures). The child is encouraged to repeat his or her utterance in a more controlled matter. According to Alms theory, the lateral system is more dominant when motion is consciously controlled. (Alm 2004) The question being can the brains plastic potential be exploited here? Can direct intervention via the Lidcombe program contribute to improved long term fluency?

There have been several effectiveness studies done on the Lidcome program with variable degrees of dependability and reliability. However, one of the more interesting studies should be considered. The study, which was randomized and controlled, was built on a considerable number of children that stuttered between the ages of 3 to 6 years (Randomexed Control Trials). The study consisted of two groups where one of the groups received intervention through the Lidcombe program. The groups were thereafter

compared and the results showed a significant difference (Jones et al, 2005)

We are of the opinion that it is important to examine as well as initiate treatment at an early age. We hope that our thoughts and hypotheses can advance professional reflection and discussion both within the fields of speech pathology and medicine. We believe that a closer interdisciplinary collaboration and more research can contribute to an increased understanding of stuttering. Our aim is to give a more evidence based , academic anchored treatment. Our fundamental goal is to provide patients that stutter the best and most effective therapy.

Referanser:

Abwender, D.A., Trinidad, K.S. et al. 1998, Features resembling Tourette's syndrome in develpmental stuttering.

Alm, P., 2004, Stuttering and the basal ganglia circuits: a critical review of possible relations, Journal of Communication Disorders 37, 2004:325-369

Christmann, H., 2007, Evidensbaseret stammebehandling, Norsk Tidsskrift for logopedi 1/2007

Comings, D. et al, 1996, Polygenetic Inheritance of Tourette Syndrome, Stuttering, Attention Deficit Hyperactivity Disorder, Conduct, and Oppositional Defiant Disorder, American Journal of Medical Genetics 67:264-288

Craig A. et al, 2002, Epidemiology of stuttering in the communication across the entire life span, Journal of Speech Language Hearing Research, 45:1097-1105.

Dietrichs E., 2007. Hjernens plastisitet – perspektiver for rehabilitering etter hjerneslag. Tidsskr Nor Lægeforen, 127:1228-1231.

Foundas, A.L. et al, 2001, Anomalous anatomy of speech-language areas in adults with persistent developmental stuttering, Neurology 2001;57:207-215

Foundas, A.L. et al, 2004, Aberrant auditory processing and atypical planum temporale in developmental stuttering, Neurology 2004;63:1640-1646

Fox, P.T. et al, 1996, A PET study of the neural systems of stuttering. Nature, 382:158-162.

Giraud, A-L. et al., 2007. Severity of dysfluency correlates with basal ganglia activity in persistant developmental stuttering. Brain Language 2007 (Tilgjengelig online i påvente av trykking)

Goldberg, G., 1991, Microgenetic theory and the dual premotor systems hypothesis: implications for rehabilitation of the brain-damaged subject. I R. E. Hanlon (Ed.), Cognitive microgenesis:a neuropsychological perspective, N.Y.: Springer.

Guitar, B. 2006: Stuttering. An integrated approach to its nature and treatment. Philadelphia: Lippincott Williams & Wilkins

Haaland-Johansen, L., 2007, Evidensbasert praksis ' av interesse for norsk logopedi?, Norsk Tidskrift for Logopedi 2/2007:5-9

Jones M.et al, 2005, BMJ, doi:10.1136(bmj.38520.451840, publisert 11. August 2005

Kloth, S., Janssen, P., Kraaimaat, F. & Brutten, G., 1995, Speech-motor and linguistic skills of young stutters prior to onset, Journal of Fluency Disorders, 20:157-170

Lindcoln, M. et al, 2006, Altered auditory feedback and the treatment of stuttering: A review, Journal of Fluency Disorders 31, 2006:71-89

Lind, M. 2004, Flyt i språkproduksjonen, Norsk Tidskrift for Logopedi I/2004

Schonfeld, A. R., 2007, Deficits, Disorganization in Speech-Control Areas of the Brain in Children Who Stutter,' Ped News, Jan. 2007:34a-34d.

Yairi, E, & Ambrose, N., 2005, Early childhood stuttering. Austin, TX:Pro-Ed, Inc.

Yairi E., 2005: On the Gender Factor in Stuttering, Stuttering Foundation of America newsletter, Fall 2005: 5

45

David's "Top Ten Pack"

Ten Pathways To Improved Speech Fluency

Here's the Top 10 things that have helped me. In reviewing, please remember my disclaimers: 1) I'm not an SLP; 2) Always put the advice and guidance of your SLP first; and 3) not all suggestions will work for everyone……..Good Luck!!!!

1. **Objectify and Analyse:** Objectify your stutter….To the extent you can, study it. Try to understand as best you can what happens when you stutter, as well as when you don't. Objectify both the physical and the emotional. Try to objectify and understand the "zone" you enter when whispering or singing or any time you speak with increased fluency, and see if you can replicate that mindset in everyday speech. It's tough, I know, sort of like being told to meditate and put everything out of your mind, and then your mind races. But be uplifted by the fact that, as the hands raised at our workshop attest, those who stutter do not stutter on all occasions all of the time.

2. **Read and Research:** Much of the literature on stuttering is complex and sometimes contradictory. But the more you know about the subject, the better. The Internet, of course, has outstanding resource material. There are many enlightening perspectives and speech exercises to be found in Google. Articles on neuroplasticity and brain elasticity can be particularly useful, encouraging and relate directly to many speech therapy interventions and fluency shaping exercises. Know and believe that your brain, your mind and your emotions and responses, can and will change over time. Your job is to manage and direct that change.

3. **Seek Difficult Speaking Situations:** De-sensitzing yourself about your stutter is absolutely paramount. You'll always be self-conscious, but you have to work to minimize your anxiety. Don't shy away from difficult situations. Ask for things in stores, ask directions, use the phone as often as possible. You may find it tough, particularly at first, but it's short term pain for long term gain. Ease yourself into it, if necessary. As I mentioned, this was the first form of therapy I took, at age 22. Standing on street corners talking to strangers was sure challenging. But it was great for me and changed my outlook and internal view of my stutter even within the first hour of activity.

4. **Speak Early In Group Settings:** When in a group, such as a meeting, classroom, seminar or whatever, try to speak as early as possible. Ask a question, ask for clarification, anything to "break your ice." You'll find this grounding and empowering. Getting into the speaking game early can be very reinforcing and will help alleviate anxiety. Why sit there terrified that you may have to speak? Slay the terror before it slays you.

5. **Fluency Shaping and Word Lists:** Make lists of difficult words, put them into sentences, and read them aloud….again and again and again. Practice, practice, practice!!!....This really helps, particularly if you employ #1 above. Do it every day you can. Memorize the sentences and say them under your breath, all day. (see my Fluency Shaping Word List included with these attachments). Hard research suggests that such repetition and hard work may be a key step in reconfiguring your neural pathways that affect and govern speech.

6. **Read Aloud:** Read out loud when you're alone as much as possible. I do this all the time, just about every day. Poetry (Dylan Thomas), Shakespeare and your scriptures of choice are great for this. Get loud. Get emphatic. Act the parts out. As emphasized in The King's Speech, realize that you have a voice! The more animated you get, you will see that you stutter less. Animation also leads to deep diaphragmatic breathing, which is crucial to improved speech patterns. Actors rely on their speaking voice and they read and speak aloud continuously. So there's got to be something to it. And believe me, there is!!

7. **Rehearse, rehearse, rehearse:** If you've got a speaking event coming up, or even a meeting, rehearse what you'll be saying out loud, and then rehearse it again. In most cases, knowing where you're going verbally will enhance speech fluency. Practice the difficult words, as in #5 above. You don't want to sound mechanical or wooden in your delivery, but preparation, where possible and appropriate, can be great tool.

8. **Speak Constantly and Often:** Speak as much as you can……Even whispering under your breath can be useful. Become loquacious. The more you speak and the more you put your voice and speaking machinery to use, the more hope you'll have for improved fluency.

9. **Stay Positive:** Easy to say, I know, but don't let the bad days get you down. Make small gains steadily and chart your progress, at least mentally. Steady improvements, and I mean over several years, can reach a tipping point, after which the gains and advances come more quickly and with greater impact. Remain true to your mission and always retain your sense of humour. Stuttering does have its humorous moments, though some days you may wonder. I'm not one to say that stuttering is a gift. But I do believe that dealing with such an issue certainly builds our character, breeds humility and teaches about human frailty and empathy. And these are good things. Very good things.

10. **Change Your Self-Image (Optional):** This is somewhat controversial and certainly complex, and is therefore suggested here only as an option. Many chronic stutterers have stuttered most of their lives. They therefore see themselves as "stutterers," "a person that stutters," and accept this version of themselves as the norm. Rightfully, they desire and expect that others will accept them as they are…..But some would argue that real personal change cannot and does not occur until there is change within, which is to say,

until a person modifies or transforms their self-image, that hidden internal mirror which reflects the person we think we are. For example, research suggests that many chronically obese people regain weight after diet programs, simply because they have an unalterable self-image of themselves as an overweight person. Likewise, many stutterers report that increased fluency can actually make them uncomfortable. We gravitate toward our self-image, both on a conscious and sub-conscious level. I only began to make key gains in my stuttering battle when I began to see myself as a person who could speak fluently, and when I began to believe in that person. Rightfully or wrongfully, I don't identify as a stutterer. I identify as a non-stutterer who sometimes stutters. This is a self-image that I've developed and honed overt time. It works for me and may work for you….One way or another, if you stay focused on 1-9 above, the self-image thing will sort itself out.

Fluency Shaping Practice List

Here's the actual list of sentences handed out to me by wonderful Brother Britton at his speech therapy course way back in 1977. You heard me recite the "m" series at the workshop. Use it often and practice, practice, practice!!

Burly Bill Bronson brought the boat back loaded with brick bats and broad boards.

Corteous Carrie caught Corrine casually chewing choice, cheap chopped cheese chips.

Dowdy Dave Dallyrimple devoured delicately designed. Delicious, dewy dew berries.

Finny flying fish, flying fast, flashed past the floundering fleet of flatboats.

Girls girded with gingham gowns. Grinned graciously at the glittering, grey geese.

Hugh Hughes of Hamilton hastily hacked the hemlock in a heavy, husky manner.

Jack and Jill jumped gaily over the jagged juniper trees growing near the junction.

Lazy listless Lester Lister laughed long and loud at the long lost lyrics.

Many men of many minds, many mice of many kinds, mixed and mingled mid the mines.

Nine hundred and ninety nine nimble nudists nonchalantly napped in the noonday sunshine.

Pretty Patricia petted the plump plumber's pretty plushy Persian pussy cat.

Quit quaking Queenie Quigley....Be quiet and quickly quarter cut the quince.

Romeo Ratcliffe ran and ripped the rod rag from off the ragged rascal's raiment.

Seven shell-shocked sailors shivered and shouted, selling shrapnel souvenirs.

Tall, talkative Tilley Thompson taught telegraphy to those ten Toronto telegraphers.

Velma Vickers visualized the vain victory of such a vaporous, valueless verdict.

Window washers, weary of winter, welcomed Wednesday's warm weather by whistling wistfully.

Yesterday the Youngsville youths yelled and yammered about the Yuletide tax.

Zelda zigzagged and zipped over the zylaphone keys with great zest and zeal.