

## Mathematical Fix | ation

By Laura Pinto

I scolded my mother for telling the Professor about her cancer diagnosis. I thought we'd agreed not to remind him of troubling things. It seemed unfair – we both knew he'd never remember that she was sick, and it might affect him in other ways. Emotional responses seemed to linger in him, even if he couldn't remember what caused them.

Five years earlier, my father the Professor received an official diagnosis of Major Neurocognitive Disorder – the modern term for dementia, intended to ease stigma among those afflicted with the wretched disease. The clouds of dementia gathered slowly, until the trauma of my brother's sudden death triggered immediate, profound memory loss and confusion. Nothing was familiar – he got lost in the only home he knew for fifty years. His recognition of family flickered. From time to time, he knew who we were, but those moments grew progressively infrequent. Though he couldn't recall if he'd married or had children, he never wavered in his identity as Professor of philosophy. I grieved when I realized I'd transitioned from his daughter to some vaguely familiar student – what's her name?

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One can hardly think about dementia without conjuring a mental image of the brain. That three-pound organ in the Professor's skull was his control center – processing, storing, and integrating information from his senses and instructing his body. He relied on it more than most in his career as an informal logician. In his final years, though, it failed him many times over. As he struggled to do things that used to come so easily to him, I imagined his brain as a nubby, tangled mess of grooves and ridges, unsuccessfully exerting itself in vain attempts to carry out the most basic functions.

I felt a desire to understand what was happening to the Professor. Medical imaging reports described structural deterioration. The outer gray matter on the surface of his brain – a layer of neurons and glial cells – atrophied and lost mass as neurons died off. The white matter, buried deep beneath and filled with long neural pathways – networks of spindly axon tracts and dendrites – progressively failed to facilitate communication among dwindling populations of neurons, the damage marked by foci or lesions in the white matter. Comparisons of the images over time revealed the advancement of dementia's assault: more atrophy, enlarged grooves and ventricles, proportional to his brain volume loss. Together, these changes were responsible for the progression of his symptoms, for the gradual fraying of this person, the one who no longer recognized me. How long before I wouldn't recognize him at all?

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The Professor had been in hospital for months recovering from pneumonia when my mother received her diagnosis. Doctors routinely predicted that he had days to live – just when we thought he had no fight left in him, he would defy medical prognostication and improve. Painful muscle contracture of the legs settled in, confining him to a hospital bed.

In spite of his condition, his state of contentment exceeded what I'd observed in several years. The hospital was familiar and recognizable to him; he had no apparent desire to leave. He didn't get lost or fall. He eagerly accepted care from nurses, and occasionally spoke about recovering, though he was uncertain how or why he was admitted.

Before my mother's diagnosis, he interacted with simple, repetitive conversations. Upon hearing the news, he withdrew and became utterly preoccupied with numbers. He became unreachable, spending every moment counting or reciting arithmetic: "One times one is one, two times one is two, three times one is three..."

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Japanese researcher Ryuta Kawashima is known for his work with dementia patients. He instructs them to perform daily arithmetic exercises aloud for six months at a time. At the end of research periods, he consistently observes improved cognitive ability. Mathematical repetition seems to awaken regions of the brain.

Kawashima's research highlights one of the remarkable features of the human brain: plasticity, or ability to re-wire itself. The neural pathways hidden deep inside white matter can replicate each other's functions, rerouting tasks along different pathways to compensate for damage or injury.

Plasticity remains well into adulthood – a person's experience and activity dictate anatomical changes to the brain. For instance, mathematicians' brains are structurally different from non-mathematicians, with higher grey matter density in the right lobe. Musicians' brain structures are directly influenced by the amount they practice. Repeating a specific activity – for example, juggling or music or math – increases white and gray matter, regardless of age or skill. Kawashima's research subjects accomplish such structural changes through arithmetic.

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Perhaps the Professor was intuitively taking advantage of plasticity. He would have activated his intraparietal sulcus – the region responsible for numerical processing and certain physical movements, especially hand-eye coordination, which he been struggling with, unable to negotiate the path of a spoon towards his mouth.

The Professor counted and multiplied around the clock for weeks. Mr. Macdonald in the bed next to him described nightly phantom lectures, during which the Professor wrote on an imagined chalkboard while reciting multiplication tables.

I was saddened at the prospect that interaction with the Professor might be limited to arithmetic for the remainder of his days. About three weeks later, his interest expanded to symbolic representation of numbers.

“One times one is what?” he asked me.

“One.”

“One what?”

“It’s a number, the number one.”

“Yes, but one what?” He seemed to understand that a number is abstract, and that it can correspond to something concrete.

I tried to explain while feeding him ice cream, “One times one bite of ice cream is how many bites?”

“One,” he said. I held up a finger.

“That’s right. So one times one is?”

“One bite.”

“Right,” I said.

He paused, then asked again. “One times one is one. One times two is two. One times three is three. One times four is what?”

“Four.”

“Four what?”

Over the next two hours, my attempts to change the subject to anything other than symbolic representation failed. After a few days, his interest shifted to simplified truth warrant statements.

One afternoon, I asked, “How are you feeling?”

“Good,” the Professor responded. “He says he feels good. But the other person says he doesn’t feel good. I have no opinion because I can’t verify either statement.”

When a meal arrived he asked, “What’s for lunch?”

“Macaroni and cheese.”

“He says macaroni and cheese is good. The other person says it’s not. I can’t verify which is true.”

“You can verify – taste it and tell me what you think,” I suggested.

“No, I don’t like macaroni and cheese.”

He continued this line of thinking for a several weeks. The warrants evolved into a simplified version of the general structure of the argument schemes – something he’d been interested in as an informal logician.

“If one-times-one person makes an argument, and one-times-two makes an argument, they finish at the same time. Is that right? The words sound right, but I don’t know.”

“If four people say something, and I’m one of the four, then three other people said it. If four people say the same thing at the same time, that must make it true.”

Around that time, the Professor became preoccupied with a series of hand-eye experiments over several days.

“If my eye equals my hand, why can’t I see it?” he asked while holding his left hand over his left eye.

He moved his hand away from his eye, and with only his right eye open he could see his hand. He demanded explanations. I wondered if his mathematic fixation somehow stimulated the intraparietal sulcus.

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Six weeks after my mother’s diagnosis and the start of the mathematical fixation, I was pleasantly surprised when the Professor greeted me with a topic other than arithmetic or logic. I entered the room, and he asked what time it was.

“You won’t believe it,” I answered, “it’s a quarter to three.”

“...there’s no one in the place, except you and me,” he sang in response, recalling “One For My Baby,” a favorite song. He continued, with mostly accurate lyrics, free-styling here and there with original rhymes – impressive for a person in his cognitive state.

From that point forward, the Professor sustained longer conversations in spite of intermittent memory lapses and delusions. For the first time in five years, he consistently recognized his wife and daughter by name.

One afternoon not long before his death, I was on the other side of the room.

“Laura?” he called out in a strong voice, with the tone he used to use to summon me from another room when I lived with my parents.

I smiled, my heart swelled to hear him call me in such a familiar way, the voice was my father, not the Professor. “Yes?”

“Laura, are you having dinner at your mother’s tonight?”

“Probably.”

“Could you give me a ride there?”

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I’ll never fully understand the specific ways in which structural changes to my father’s brain corresponded to the symptoms of dementia he displayed. Likewise, I cannot know for certain if his six-week mathematics fixation had any impact on his renewed clarity and improved memory. Or, it might have been parsimonious.

In his final months, my father and I enjoyed music together for the first time in over two years. He crooned old lyrics that I presumed had been extinguished from his memory, and moved his legs to beats. He even started singing to the nurses now and then. A neurologist opined that his short-term memory loss had made it impossible to make sense of melodies, and the subsequent frustration caused his total aversion to music. The unexplained return of some of his cognitive abilities made it possible for him to recall lyrics and enjoy music one last time.

“Let’s dance,” I said, grabbing his hand one afternoon.

We moved our arms while singing “Fly Me to the Moon.”

“...In other words I love you,” he sang to me as we finished our duet.

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**Laura Elizabeth Pinto is a writer whose scholarly work was shortlisted for the Ontario Speakers’ Book Award, and she received a Canadian Governor General’s Gold Medal, among other honors. Her creative writing has appeared in *Decomp*, *HAD*, *Sociological Review* magazine’s Fictions Series and *Tint Journal*, and is forthcoming in *The Tonic* and *Studies in Social Justice*.**

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