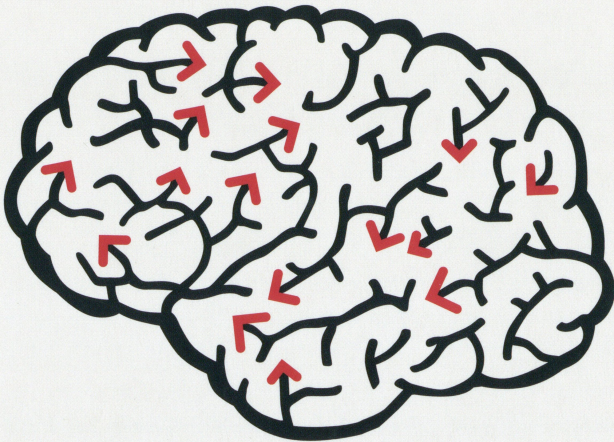


NORMAN DOIDGE

The Brain that Changes Itself



Stories of Personal Triumph from
the Frontiers of Brain Science

'The power of positive thinking finally gains scientific credibility. Miracle-making stuff'

THE NEW YORK TIMES

'Doidge has identified a tidal shift in basic science and a potential one in medicine. The implications are monumental'

PENNY WARK, THE TIMES





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'Doidge turns everything we thought we knew about the brain upside down' *Publishers Weekly*

ABOUT THE AUTHOR

Norman Doidge is a psychiatrist, psychoanalyst and researcher on the faculty at the Columbia University Center for Psychoanalytic Training and Research in New York and the University of Toronto's Department of Psychiatry, as well as an author, essayist and poet. He is a four-time recipient of Canada's National Magazine Gold Award. He is a native of Toronto.



The Brain That Changes Itself

Stories of Personal Triumph
from the Frontiers of Brain Science

*Dearest Tun Mahathir,
Happy 100th Birthday!*

NORMAN DOIDGE

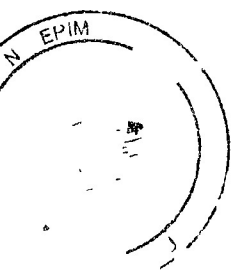
*Best wishes,
Niap Ming*

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Published by the Penguin Group

Penguin Books Ltd, 80 Strand, London WC2R 0RL, England

Penguin Group (USA) Inc., 375 Hudson Street, New York, New York 10014, USA

Penguin Group (Canada), 90 Eglinton Avenue East, Suite 700, Toronto, Ontario, Canada M4P 2Y3
(a division of Pearson Penguin Canada Inc.)

Penguin Ireland, 25 St Stephen's Green, Dublin 2, Ireland (a division of Penguin Books Ltd)

Penguin Group (Australia), 250 Camberwell Road,

Camberwell, Victoria 3124, Australia (a division of Pearson Australia Group Pty Ltd)

Penguin Books India Pvt Ltd, 11 Community Centre,

Panchsheel Park, New Delhi – 110 017, India

Penguin Group (NZ), 67 Apollo Drive, Rosedale, North Shore 0632, New Zealand

(a division of Pearson New Zealand Ltd)

Penguin Books (South Africa) (Pty) Ltd, 24 Sturdee Avenue,

Rosebank, Johannesburg 2196, South Africa

Penguin Books Ltd, Registered Offices: 80 Strand, London WC2R 0RL, England

www.penguin.com

First published in the United States of America by Viking Penguin 2007

First published in Great Britain in Penguin Books 2008

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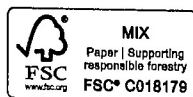
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Printed and bound in Great Britain by Clays Ltd, Elcograf S.p.A.

A CIP catalogue record for this book is available from the British Library

978-0-141-03887-2

www.greenpenguin.co.uk



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For Eugene L. Goldberg, M.D.,
because you said you might like to read it



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Note to the Reader

All the names of people who have undergone neuroplastic transformations are real, except in the few places indicated, and in the cases of children and their families.

The Notes and References section at the end of the book includes comments on both the chapters and the appendices.



Preface

This book is about the revolutionary discovery that the human brain can change itself, as told through the stories of the scientists, doctors, and patients who have together brought about these astonishing transformations. Without operations or medications, they have made use of the brain's hitherto unknown ability to change. Some were patients who had what were thought to be incurable brain problems; others were people without specific problems who simply wanted to improve the functioning of their brains or preserve them as they aged. For four hundred years this venture would have been inconceivable because mainstream medicine and science believed that brain anatomy was fixed. The common wisdom was that after childhood the brain changed only when it began the long process of decline; that when brain cells failed to develop properly, or were injured, or died, they could not be replaced. Nor could the brain ever alter its structure and find a new way to function if part of it was

damaged. The theory of the unchanging brain decreed that people who were born with brain or mental limitations, or who sustained brain damage, would be limited or damaged for life. Scientists who wondered if the healthy brain might be improved or preserved through activity or mental exercise were told not to waste their time. A neurological nihilism—a sense that treatment for many brain problems was ineffective or even unwarranted—had taken hold, and it spread through our culture, even stunting our overall view of human nature. Since the brain could not change, human nature, which emerges from it, seemed necessarily fixed and unalterable as well.

The belief that the brain could not change had three major sources: the fact that brain-damaged patients could so rarely make full recoveries; our inability to observe the *living* brain's microscopic activities; and the idea—dating back to the beginnings of modern science—that the brain is like a glorious machine. And while machines do many extraordinary things, they don't change and grow.

I became interested in the idea of a changing brain because of my work as a research psychiatrist and psychoanalyst. When patients did not progress psychologically as much as hoped, often the conventional medical wisdom was that their problems were deeply “hardwired” into an unchangeable brain. “Hardwiring” was another machine metaphor coming from the idea of the brain as computer hardware, with permanently connected circuits, each designed to perform a specific, unchangeable function.

When I first heard news that the human brain might not be hardwired, I had to investigate and weigh the evidence for myself. These investigations took me far from my consulting room.

I began a series of travels, and in the process I met a band of brilliant scientists, at the frontiers of brain science, who had, in the late 1960s or early 1970s, made a series of unexpected discoveries. They showed that the brain changed its very structure with each different activity it performed, perfecting its circuits so it was better

suiting to the task at hand. If certain “parts” failed, then other parts could sometimes take over. The machine metaphor, of the brain as an organ with specialized parts, could not fully account for changes the scientists were seeing. They began to call this fundamental brain property “neuroplasticity.”

Neuro is for “neuron,” the nerve cells in our brains and nervous systems. *Plastic* is for “changeable, malleable, modifiable.” At first many of the scientists didn’t dare use the word “neuroplasticity” in their publications, and their peers belittled them for promoting a fanciful notion. Yet they persisted, slowly overturning the doctrine of the unchanging brain. They showed that children are not always stuck with the mental abilities they are born with; that the damaged brain can often reorganize itself so that when one part fails, another can often substitute; that if brain cells die, they can at times be replaced; that many “circuits” and even basic reflexes that we think are hardwired are not. One of these scientists even showed that thinking, learning, and acting can turn our genes on or off, thus shaping our brain anatomy and our behavior—surely one of the most extraordinary discoveries of the twentieth century.

In the course of my travels I met a scientist who enabled people who had been blind since birth to begin to see, another who enabled the deaf to hear; I spoke with people who had had strokes decades before and had been declared incurable, who were helped to recover with neuroplastic treatments; I met people whose learning disorders were cured and whose IQs were raised; I saw evidence that it is possible for eighty-year-olds to sharpen their memories to function the way they did when they were fifty-five. I saw people rewire their brains with their thoughts, to cure previously incurable obsessions and traumas. I spoke with Nobel laureates who were hotly debating how we must rethink our model of the brain now that we know it is ever changing.

The idea that the brain can change its own structure and function through thought and activity is, I believe, the most important

alteration in our view of the brain since we first sketched out its basic anatomy and the workings of its basic component, the neuron. Like all revolutions, this one will have profound effects, and this book, I hope, will begin to show some of them. The neuroplastic revolution has implications for, among other things, our understanding of how love, sex, grief, relationships, learning, addictions, culture, technology, and psychotherapies change our brains. All of the humanities, social sciences, and physical sciences, insofar as they deal with human nature, are affected, as are all forms of training. All of these disciplines will have to come to terms with the fact of the self-changing brain and with the realization that the architecture of the brain differs from one person to the next and that it changes in the course of our individual lives.

While the human brain has apparently underestimated itself, neuroplasticity isn't all good news; it renders our brains not only more resourceful but also more vulnerable to outside influences. Neuroplasticity has the power to produce more flexible but also more rigid behaviors—a phenomenon I call “the plastic paradox.” Ironically, some of our most stubborn habits and disorders are products of our plasticity. Once a particular plastic change occurs in the brain and becomes well established, it can prevent other changes from occurring. It is by understanding both the positive and negative effects of plasticity that we can truly understand the extent of human possibilities.

Because a new word is useful for those who do a new thing, I call the practitioners of this new science of changing brains “neuroplasticians.”

What follows is the story of my encounters with them and the patients they have transformed.



1

A Woman Perpetually Falling . . .

Rescued by the Man Who Discovered
the Plasticity of Our Senses

And they saw the voices.

EXODUS 20:18

Cheryl Schiltz feels like she's perpetually falling. And because she feels like she's falling, she falls.

When she stands up without support, she looks, within moments, as if she were standing on a precipice, about to plummet. First her head wobbles and tilts to one side, and her arms reach out to try to stabilize her stance. Soon her whole body is moving chaotically back and forth, and she looks like a person walking a tightrope in that frantic seesaw moment before losing his balance—except that both her feet are firmly planted on the ground, wide apart. She doesn't look like she is only afraid of falling, more like she's afraid of being pushed.

“You look like a person teetering on a bridge,” I say.

“Yeah, I feel I am going to jump, even though I don’t want to.”

Watching her more closely, I can see that as she tries to stand still, she jerks, as though an invisible gang of hoodlums were pushing and shoving her, first from one side, then from another, cruelly trying to knock her over. Only this gang is actually inside her and has been doing this to her for five years. When she tries to walk, she has to hold on to a wall, and still she staggers like a drunk.

For Cheryl there is no peace, even after she’s fallen to the floor.

“What do you feel when you’ve fallen?” I ask her. “Does the sense of falling go away once you’ve landed?”

“There have been times,” says Cheryl, “when I literally lose the sense of the feeling of the floor . . . and an imaginary trapdoor opens up and swallows me.” Even when she has fallen, she feels she is still falling, perpetually, into an infinite abyss.

Cheryl’s problem is that her vestibular apparatus, the sensory organ for the balance system, isn’t working. She is very tired, and her sense that she is in free fall is driving her crazy because she can’t think about anything else. She fears the future. Soon after her problem began, she lost her job as an international sales representative and now lives on a disability check of \$1,000 a month. She has a new-found fear of growing old. And she has a rare form of anxiety that has no name.

An unspoken and yet profound aspect of our well-being is based on having a normally functioning sense of balance. In the 1930s the psychiatrist Paul Schilder studied how a healthy sense of being and a “stable” body image are related to the vestibular sense. When we talk of “feeling settled” or “unsettled,” “balanced” or “unbalanced,” “rooted” or “rootless,” “grounded” or “ungrounded,” we are speaking a vestibular language, the truth of which is fully apparent only in people like Cheryl. Not surprisingly, people with her disorder often fall to pieces psychologically, and many have committed suicide.

We have senses we don't know we have—until we lose them; balance is one that normally works so well, so seamlessly, that it is not listed among the five that Aristotle described and was overlooked for centuries afterward.

The balance system gives us our sense of orientation in space. Its sense organ, the vestibular apparatus, consists of three semicircular canals in the inner ear that tell us when we are upright and how gravity is affecting our bodies by detecting motion in three-dimensional space. One canal detects movement in the horizontal plane, another in the vertical plane, and another when we are moving forward or backward. The semicircular canals contain little hairs in a fluid bath. When we move our head, the fluid stirs the hairs, which send a signal to our brains telling us that we have increased our velocity in a particular direction. Each movement requires a corresponding adjustment of the rest of the body. If we move our heads forward, our brains tell an appropriate segment of our bodies to adjust, unconsciously, so that we can offset that change in our center of gravity and maintain our balance. The signals from the vestibular apparatus go along a nerve to a specialized clump of neurons in our brain, called the “vestibular nuclei,” which process them, then send commands to our muscles to adjust themselves. A healthy vestibular apparatus also has a strong link to our visual system. When you run after a bus, with your head bouncing up and down as you race forward, you are able to keep that moving bus at the center of your gaze because your vestibular apparatus sends messages to your brain, telling it the speed and direction in which you are running. These signals allow your brain to rotate and adjust the position of your eyeballs to keep them directed at your target, the bus.

I am with Cheryl, and Paul Bach-y-Rita, one of the great pioneers in understanding brain plasticity, and his team, in one of his labs. Cheryl is hopeful about today's experiment and is stoical but open about her condition. Yuri Danilov, the team biophysicist, does the calculations on the data they are gathering on Cheryl's vestibular

system. He is Russian, extremely smart, and has a deep accent. He says, “Cheryl is patient who has lost vestibular system—ninety-five to one hundred percent.”

By any conventional standard, Cheryl’s case is a hopeless one. The conventional view sees the brain as made up of a group of specialized processing modules, genetically hardwired to perform specific functions and those alone, each developed and refined over millions of years of evolution. Once one of them is this damaged, it can’t be replaced. Now that her vestibular system is damaged, Cheryl has as much chance of regaining her balance as a person whose retina has been damaged has of seeing again.

But today all that is about to be challenged.

She is wearing a construction hat with holes in the side and a device inside it called an accelerometer. Licking a thin plastic strip with small electrodes on it, she places it on her tongue. The accelerometer in the hat sends signals to the strip, and both are attached to a nearby computer. She laughs at the way she looks in the hat, “because if I don’t laugh I will cry.”

This machine is one of Bach-y-Rita’s bizarre-looking prototypes. It will replace her vestibular apparatus and send balance signals to her brain from her tongue. The hat may reverse Cheryl’s current nightmare. In 1997 after a routine hysterectomy, Cheryl, then thirty-nine years old, got a postoperative infection and was given the antibiotic gentamicin. Excessive use of gentamicin is known to poison the inner ear structures and can be responsible for hearing loss (which Cheryl doesn’t have), ringing in the ears (which she does), and devastation to the balance system. But because gentamicin is cheap and effective, it is still prescribed, though usually for only a brief period of time. Cheryl says she was given the drug way beyond the limit. And so she became one of a small tribe of gentamicin’s casualties, known among themselves as Wobblers.

Suddenly one day she discovered she couldn’t stand without falling. She’d turn her head, and the whole room would move. She



couldn't figure out if she or the walls were causing the movement. Finally she got to her feet by hanging on to the wall and reached for the phone to call her doctor.

When she arrived at the hospital, the doctors gave her various tests to see if her vestibular function was working. They poured freezing-cold and warm water into her ears and tilted her on a table. When they asked her to stand with her eyes closed, she fell over. A doctor told her, "You have no vestibular function." The tests showed she had about 2 percent of the function left.

"He was," she says, "so nonchalant. 'It looks like a side effect of the gentamicin.'" Here Cheryl gets emotional. "Why in the world wasn't I told about that? 'It's permanent,' he said. I was alone. My mother had taken me to the doctor, but she went off to get the car and was waiting for me outside the hospital. My mother asked, 'Is it going to be okay?' And I looked at her and said, 'It's permanent . . . this is never going to go away.'"

Because the link between Cheryl's vestibular apparatus and her visual system is damaged, her eyes can't follow a moving target smoothly. "Everything I see bounces like a bad amateur video," she says. "It's as though everything I look at seems made of Jell-O, and with each step I take, everything wiggles."

Although she can't track moving objects with her eyes, her vision is all she has to tell her that she is upright. Our eyes help us know where we are in space by fixing on horizontal lines. Once when the lights went out, Cheryl immediately fell to the floor. But vision proves an unreliable crutch for her, because any kind of movement in front of her—even a person reaching out to her—exacerbates the falling feeling. Even zigzags on a carpet can topple her, by initiating a burst of false messages that make her think she's standing crookedly when she's not.

She suffers mental fatigue, as well, from being on constant high alert. It takes a lot of brain power to maintain an upright position—brain power that is taken away from such mental functions as memory and the ability to calculate and reason.

'A wonderful and engaging way of re-imagining what kind of creatures we are'

JEANETTE WINTERSON, *GUARDIAN*

'A remarkable and hopeful portrait of the endless adaptability of the human brain'

OLIVER SACKS



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'Utterly wonderful ... without question one of the most important books about the brain you will ever read; yet it is beautifully written, immensely approachable, and full of humanity'

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'A masterfully guided tour through the burgeoning field of neuroplasticity'

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