PERSPECTIVE

The Depths of Strabismus

Susan R. Barry, PhD

Let's start by going back to a time in my childhood. It's September, 1962. John Kennedy is president, John Glenn has recently become the first American to orbit the earth, and the Cuban Missile crisis is only one month in our future.

But I am 8 years old and only dimly aware of the global situation. My main concern is the start of the new school year and beginning third grade. School is stressful for me because I read slowly and have trouble following directions. I'm constantly afraid of falling behind. But third grade starts out OK. I'm in a class with my friends. This situation did not last long.

Shortly after the school year began, the assistant principal came into the classroom. She spoke briefly to my teacher and then positioned herself in the front of the class, called my name, and asked me to stand up. She said a mistake in class assignments had been made, and I belonged in Mrs. D.'s class. She asked a boy sitting near me to drag my desk behind me as I was led out of the classroom. I just wanted to die. No one wanted to be in Mrs. D.'s class. There was something wrong with every kid in the class. Some of my classmates had physical problems – I became friends with a boy who had polio. Most had trouble paying attention, and several were completely disruptive.

My mother arranged a meeting with the school principal to talk about my classroom change. He told her that my score on standardized tests taken at the end of second grade indicated that I was of subnormal intelligence. When my mother pointed out that my second grade teacher thought I was doing fine, he told my mom that the teacher, being human, was biased while the tests were scientific and objective, and I was now in the right classroom. When my mother protested further, he said to her, and this is a direct quote, "You must face facts. Your daughter is a dim bulb."

My mother must have panicked. She snuck into the school's office after hours and stole a copy of the achievement test on which I had performed so poorly. At home, she took me down to the basement, told me not to breathe a word to my brother or sister, and gave me the test. My parents told me that I did fine.

My mother knew that the most common adaptation to a problem was not compensation; it was avoidance, and she was afraid I would avoid reading. She could not change my classroom placement, but she could teach me to love books. She read with me and to me constantly. If I expressed an interest in a particular subject, I'd discover a book about that subject on my bed when I came home from school. Her efforts worked, and by the time I finished elementary school, I had become a good reader. I still read slowly but with good comprehension. I enjoyed reading and could lose myself in a novel. Most important, I had become an autodidact. I could teach myself many things by reading books.

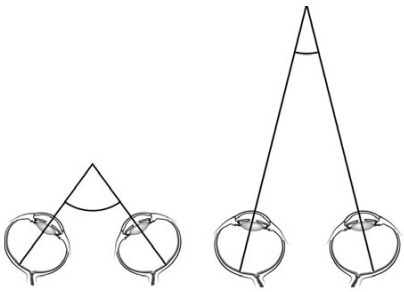
And I learned another very important lesson. I learned that my mother, normally so gentle and soft-spoken, would not only fight but break the rules for me, and she questioned the school authorities—not my intelligence. For all along, my mom did not think I was a dim bulb. She suspected that it wasn't my intelligence that was holding me back in school. It was my vision.

My parents noticed that I was cross-eyed in my first months of life. I alternated fixation, sometimes fixating with my right eye and turning in the left and sometimes fixating with my left eye and turning in the right. I had infantile alternating esotropia.

By the time I started third grade, I had had 3 eye muscle operations, at ages 2, 3, and 7. After the third operation, my eyes looked straighter. Even though I still crossed my eyes, the eye turn was much less noticeable.

Since my eyes now looked straight and I passed the school screening with 20/20 acuity through either eye, the school administrators assumed I had perfectly normal vision for reading. However, the school vision screening which tests the distance acuity of one eye at a time does not evaluate, in the least, how well a child will use their eyes together at a near distance while reading. Moreover, I had no stereopsis, no 3D vision, and this deficit affected my ability to learn to read.

But why would there be a correlation between stereopsis and reading? After all, you can read with only one eye; when you read, you are looking at a flat page, not a three-dimensional object, and you do not need to judge depth while reading. But the eye movements you make to see with stereopsis are also the same eye movements you use to read most efficiently. Stereopsis occurs when you direct the two eyes to the same place in space at the same time so that the brain receives correlated input from the two eyes.



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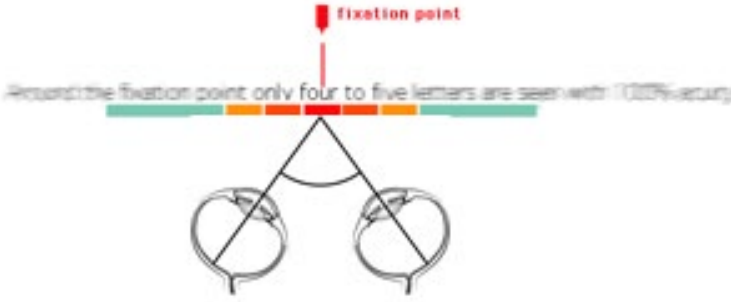
When looking at a near target, you turn in or converge your eyes so that the target's image falls on the central foveal region of both retinas and then you turn out or diverge your eyes to fixate a more distant target. These disparity vergence skills are learned within the first six months of life.

When reading, only four of five letters can be seen with optimal acuity. These are the letters seen by the fovea.

So efficient reading requires that we aim both eyes at the same place on the page at the same time. Indeed, a normal reader aims

Adapted from Hans-Werner34 at English Wikipedia

the two eyes at the same letter in a word or one letter's distance apart.[1]



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As a result, the brain is able to merge the input from the two eyes into one image leading to easy and quick identification of the word. After a fixation period of about one quarter second, the efficient reader makes a small conjugate saccade which brings the two eyes about 7 to 9 characters further along the line. Again, the eyes land on the same letter or about one character apart, and any small disparity between the two eyes is easily handled by the brain.

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However, a person, like me, with a constant strabismus, makes poor disparity vergence movements or no disparity vergence movements at all. The two eyes do not point to the same place on the page.

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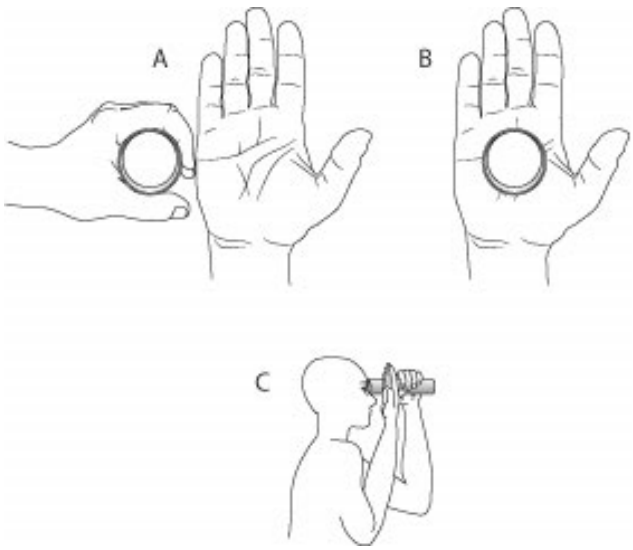
The same may also be true for people with other binocular disorders, such as strabismic amblyopia and convergence insufficiency.

The information from the two eyes is conflicting. What then do

you see if the two eyes are pointing at different letters and bring this conflicting input to the brain?

This can be demonstrated with what is known as the hole-in-the-hand experiment. Take a sheet of paper and roll it up lengthwise so that it creates a tube that's about the diameter of a paper towel tube. Put it in front of your right eye and look through it as if you were sighting through a telescope. Take you left hand, with you palm facing toward you, and place it alongside the tube toward the far end. The edge of your palm should be touching the edge of the tube. When you look into the distance, you should have the appearance of a hole in your hand.



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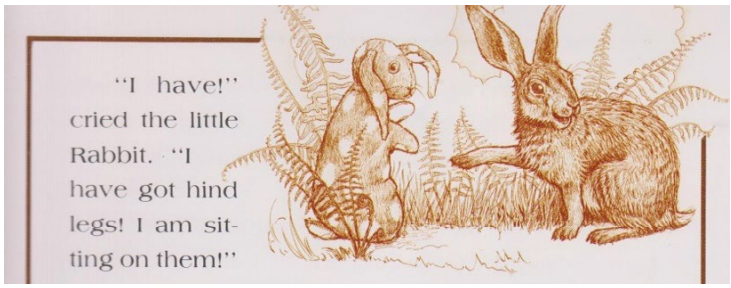
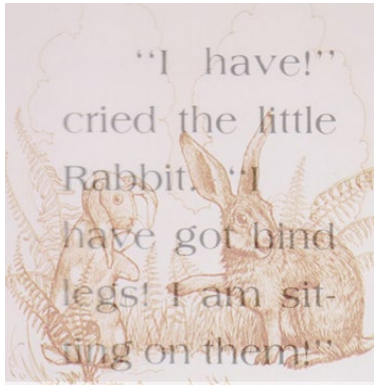
The visual confusion your brain experiences with the hole-in-the-hand experiment creates the type of confusion that I experienced when I read. Here, for example, is a page with words on the left and a picture on the right:



But when I read, my left eye would turn in to see the picture, so I would see the words and picture overlapping:



Or words would overlap, double, and blink in and out:

Can you read this?

And you can see how visual confusion would make filling out the answers in a standardized or "bubble" test harder. The circles appear to drift, so that the circle you actually fill in may not have been the one you intended.

With my mother's encouragement, I became a good reader. Like many with strabismus, I adapted to the situation by reading with one eye and suppressing the other. But suppressing the input from one eye takes time and effort.

Indeed, when a study was done on reading in children, like me with strabismus, it was found that children with strabismus made fixations that last about 35 % longer than children with normal vision.[2] When they made saccades from word to word, their two eyes did not land on the same letter or within a distance that is only one or two letters apart. The eyes landed several letters away making it harder or impossible to merge their images and identify words. These results were found despite the fact that the children in this study had normal 20/20 acuity with each eye.

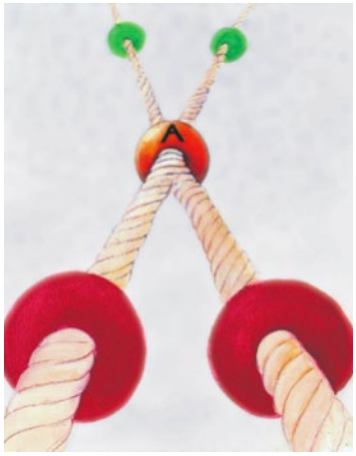
Reading is an endurance activity. As we advance into the higher grades in school, the print gets smaller, and we must read for longer and longer periods of time. So evaluating a child's ability to read one paragraph doesn't tell you how well a child can sustain reading.

And anyone with a binocular vision problem, such as strabismus, amblyopia, or convergence insufficiency, will expend extra effort to read and understand.

Now, fast forward 40 years. My gaze has become increasingly unstable, and driving is difficult and frightening. So I consult an optometrist in my hometown, Dr. Steven Markow, who thinks I might benefit from vision therapy and refers me to Dr. Theresa Ruggiero, a developmental optometrist. Dr. Ruggiero guides me through vision therapy, a set of procedures that taught me what most people learn in the first months of life: how to aim both eyes at the same place in space at the same time.

How was I going to learn how to direct both eyes to the same place in space?

I did not know where my two eyes were pointing. I needed a conscious form of feedback to redirect my eyes, and this was provided by several vision therapy tools, including the Brock string. The Brock string is only one of the many tools I used, but it was my favorite.



The Brock string is as elegant a tool as it is simple because, as you fuse a bead on the string, the resulting double sting image shows you the line of sight of each eye.

At first I could only fuse one bead on the string very close up, but, with practice, I was able to fuse the bead after moving it further away. Let me tell you what happened when I first worked with two beads … I'll never forget that vision therapy session … As I fused the closer then further bead, I COULD FEEL MY EYES MOVING! I could feel them converge on the closer bead and then diverge to fuse the further one. I was in control of what my eyes were doing. Learning this new binocular skill was accompanied by an empowering feeling – one that I needed to remember and recapture every time I performed the task.

The sun was setting as I left Dr. Ruggiero's office after that long session with the Brock string. I got into my car, sat down in the driver's seat, and glanced at the steering wheel. The steering wheel was floating in its own space, with a palpable volume of empty space between the wheel and the dashboard. That I could see, not just infer, that volume of empty space astonished me. This was my first view with stereopsis, and it occurred one day after my 48th birthday, more than 40 years past the presumed critical period for stereovision.

Over the next couple of months, as I worked diligently on my vision therapy, space inflated, expanded, and unfolded. The world began to pop out at me. I could see the volumes of space between falling snowflakes and how the outer branches of trees enclosed and captured pockets of space through which the inner branches penetrated.

Learning disparity vergence, pointing the two eyes at the same place at the same time, not only gave me stereopsis but made reading more comfortable. I could read for longer periods without experiencing visual confusion or fatigue, or constantly rereading the same line. I could work on the computer for longer periods of time.

My early school years would have been considerably easier and less traumatic if the medical and educational professionals had recognized how important normal binocular

vision skills are to reading and school performance. Indeed, my experiences taught me that all children should have a thorough binocular vision exam before beginning school and then receive lenses, prisms, vision therapy, or any other treatments they might need. That would not only conserve resources for remedial classes, but it would save a lot of children from the needless heartbreak and emotional scars of being misclassified and mislabeled.

But there was one more very important lesson that I learned from my vision therapy. When I first consulted Dr. Ruggiero in my late forties, and she performed the cover test and other exams on me, I felt exactly like the little girl in my surgeon's office – the little girl who had no control over her eyes and had to go the hospital and have operations just to look normal. Yet, the day I felt my eyes moving to fixate different beads on the Brock string, I took control of my own vision. I learned that I was not a victim of a visual fate sealed in infancy. With help and guidance from my developmental optometrist, I could fix a problem that had always hounded me. I could change my own vision.

If that's not a life-affirming and life-changing experience, then I don't know what is.

Editor's Note: This perspective is adapted from a talk presented by Susan R. Barry, PhD, at Optometry's Meeting, the annual meeting of the American Optometric Association, in 2016. It is available online at:

https://youtu.be/_JcQV1Y9SgI

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