

Strange lessons

Having half your brain surgically removed is bound to leave you horribly disabled – or does it? Two active teenaged boys, one with just a right cerebral hemisphere and the other with a left, are challenging ideas about how the brain works and the role of emotion in learning. **Mary Helen Immordino-Yang** explains how the boys may help transform the classrooms of the future

NICO is a charming and sociable teenager from Argentina who loves fencing, singing in his school choir, and drawing cartoons. He rushes, smiling, to kiss my cheek whenever we meet, chatting animatedly about the drawings he has brought me. A few years older, Brooke is a friendly and witty young man who radiates positivity. He settles comfortably into a chair in my office, leisurely sipping a Coke and ready to try my latest battery of tests. He recently graduated from high school, and enjoys his job bagging groceries at a local supermarket.

They both look like ordinary teenagers, but peer inside their heads and you will find they are anything but. At the age of 3, Nico had his right cerebral hemisphere removed to control severe, intractable seizures. Brooke had his left hemisphere removed at 11 because he was suffering from Rasmussen's encephalitis, an autoimmune condition in which the body begins attacking the brain.

Amazingly, despite the cognitive challenges associated with the removal of a brain hemisphere, Nico and Brooke have compensated for their extensive brain damage to an unexpected degree. Such cases are rare, and the boys' recovery may owe much to the peculiarities of their brains before surgery as well as to encouragement they received from their families and teachers. Even so, the amazing way the boys have

compensated demands further exploration.

As all good teachers know, to get the most out of any child, they must tap into the child's strengths, using those to offset weaknesses. Just how to do this, though, is a perennial question. But now cognitive neuroscience is offering a new tool, one that lets us rethink the biological constraints and possibilities of learning, the relationship between strengths and weaknesses, and even wonder about the general social implications of cognition. We can begin to ask: how does the brain change in response to experience? Is there any evidence that the person doing the learning can take an active role in this neural plasticity? And what part do emotion and social interaction play in shaping or driving plasticity?

With Nico and Brooke, two things intrigued me. How were the boys doing what they ought not to have been capable of doing? And while I knew better than to expect them to have similar strengths – after all, they could be said to have “opposite” neurological hardware – I did wonder about commonalities in the logic of the way they had learned to compensate. Might such commonalities point to basic principles we could test with “typical” children, and help us reshape education?

So when I studied the boys I chose to concentrate on skills thought to require both brain hemispheres, and to involve both cognitive and emotional components, something we call affective prosody – the non-linguistic intonation that conveys emotion through the melody of speech.

Try reading aloud the following exchange:

Person A: “I'm going to Timbuktu.”

Person B: “YOU'RE going?”

Person C: “You're GOING?”

Clearly, both B and C are incredulous about A's plans: B thinks either that someone else should go, or that A in particular is not fit to



go, while C had been under the impression that A had previously decided not to go. These nuances of meaning and emotion are conveyed through intonation and other cues, such as the facial expressions of B and C.

In most adults, the syntactic and semantic aspects of language are mainly localised to the brain's left hemisphere, while affective prosody and its associated skills are mainly handled by the right hemisphere. For someone to be able to say those sentences above in the ways intended, the two hemispheres must have integrated very early on. How would Nico (missing the intonation hemisphere) and Brooke (missing the syntax and words hemisphere) understand and produce vocal intonation, such as “YOU'RE going?”

I tested both Nico and Brooke, using everything from simple discrimination and identification of pitch patterns in speech to complex descriptions of sarcasm versus sincerity in naturalistic exchanges and stories. The results were startling. As I expected, the boys performed differently from each other. Nico was fantastic at discriminating pitch

Profile

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Could new information on how the brain learns shape the way we teach our children?

neuropsychological strategy. I designed these tasks to build in difficulty, but I had failed to realise that removing the pitch from its social context made things more difficult for Brooke. He often mused on the speaker's emotions in the discrimination task, for example, although emotion was not relevant to solving the problem of matching pitch.

It seemed to me that the boys were highly motivated, largely because engaging in social interactions was very important to them. Yet they seem to have changed the problem to suit their strengths and emotional tendencies more than they changed their strengths to suit the problem. It made me wonder if we all do this to a less dramatic extent, and if teachers could capitalise on it.

Research on Nico and Brooke produced remarkable findings about their ability to acquire skills that ought to have been "domain-specific" and localised to particular brain networks. While much work is being done to work out how typical brains learn domain-specific skills such as reading, mathematics, or pitch discrimination, we also need to understand how domain-general neural systems – for example, systems for social emotion – function to promote learning and neural plasticity. These domain-general systems are fascinating because they remain hooked to basic homeostatic systems such as those that control blood pressure and heart rate, yet they have evolved to support complex, subtle thoughts and behaviours that reflect culture, context and individual predispositions.

As we discover more, a bigger picture still may emerge. Much as economic principles predict the workings of dynamic, complex cycles of trade and the availability of goods and services in order to predict and stave off recessions and resources wars, the dream is to find principles of learning, grounded in biology and shaped by culture and experience, that have implications for teaching children to get along in the modern world. ●

and matching it to melodies while Brooke was strikingly bad. Brooke, meanwhile, was fabulous at recognising sarcasm, while Nico was competent but seemed at a loss to say how sarcasm, even when it was flagged up, changed a story's outcome.

After careful comparison with their peers, a more subtle, interesting pattern emerged. People who speak tonal languages, such as Mandarin Chinese, use the right hemisphere to handle affective prosody, while the left hemisphere handles the pitch cues indicating

differences in word meaning. Might Nico be using such a strategy, but for emotional information? Might he handle a sarcastic tone more like a grammatical category than an inherently emotional cue? This would explain his high performance on identification, coupled with a poor ability to infer emotional meaning.

In a complementary fashion, Brooke's inability to simply discriminate and label pitch cues independently of their social and emotional context may reveal his

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