

The Stories of Nico and Brooke Revisited: Toward a Cross-Disciplinary Dialogue About Teaching and Learning

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ABSTRACT—In “A tale of two cases: Lessons for education from the study of two boys living with half their brains” (M. H. Immordino-Yang, 2007), I showed that Nico (missing his right cerebral hemisphere) and Brooke (missing his left) had compensated for basic neuropsychological skills to previously unexpected degrees and argued that the ways they had compensated revealed general principles about the active role of the learner and the organizing role of emotion and social interaction in development. Here, I briefly review my findings and interpretations of that work as background for readers to engage in the cross-disciplinary conversation that follows in this journal issue.

In current views of education, neuroscience is coming increasingly to inform educators’ understanding of how children’s strengths, weaknesses, and preferences are shaped by their experiences and constrained by their biology. However, although this new interdisciplinary approach presents an unprecedented opportunity to explore and debate the educational implications of neuropsychological research, a good model for dialogue between educators and neuroscientists is lacking. In the exchange that follows, our aim is to take tentative strides toward remedying this situation by bringing together the responses of colleagues from various related disciplines, including neuroscience, computational modeling, human development, and education, around the interesting

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cases of two high-functioning hemispherectomized boys. In the end, we hope that this discussion will both contribute new insights into the nature of learning in educational contexts and spur similar debates around other educationally relevant applications of neuroscience.

The purpose of my original study of Nico and Brooke and their peers was to discover whether and how these hemispherectomized boys were compensating for abilities that normally require the recruitment of their missing hemispheres (Immordino-Yang, 2007).¹ To test this, I chose a domain of skills that involves both cognitive and emotional components (Immordino-Yang & Damasio, 2007), as well as bilateral processing in the brain: affective prosody, also known as the melody of speech. I examined both the boys’ comprehension of affective prosody in other people’s recorded speech and their spontaneous production of prosody in their own naturalistic speech. For comprehension, I designed a battery of tests that moved from basic discriminatory measures of pitch in language to socially relevant and contextualized judgments of affective prosody (to express sarcasm vs. sincerity) in short vignettes. For production, I analyzed the hemispherectomized boys’ spontaneous speech during the testing session, as they described their thoughts about the characters’ use of sarcasm in the vignettes. Throughout the study, I refrained from comparing Nico and Brooke directly, as there are many differences between these boys’ histories. Instead, I compared each boy’s performance to that of a group of matched peers and then juxtaposed the resulting profiles. Careful study of such rare boys’ cognitive and emotional skills compared to those of their matched peers could lead to new insights about the nature of the brain–experience relationship, because it may reveal principles about how neuropsychological strengths and weaknesses play out in development and learning, in both typically and atypically developing

children. In other words, although I expected there to be substantial differences between Nico and Brooke based on their neurological profiles, the principles governing their compensatory processing ought to show similarities that reflect the active role of the learner in recruiting relative strengths and overcoming weaknesses.

Overall, I found that each of these boys could understand and produce affective intonation in speech despite predictions to the contrary based on prognoses from brain-damaged adults. However, careful comparison to the performance of their peers revealed that although Nico and Brooke had managed to build skills that should have been “impossible” for them to accomplish, each appeared to be functioning in a way that was different from that of their peers and that recruited their remaining neurological strengths. That is, each hemispherectomized boy appeared to have transformed the very nature of the prosodic processing problem into a new kind of problem that suited the neuropsychological strengths of his remaining hemisphere. This transformation of prosodic processing into a new sort of cognitive problem appeared to be organized by the boys’ emotional profiles and to reflect both their supportive educational histories and their intense desire for effective social interaction.

Specifically, although Nico is missing the hemisphere that is normally recruited for the processing of melody both in speech and in music, I found that he performed as competently as his peers on tasks involving melodic contour perception in speech and the perception and identification of orally presented sarcastic tone of voice. In addition, frequency analyses of the profiles of pitch contours Nico used in his own spontaneously produced speech were surprisingly similar to those from the speech of his neurologically normal matched peers despite predictions from the literature on right brain-damaged adults, who tend to speak monotonically and with insufficient prosodic range. In probing Nico’s strategies, it became apparent that prosodic processing for him was not solved by emotionally evaluating speakers’ tone, the heavily right hemisphere-dependent strategy that his peers appeared to use. Instead, Nico seemed to have developed a strategy that capitalized on the linguistic categorization strengths of his remaining left hemisphere. That is, he developed a skill for discriminating and classifying typical melodic speech patterns as either sarcastic or sincere, probably based on the contour of their respective melodies. This approach enabled him to label the emotional category of utterances by their pitch contours and to produce relatively normal sounding speech, two skills that he ought not to have been able to accomplish. At the same time, his unique strategy left him relatively unable to draw inferences about the emotional outcome of the vignettes.

In a complementary fashion, Brooke’s ability to use and understand affective prosody defied prediction based on findings with left brain-damaged adults, whose use of melody and intonation is reportedly unaffected. Here, I found that

Brooke often produced too much intonation in his spontaneous speech, exaggerating the rises and dips used by his peers. Despite his good recovery of other language skills, such as grammar and vocabulary use, he was impaired on tasks of basic perception of pitch contours, which I had designed to test the underlying perceptual skills necessary for prosodic comprehension in conversational contexts. Yet, he performed better than his neurologically normal matched peers on comprehending sarcastic tone of voice in naturalistic vignettes. How could this be? By standard wisdom, Brooke ought not to have been able to accomplish complex conversational recognition of sarcastic tone of voice without good performance on the lower level component skills embedded in the higher level task.

The answer belies Brooke’s heavily right hemisphere-dependent and socially contextualized strategy, which could be seen as a complement to Nico’s strategy described above. Unlike Nico, Brooke appeared to be using a heavily emotional strategy to solve the prosodic processing problems. He mused over the emotional implications of the prosody, sometimes even repeating back the utterance with different emotional tones and relating each rendition to a social and emotional context. As the right hemisphere is normally heavily implicated in the production and comprehension of emotional melody in speech, I suggested that Brooke had recruited his emotional and prosodic strengths in the processing of all prosodies whether or not emotional implications were relevant. This strategy left him impaired at simple discrimination of melodies, for which emotional context is not relevant, but better than his peers at the comprehension of emotional speech tone in complex socially relevant contexts.

Clearly, both these boys’ performances defied neuropsychological prediction; each had compensated for basic skills that, by standard wisdom, they ought not to have been able to accomplish. How were they doing this, and what could be learned about the nature of development and compensation in normal children, each of whom present with a neuropsychological profile of relative strengths and weaknesses? No one is equally talented at everything—to effectively learn and live in a complex, messy, and unpredictable world, each of us (and each of our students) by necessity engage in dynamic interactions with the social and physical worlds, grappling with the internalization and processing of the problems we perceive and creating cognitive, emotional, and behavioral responses. Any competent educator knows that there is enormous variability in the ways children learn and grow and that this variability reflects, among other things, a child’s profile of relative neuropsychological strengths and weaknesses, as well as the sociocultural context in which the child is constructing knowledge. But how can exceptional cases such as those of Nico and Brooke help us differentiate these factors further to understand more about the dynamic relationships between children’s experiences, brain development, and learning?

In essence, I argued that each of these boys had accomplished a good skill level in conversational speech by recruiting his processing strengths. This meant that each boy transformed the nature of the task into a new one that suited his strengths, more than he adapted his strengths to suit the task, as it is typically perceived. Furthermore, I argued that the boys' transformation of the task was heavily organized by their emotional predispositions, as well as by the sociocultural contexts in which they were developing. That is, Nico, with his relatively unemotional left hemisphere, settled on a more cognitive categorical strategy for processing the linguistic aspects of social communication, whereas Brooke, with his relatively emotional right hemisphere, settled on a heavily emotional strategy. Furthermore, both boys' motivations to comprehend and produce affective prosody reflected their desires to engage effectively in the social context. They wanted to talk and be talked to, and they wanted to accomplish this in a culturally and socially appropriate manner.

In the commentaries that follow, my colleagues provide interesting interpretations and critiques of the work with these boys from the perspectives of their various disciplines (Ablin, 2008; Christoff, 2008; Snow, 2008; van Geert & Steenbeek, 2008). Building from these insights, I then propose in my response to the commentaries a further differentiated theory about Nico's and Brooke's development and suggest that these boys' compensatory skills reflect the complementary processes of perception and action as they converge in association areas of the brain (Immordino-Yang, 2008).

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NOTE

1 Hemispherectomy refers to a surgical procedure in which one cortical hemisphere of the brain is removed or functionally disconnected to control severe and intractable epileptic seizures.

Both boys and their families asked that they be identified by their real first names.

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