Neuroscience Meets Reading Recovery

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Introduction
In a previous article (Raban, 2014), it was reported that developmental scientists argue that “knowledge from brain research does not lead to any specific or particular outcomes for education at this time” (p. 46). As Bruer (1997) points out, neuroscience is still in its infancy and while the bridge between education and cognitive psychology has a long tradition, the bridge between education and neuroscience is a more recent endeavor and less well developed. This discussion reviews current understandings of interesting implications of neuroscience for teachers of literacy and links these understandings to instructional suggestions offered by Marie Clay in the 2016 second edition of Literacy Lessons Designed for Individuals. (Unless otherwise noted, all Clay citations refer to this 2016 publication.)

Overview and Perspective
At the University of Chile in March 2007, 145 developmental scientists met to discuss recent issues of neuroscience. The outcome of this meeting, referred to as The Santiago Declaration, was signed by all participants and states: “Neuroscientific research, at this stage in its development, does not offer scientific guidelines for policy, practice, or parenting. Current brain research offers a promissory note, however, for the future.”

During the years that have followed, there have been many continuing misconceptions concerning the links between neuroscience and education (Alferink & Farmer-Dougan, 2010). These misconceptions are typically referred to as neuromyths by the Organisation for Economic Co-Operation and Development (OECD) (2002, p. 71; 2007.) (Also see Center for Educational Research and Innovation (CERI) website; Howard-Jones, 2014; Geake, 2008).

In addition, Howard-Jones (2008, 2014) and Dekker and colleagues (2012) identify the extent to which teachers hold misunderstandings about the brain and how it can affect teaching and learning.

One such misunderstanding is that the first 3 years of life are critical and decisive for later development and success in life, a view challenged by Barinaga (2000). More recently, words like decisive and critical periods have given way to understandings about sensitive periods (Bruer, 1999a, 2006; Bailey, Bruer, Symonds, & Lichtman, 2001). This change in vocabulary choice places less emphasis on when and more emphasis on how experiences impact the early years.

In further considering how experiences impact learning, Zull (2011) argues that the transformation of experience into knowledge is a process—not a single step—and that reflection (through appropriate feedback) is a search for connections between experiences and understandings. Marie Clay makes this apparent in terms of literacy learning as she describes theory and instruction addressing how the young learner’s brain constructs neural networks and how strategic activity is developed, leading to increasingly sophisticated, successful literacy processing over time. Throughout her book, Clay elaborates how:

The goal of teaching is to assist the child to construct effective networks in his brain for linking up all the strategic activity that will be needed to work on texts, not merely to accumulate items of knowledge. (p. 41)

By this means he is extending his own literacy learning and is building his own neural networks to support continuing progress. (p. 44)

Although there are many who suggest that we need to be cautious concerning the links between neuroscience
and knowledge about the brain with teaching and learning, there are some things we are becoming clearer about (Carew & Magsamen, 2010; Anderson & Oliver, 2012). For this discussion, 10 of these clearer pieces of information are presented. They focus, in particular, on the ways in which what we now know about the brain are observed in Clay’s Reading Recovery instructional practices. These 10 concepts are discussed individually with direct references to Reading Recovery instructional procedures.

Linking Understandings of Neuroscience to Reading Recovery

1. More information doesn’t mean more learning.

The brain is equipped to tackle large amounts of information and sensory input, but there is a point at which the brain becomes overwhelmed, an effect scientists call cognitive overload (Torcasio & Sweller, 2010; Sweller, 2016). The discovery of this cognitive phenomenon has major implications for our work as teachers. In order to reduce mental noise, we have to approach the presentation of ideas and activities using techniques like focusing on past experiences and making links with what the child already knows, rather than ignoring what they bring with them into our school settings.

Clay points out that the initial lessons, referred to as Roaming Around the Known, provide a critical time for Reading Recovery teachers to discover these aspects of each child they work with. The teachers then plan instruction with each learner’s unique history, level of language development, stores of knowledge, and cultural understandings in mind. (See Roaming around the known, pp. 29–34.) Teachers tend to provide much information through talk; however, Clay cautions that teachers often “underestimate how complex children find . . . the things that teachers say” (p. 162). Resultantly, children are confused by teachers’ talk and learning is diminished. To avoid this, she recommends teachers demonstrate in place of complex verbal explanations, and thus, Reading Recovery teachers model actions for the child often and they avoid talking about their actions. A few examples found in Clay’s procedures include instruction addressing learning about directional movement (p. 52), acquiring appropriate matching behaviors (p. 56), forming letters (p. 65), breaking letters out of words (p. 73), using Elkonin boxes in writing (p. 97), and reassembling a cup-up sentence (p. 107), among others.

Even in the context of reading continuous text, Clay argues that Reading Recovery teachers should not waste words. They should, of course, “commend the child for good work on processing print, praise to boost morale . . . BUT eliminate all unnecessary talk” (p. 119). (See pp. 67 and 199 for more detail.)

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2. The brain is a highly dynamic organism.

Until the past few decades, people believed that the connections between the neurons in the brain were fixed by the time children left high school, and perhaps even earlier. One of the biggest breakthroughs in understanding the science of learning happened when scientists began to realize that this just wasn’t the case (Kolb, Gibb, & Robinson, 2003). In fact, the brain’s wiring can change at any age and it can grow new neurons and adapt to new situations, though the rate at which this happens will slow with age (Doidge, 2007; Park & Reuter-Lorenz, 2009). This plasticity does not increase the brain’s underlying capacity; it simply means the brain has the capability for change (Kolb & Whishaw, 1998) and for the expansion of knowledge and learning until late old age (Burke & Barnes, 2006), yet this is a common misinterpretation.

Clay draws our attention to the work of Larry Squire, quoting: “We know now that the brain goes on developing and that its formation is impacted by learning and remembering” (p. 231). Clay reminds us that there are different sources of information in print to learn about and new connections in the brain have to be made, linking information through
the eyes to information from the ears to what we already know about language and how the world works. The learner’s active brain is rapidly crossrelating all this information and making decisions about what works by mapping past experiences with the new experience and making it make sense. It is the nature of the brain to move with urgency from early slow processing to fast processing on things the brain can recognize, which leaves space and time for slower processing on the things the learner does not yet fully know. It seems likely that if the learner develops faster responses racing around the neural circuits in his brain, this will make reading more effective.

On texts of an appropriate level of difficulty, during a Reading Recovery lesson the child can

- monitor his own reading and writing;
- search for information in word and letter sequences, and in meanings;
- discover new things for himself;
- cross-check one source of information with another;
- repeat as if to confirm his reading or writing so far; and
- self-correct to solve problems. (p. 43)

In *Becoming Literate*, Clay (1991, 2015) refers to this process as “building a network of strategic activities” (p. 362) resulting from appropriate literacy learning experiences and leading to the building of more-complex strategies. In effect, “[a]s children work on simple texts they solve complex problems and become able to read slightly more difficult texts” (Clay, 2016, p. 127).

3. Emotion influences the capability to learn.
The ability to learn, retain, and use information isn’t just based on our raw IQs. Over the past few decades it has become increasingly clear that how we feel and our overall emotional state can have a major impact on how well we can learn new things (Clore & Huntsinger, 2007; Immordino-Yang & Damasio, 2007; Hinton, Miyamoto, & Della-Chiesa, 2008). Educational (and family) situations where children feel stressed, shamed, or just uncomfortable can actually make it more difficult for them to learn, increase negative emotions, and spark a vicious cycle that may leave some reluctant to even attend school.

When under stress or anxiety, the brain blocks access to higher processing and stops forming new connections, making it difficult or impossible to learn. This is discussed quite vividly by Tough (2013) who explores the impact of stressful lives, both physiologically and psychologically, on children’s ability to learn in school. Likewise, Greenspan’s research (cited by Lyons) “shows that when an infant is confused, senses disapproval, or feels anxiety or stress, there is a psychological and physiological reaction in the brain that inhibits processing” (Lyons, 2003, p. 60). It may seem like common sense that classrooms should be welcoming, non-stressful environments, but different children have different triggers for negative emotional states, making

Emotions are the brain’s primary architect, and teachers can read emotions. Emotions are at the heart of learning and remembering. Because of this, learning is not solely a cognitive process. Emotions are essential to thinking and are an inseparable part of the learning process.
the emotional or affective reaction to the experience, both of which will be coded together in the brain” (Lyons, 2003, p. 61).

Children who have positive experiences while being taught to read and write are more likely to confidently try different ways to solve the problems they encounter. Thus, Clay reminds Reading Recovery teachers that reading “several familiar books provides an enjoyable start to the lesson and encourages confidence and a feeling of being in control” (p. 111). (See Familiar reading, pp. 111–112.)

Children who continually experience failure are more likely to wait for the teacher to tell them what to do and ‘silence to an unknown word’ is a common response. Clay invites Reading Recovery teachers to give the child liberal praise for any attempts that move his behavior closer to what is required, bolster his confidence and while it is alright to be negative about unwanted responses, she asks teachers to be “charmingly negative” (p. 183).

4. **Mistakes are an essential part of learning.**

Failure is a negative word in most aspects of modern society, but when it comes to the science of learning, research shows that failure when experimenting is essential. A recent study (Autin & Croizet, 2012) found that children performed better and felt more confident when they were told that failure was a normal part of learning, and their study results are bolstered by a growing body of research pointing to similar findings. Much like it takes multiple tries to get the hang of riding a bike or completing an acrobatic feat, it can also take multiple tries to master learning tasks like reading and writing.

Neuroscience research suggests that the best way to learn something new isn’t to focus on mistakes but instead to concentrate on how to do a task correctly, what to do to get it right, and this may well be different for different learners. (See Teaching after the second reading, p. 121).

Whenever a mistake reveals the reappearance of an inappropriate behavior, Clay stresses the need for the teacher to intervene “to prevent the occurrence of an old unwanted response” (p. 61) not giving “an old bad habit any chance to recur when you are trying to eliminate it” (p. 61). Sort out confusions, of course, but Clay asks Reading Recovery teachers not to become trapped by the detail of an error, but to focus on successful processing. (See When strong skills block learning, pp. 92–93.)

There are additional cautions to consider. Paying attention to a mistake or error only reinforces the existing incorrect neural pathway and will increase the chance that the mistake will be made again. (See Research, pp. 1–10.)

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A new pathway has to be built, which means abandoning the old one as a different approach is developed for solving problems. For instance, show children: “You do it like this,” thereby focusing on potentially successful strategic action.

When Clay states that Reading Recovery “sets the highest value on independent responding” (p. 41), she acknowledges that this involves the risk of error. “Any theoretical position that includes self-monitoring and self-correcting as significant behaviours in reading or in writing implies the existence of near misses, approximations, uncorrected responses and sometimes corrected responses” (p. 41). “The important thing about self-corrections is that the child initiates them because he sees that something is wrong and calls up his own resources for working on a solution” (p. 139). A teacher who allows only for correct responding would not be supporting the child to explore the strengthening potential of self-correcting behaviors. (See Self-correcting, p. 139.)

5. The brain needs novelty.
It turns out that boredom really can undermine productivity and will lessen your will to pay attention and to learn (Bench & Lench, 2013; Willis, 2014). Repetition may have some place in learning, but what the brain really craves is novelty. Researchers have found that novelty causes the dopamine system in the brain to become activated, sending the chemical throughout the structure (Kyeong, Kim, Park, & Hwang, 2014).

While we often regard dopamine as the “feel good” chemical, scientists have shown that it actually plays a much bigger role, encouraging feelings of motivation and prompting the brain to learn about these new and novel stimuli (Balci, 2014). This breakthrough has led to some major changes in how we think about learning and has motivated many schools to embrace learning methods that cater to our brains’ need for new and different experiences.

Parts of the brain—referred to as the limbic system—can either facilitate or shut down the processing system if it fails to find some kind of challenge. Evidently, detecting novelty and seeking reward are two primary sources that determine where we focus our attention. Children who have positive...
Research

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6. There are no learning styles.

What kind of learner are you? Chances are that at some point during your educational career someone labeled you as a particular type of learner — either visual, auditory, or kineasthetic. This idea that there are distinct types of learners who learn best with a certain assortment of stimuli has been showing up in education and brain science for decades (Corballis, 2012; Coffield, 2013); but, studies have shown that this idea really doesn’t hold up to scrutiny (Pashler, McDaniel, Rohrer, & Bjork, 2009). Children may have preferences for how they learn but when put to the test, children were found to have equivalent levels of learning regardless of how information is presented to them (Hattie, 2012, p. 79).

Attention to the individual talents, preferences, and abilities of children, which helps create novelty and caters to their emotional and social needs improving their ability to learn, is more important than styles — of which there have been over 70 different models during the past few decades (Coffield, Moseley, Hall, & Ecclestone, 2004). According to Susan Greenfield (2000), the practice of separating out students on the basis of their learning style is “nonsense” from a neuroscientific point of view. Greenfield shows how humans have evolved to build a picture of the world through the senses working in unison, exploiting the immense interconnectivity that exists in the brain. Indeed, Reading Recovery teachers “[c]reate varied learning opportunities that involve looking, hearing, saying, manipulating, moving, changing colour, changing pens and pencils, changing textures, changing surfaces (horizontal and vertical) and changing books” (Clay, p. 176). This is clearly depicted in the procedures addressing instruction for the learner who finds it hard to remember. (See, When it’s hard to remember, p. 176.) Clay argues that the more senses the teacher engages when addressing a hard-to-remember problem, the more likely this will catch the brain’s attention. Similarly, teachers may more appropriately consider using conceptions of learning to build novelty, variety, and interest into the presentation of their lessons (Bowles, 2008; Bowles & Hattie, 2016).

7. Brains operate on the “use it or lose it” principle.

There’s a reason that you forget how to speak a foreign language or work out a trigonometry problem if you don’t use those skills on a regular basis. Information in the brain that isn’t used is often lost, as neural pathways are weakened over time (Bruer, 1999b; Verghese et al., 2003). Research has found that the brain generates more cells than it needs, with those that receive both chemical and electrical stimuli surviving and the rest dying off (Lehman & Skoe, 2015).
Clay’s theory is that learning to read and write is complex and at any one time on any one day each learner’s challenge will be idiosyncratic. Therefore daily, individual lessons with each child are essential to respond effectively to a learner’s current responses and hypothesized needs.

The brain has to receive regular stimulation through a given pathway to sustain those cells, which is why Reading Recovery lessons occur daily and indeed why lifelong learning is so important to brain health. There is a great deal of variability among all learners at all ages and levels of learning. As such, for a child having difficulty with literacy learning, the lesson series will be ideally tailored to the unique needs of the particular child. (See Intervening early to reduce literacy difficulties, p. 14.)

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8. Learning is social.
The majority of people need a social environment to maximize their learning (Blakemore, 2010; Frith & Frith, 2010). Research has found that from infancy on, people learn better through social cues, much more easily recalling and emulating the actions or words of another human being (Meltzoff, Kuhn, Movellan, & Sejnowski, 2009). Aside from social cues, socialization has been shown to have other learning benefits. Peer collaboration offers children access to a diverse array of experiences (Fawcett & Garton, 2005) and requires the use of nearly all the body’s senses, which in turn creates greater activation throughout the brain and enhances long-term memory.

Small-group work, especially when it capitalizes on the strengths of its members, may be more beneficial than many realize, both for teachers and the children they work with. Lyons (2003) reminds us that social relationships and interactions with others profoundly influence learning. If social interactions are traumatic or indifferent, then resultant learning is diminished.

Purposeful, contextualized conversations with young children impact their emotional, cognitive and physical development (Siraj, Kingston, & Melhuish, 2015). Children learn their language through interaction with others from birth. And through language children learn to make sense of and interact with their world. Language is intimately related to learning.

To help children control their attention, Reading Recovery teachers engage them in conversation that is genuine and tied to the specific activity or task at hand. In addition, drawing on each child’s experiences, interests, and ideas focuses and sustains the learner’s attention. When interactions are positive, emotional connectedness occurs and learning is enhanced. Indeed, it is through such positive social interactions with caring adults that children learn how to learn. This reflects Vygotsky’s (1962) theory of the zone of proximal development (ZPD) that underscores the notion that from interpersonal engagement, new learning becomes intrapersonal and then automatized, requiring little or no attention.

“Recursion through prior phases of the ZPD,” (Lyons, 2003, p. 55) from intrapersonal to interpersonal, allows the learner to revise or add new learning, knowledge or skills.

9. Learning is best when patterns are capitalized on.
All of us, from the time we are born, possess innate abilities to see and hear patterns, something that psychologists doubted was true for decades but that we now know to be the case (Bob & Louchakova, 2015). Indeed,
Marie Clay’s first book, published in 1972, was entitled Reading: The Patterning of Complex Behaviour. Research suggests that reinforcing those innate capabilities by teaching patterns early on may actually help children learn more and sharpen their brains (Sullivan, Gervasori, & Phillips, 2017).

Aside from being able to see and hear patterns, the human brain has a number of innate abilities (the ability to learn a language, for instance) that when capitalized on in the right way, can help make learning any concept, even one that is abstract, much easier (Tymms, 2016). Combining these innate abilities with opportunities to practice frequently, indeed daily, in meaningful contexts—as in Reading Recovery lessons—can help make new ideas and concepts stick and make more sense. (See Finding and using the information in print: developing the brain’s activity on text, p. 127.)

Due to the nature of language and how the brain uses language, if you help the child move easily around his secure knowledge, he will become able to venture beyond his known repertoire by linking novel experiences to the body of knowledge that he owns. It is this knowledge that he owns that is accessed by Reading Recovery teachers in order to inform their teaching decisions. (See Building the foundation of a self-extending processing system, p. 44.)

10. Learning changes the structure of the brain.

Brain structure and function are intertwined, and one cannot be improved without taking the other into consideration. Yet, in years past, most ideas about learning ignored ways that the brain’s structure itself could be modified, instead focusing on brain function or the brain’s output. The reality is that brain function can only be changed through changing brain structure, which is actually less complicated than it sounds (Zull, 2002).

For example, brain cells fired up during both perception and action overlap, and lessons that engage both enable children to more easily identify with their teachers and to learn concepts more quickly as their brain cells are getting twice the attention and workout. In fact any new information, if used enough, can modify the structure of the brain, which is actually less complicated than it sounds (Zull, 2002).

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Reading Recovery teachers alter their instructional support as children’s competencies grow and develop.

In Conclusion

Recent research in neuroscience provides concrete evidence that learning is much more than just a cognitive process. Lyons (2003) reminds us that “[l]earning involves perceptual, emotional, cognitive and social functions that are not a hierarchy, that are not acquired in sequence. Nor is one function more important than the others but rather, all functions are a synergy, a combined and correlated force of united action” (p. 66).

Greenfield (2000) tells us that learning occurs when neurons set up networks that fire together, and the more you use these synchronizing networks by acting successfully, the more developed those networks become, until they become automatic. She continues by saying that neurons go to where the action is and they are ruthlessly practical, designed to survive and adapt to the needs of today — the here and now. This description of the brain’s activity links well with Clay’s suggestions for Reading Recovery teaching. Daily lessons focused on communicating
meaning in reading and writing engage the learner in “building a network or processing system for working on print that becomes smart enough to extend itself” (Clay, 2016, p. 127), and this is the self-extending system for literacy.

In Educational Neuroscience, a new open access journal, editors Brown and Daly (2016, p. 1), provide the opportunity to better link the potential that lies within multiple interconnected fields like education, psychology, child development, neuroscience, and medicine, to fundamentally transform how we think about and create educational neuroscience. This positive and farsighted view is also echoed by Morris and Sah (2016). It is worth noting that Reading Recovery teachers, trainers, and leaders will have much to offer this new discourse.

References


Anderson, M., & Oliver, M. (2012). Of tutors, and leaders will have much to offer this new discourse.


About the Author

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