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SUSTAINABILITY IN THE SYNAPSES:
NEUROPLASTICITY AND TRANSFORMATIVE LEARNING

**Sustainability in the Synapses:
Neuroplasticity and Transformative Learning**

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Abstract

For decades, transformative learning theory has explained that perspective transformation is associated with fundamental and far-reaching changes in the way people view their experiences (Brookfield, 2000; Cranton, 2006; Daloz, 2000; Mezirow, 1978). Transformation—interpreted cognitively—is understood as a process through which people mindfully critique previously unexamined premises and then rationally choose more accurate paths of thought and behavior.

Recent developments in cognitive neuroscience have shed new light onto the cognitive physiology of learning. These findings suggest insights into perspective transformation at the neuronal and synaptic levels. Such insights include the emerging understanding of neuroplasticity—that experience shapes and rewires brain structure and function at the neuronal level (Jensen, 2005; Sylwester, 2005; Zull, 2006), after which the brain is substantively changed.

This paper explores the relationship between cognitive interpretations of transformative learning and neuroplasticity. The purpose of this inquiry is to better understand the synaptic sustainability of perspective transformation in light of recent developments in cognitive neuroscience.

Sustainability in the Synapses: Neuroplasticity and Transformative Learning

“That’s so gay,” scoffed Adam at his college roommates’ perpetually unwashed dishes strewn about the kitchen.

“What exactly do you mean by that?” probed Sierra, the woman who intimidated and intrigued Adam, lifting her eyes from her kitchen table calculus.

When Adam responded with a litany of reasons why leaving dirty dishes for others was offensive, Sierra stopped him. “No, what exactly about ‘gay’ is offensive to you?”

Uneasy under the scrutiny of his college roommate and crush, Adam averted his gaze and penned a furtive “Please do your own dishes” note to stick on the fridge.

“Look, Adam, you’ve got to stop this passive-aggressive bullshit,” insisted Sierra, brandishing Adam’s note as Adam retreated toward the sink.

Adam stuffed his nervous hands into his pockets and wilted under the intensity of Sierra’s scrutiny, under which he felt both dissonance and desire. Dissonance from provoking Sierra’s disapproval. Desire because he was drawn to Sierra’s clarity and confidence. Sure, Adam the Eagle Scout was confident in his ability to accomplish instrumental badges and service projects, but in matters of relational and reflective analysis, he still felt like a tenderfoot. Sierra, by contrast, seemed to be a sage—both authentic and insightful in the midst of life’s relational complexities.

Adam stood confused, yet curious. He was confused that Sierra objected to what he assumed was justified ire. And he was curious about how this sagely senior always seemed to offer insight. Confused, curious, and smitten, Adam awkwardly confessed his affection for Sierra. Sierra smiled and cautioned, “Thanks, but I’m too much woman for you.”

He knew she was right.

Sierra’s life erudition juxtaposed against his own sense of stunted growth left Adam feeling disoriented. Unsure of what to do next, he confined his gaze to the floor and retreated to his upstairs room.

Behind his closed door, Adam looked up the definition of “passive-aggressive.” Then he sighed and acknowledged that Sierra was right; he had avoided direct confrontation for most of his life, but no one had ever intervened, except for his insightful Sierra.

Disoriented and seeking clarity, Adam’s transformative process had been triggered. He was ready to have his thoughts challenged and his mind changed.

Neuroplasticity and Transformation

What then is happening in Adam’s mind as he begins what transformative learning scholars refer to as fundamental and far-reaching changes in the way people view their experiences (Brookfield, 2000; Cranton, 2006; Daloz, 2000; Mezirow, 1978)?

Moreover, what is likely taking place in Adam’s brain as he engages—under Sierra’s tutelage—in what Mezirow (2000) described as “the process by which we transform our taken-for-granted frames of reference to make them more inclusive, discriminating, open, emotionally capable of change, and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action” (p. 8)?

Current cognitive neuroscience, which studies how the brain produces cognitive functions, suggests that such experiences are literally transforming brains like Adam’s through neuroplasticity—the process of experience reshaping and rewiring the brain and its function at the neuronal level (Jensen, 2005; Sylwester, 2005; Zull, 2006), leaving the brain substantively

changed.

This paper sets out to explore the relationship between the cognitive dimensions of transformative learning theory and current brain research. In order to do so, this paper will analyze Adam's experiences through the dual lenses of cognitive interpretations of transformative learning theory and current cognitive neuroscience. In the pages to follow, Adam's experiences will offer examples and opportunities for further analysis of the apparent physiological bases for sustainability in the synapses, or neuroplasticity and transformative learning.

While Adam's transformation is not without affective, psychosocial, and spiritual dimensions, this exploration will focus its inquiry into cognitive neuroscience and what Mezirow (1991) called "the process of becoming critically aware of how and why our assumptions have come to constrain the way we perceive, understand, and feel about our world" (p. 167). In doing so, this paper aims to facilitate a discussion of the apparent cognitive physiology of perspective transformation.

Adam's Disorienting Dilemma or Trigger Event

Transformative learning theorists generally refer to cognitive dissonance such as Adam's as a disorienting dilemma (Mezirow, 2000) or a trigger event (Cranton, 2009) that catalyzes the transformative learning cycle (Herber, 1998; Taylor, 2000).

Sierra first triggered Adam's disorientation when she insisted he stop and examine his meaning schemes, or "habitual, implicit rules for interpreting behavior" (Cranton, 2006, p. 22) regarding his pejorative use of the word "gay." Later, she intensified his cognitive dissonance when during the following week she challenged Adam to reexamine his habits of mind, or the "broad, generalized, orienting predispositions that act as a filter for interpreting the meaning of experience" (Mezirow, 2000, p. 17), by joining her for the highly anticipated campus drag show.

Because Adam admired Sierra's meaning schemes and habits of mind, he trusted her to help him change his worldview in fundamental and far-reaching ways. He followed her lead to the drag show, apprenticing himself to her emancipated habits of mind.

"At the drag show," recalled Adam, "I was kind of nervous, and then Sierra put a dollar in my hand. I didn't know what to do with it until someone came over and did their dance, which made me go from kind of nervous to extremely uncomfortable."

This triggered deeper disorientation—or cognitive dissonance—for Adam, as he had no communicative or shared contextual knowledge (Habermas, 1984) that aligned with such social norms. And so Adam's mind struggled to make sense of this dissonance.

The Physiology of Cognitive Dissonance

An adult human brain like Adam's contains approximately 100 billion neurons, according to Jenson (2005) and Sousa (2006). These neurons, explained Zull (2002), form networks that are the physical embodiment of knowledge. "Every fact we know, every idea we understand, and every action we take" emphasized Zull (2002), "has the form of a network of neurons in our brain" (p. 99). "Neurons are sensitive and observant," continued Zull (2002). "They pick up on signals and send them to other neurons" (p. 96). Experience first activates such sensitive exchanges between neurons and then triggers the creation of new brain cells and synaptic communication (Jensen, 2005).

When Sierra confronted Adam, he experienced the cognitive dissonance associated with trigger events that begin the transformative learning cycle (Herber, 1998). This dissonance, in the form of being called out by Sierra, appears to have been received by the neurons in his brain's sensory cortex, wherein sounds, sights, smells, and tactile experiences ranging from

Sierra's exhortations to the campus drag show's sensory intensity all converged. This likely disoriented Adam's existing neuronal networks and stimulated the development of new neurons and synaptic communication through the process of neuroplasticity (Jensen, 2005; Sylwester, 2005; Zull, 2002).

The juxtaposition, then, of novel and conflicting sensory data upon Adam's existing neuronal networks may have served as the biochemical trigger for his cognitive dissonance and disorienting dilemmas at the kitchen sink and the campus drag show.

But Adam's dissatisfaction with his current words and actions motivated him to critically reflect, or to scrutinize the accuracy of his own assumptions and the assumptions of others. This enabled him to proceed toward perspective transformation. His temporal integrative cortex and his frontal integrative cortex would soon attempt to sort out the premises underlying his disorientation.

Adam's Critical Reflection

As Adam engaged in critical self reflection—which Brookfield (2000) described as critiquing previously unexamined premises and then rationally choosing more accurate paths of thought and behavior—he acknowledged to himself alone, in the safety of his own room, that his words and actions were undeniably passive-aggressive and thereby, in his own estimation, untenable and in need of revision.

After the drag show, Adam further critiqued his own meaning schemes when he admitted that his assumptions about gayness were decidedly inaccurate. He explained, "Although it was really uncomfortable, as a result, I learned that everybody is just there to have a good time, and I was not going to catch the gay disease or anything like that. That was important, because since then I have found out that some of my friends have been gay, just as other people in my life are gay."

Through what Cranton (2006, p. 34) called "premise reflection," Adam questioned the bases for his objections to gayness, explaining, "I started to think about my stereotypes and the people I hang out with and the people I don't hang out with. And the "why" was the big question. I learned there wasn't really a good reason why I didn't hang out with gay people. And if there was, then it wasn't very legitimate. And I think it went beyond dealing with gay people into dealing with all kinds of people. So thinking about the "why" for everything else is really important to me now."

As Adam scrutinized the premises of his thoughts and actions, his brain's temporal integrative cortex—or the cognitive location of insight development and meaning making—was vigorously engaged in construction of more informed and accurate meaning schemes and habits of mind.

The Physiology of Critical Reflection

The brain's sensory cortex, according to Zull (2002), sends sensory impressions to its temporal integrative cortex for decoding and meaning making. As Adam's temporal integrative cortex decoded disorienting sensory data, the neuronal networks between these two cortices, were, according to the principle of neuroplasticity, developed and strengthened through use. Adam's premise reflection likely fostered new neuronal networks that supported meaning making in his temporal integrative cortex (Zull, 2002). Soon, Adam would use this ability to sort out his neuronal tangles.

Adam's Neuronal Tangles

Sierra provoked Adam to reconsider his words and behavior as problematic when she labeled them "bullshit." Cognitive neuroscientists refer to such networks of problematic thought

as “neuronal tangles,” or networks of brain cell structures that perpetuate faulty interpretations and sustain incomplete understandings (Zull, 2002, p. 104). While Adam seemed to be unaware of his own faulty interpretations, Sierra was not shy about identifying Adam’s tangled meaning schemes and habits of mind. But Adam’s high regard for Sierra’s insights motivated him to put his frontal integrative cortex to work analyzing the new and competing meaning schemes that he found too compelling to disregard.

As Adam rationally compared meaning schemes, his temporal and frontal cortices—which Zull (2002) identified as the brain’s regions of data interpretation and analysis—were hard at work interpreting and reasoning. Adam concluded that Sierra was right again. Not just his words, but also his larger meaning schemes, were inaccurate. But this time he didn’t resist or flee to his upstairs room.

His brain’s amygdala—which serves as the brain’s fear center—likely determined that his perception of threat was sufficiently low and his perception of control sufficiently high enough to enable his temporal integrative cortex and frontal integrative cortex to work together to assemble and analyze alternate interpretations of conflicting sensory data.

If Adam’s amygdala had been threatened and overwhelmed by disorienting sensory stimuli, explained Zull (2002), his amygdala would have sent out messages to his hypothalamus, triggering his adrenal glands to release adrenaline into the blood stream, thereby inhibiting frontal cortex reasoning.

Instead, Adam’s frontal integrative cortex—responsible for rational decision making—judged that these competing meaning schemes demanded what Daloz (1990) described as proactive thinking, incorporating of multiple perspectives, and encouraging dialogue and construction of knowledge. Illuminating the tenuous relationship between fear and reason, Zull (2002) explained, “Different sensory signals physically compete for attention in the brain, and those that are the strongest win. It’s a physical battle . . . If reason is to win, it must produce stronger feelings than the competition” (p. 75).

Adam’s trust in Sierra and in himself as an increasingly autonomous thinker won his brain’s physical battle between fear and critical reflection. As a result, Adam’s frontal integrative cortex was uninhibited to critically rethink his tangled meaning schemes—or problematic prior knowledge.

“Prior knowledge,” explained Zull (2002) “is the beginning of new knowledge. It is always where all learners start. They have no choice” (p. 93). This observation is consistent with transformative learning theory’s view of disorienting trigger events as a source of what Brookfield (2000) called “critical self reflection on assumptions” in order to understand the “culturally contingent . . . tacit, and unproblematized” assumptions, which are “socially created and learned” (pp. 131-133).

In support of critical self reflection on problematic assumptions, Zull (2002) suggested that opportunity for negotiating neuronal tangles lies in using an individual’s existing neuronal networks in order to revisit and rethink neuronal tangles. To do so, Zull (2002) recommended scaffolding such substantive reflection by introducing new and competing information, enabling the individual to recognize, problematize, and sort out competing information. Doing so reflects transformative learning theory’s stages of critical reflection and rational dialogue, which likely take place in the brain’s frontal integrative cortex, as it is associated with problem solving, making decisions, assembling plans for action, and making judgments and evaluations (Zull, 2002).

Adam’s Rational Dialogue

“So, the seed had been planted,” recalled Adam referring to his increasingly rational, nuanced, and inquiring habits of mind. “I started thinking about that experience, and then I started thinking about myself a lot more. Sierra opened my eyes to seeing words and experiences differently, and this let me see other things differently. Since then, I’ve really changed my approach . . . I need to ask the question, “why?” That is really important to me.”

As Adam explained why he has been led to ask "why?" about many aspects of his life—including why he is drawn to or away from people, experiences, and possessions—his admissions revealed the rational dialogue and inquiring discourse that guided his transforming habits of mind.

Engaged in progressively more substantive layers of subjective reframing, or analyzing his own internalized frames of reference (Boyd, 1991), Adam found himself increasingly drawn to premise reflection, or analyzing why certain assumptions and values merit consideration (Cranton, 2006, p. 34).

So if, as Adam explained, the seed of rational dialogue had been planted, where in Adam’s brain was it germinating?

The Physiology of Rational Dialogue

The frontal integrative cortex, according to Zull (2002) “is responsible for problem solving, making decisions, assembling plans for action, and making judgments and evaluations” (p. 21). It is the frontal integrative cortex that works to rationally process the meaning made by the temporal cortex, based upon data from the sensory cortex.

Adam’s frontal integrative cortex, then, appears to be the site of his rational dialogue regarding the meaning schemes and habits of mind that he discovered in himself, his roommate Sierra, his classmates at the campus drag show, and his wider circle of acquaintances. As Adam’s frontal integrative cortex engaged in the complex work of critical self reflection, his neuronal pathways were, by virtue of neuroplasticity, likely activated and augmented to engage in further complex cognition through what Jensen (2008) called “rewired and remapped” brain structure (p. 410). In light of his rewired and remapped meaning schemes, Adam was committed to act on his transformed habits of mind.

Adam’s Committed Action

“My role in life has now changed,” emphasized Adam. “After my assertive roommate Sierra helped me to grow, I became more of the person I wanted to be. I now need to go beyond spending time with people who are going to have exactly the same views as me. Now I search for meaning in what I do. I need to ask the question, “why?” That is really important to me.”

Regarding his work as a secondary school teacher, Adam explained, “I can have an impact on that one student who asks the question “why?” And that one will impact somebody else. I think it can grow. And the people that give me crap for that, I can’t listen to them.”

“Part of my job as an Eagle Scout,” continued Adam, “is working as a counselor at a leadership camp, where I lead reflections. I now do things that people used to make fun of me for, and I’m alright with it.”

Adam’s transformed habits of mind ultimately culminated in commitments to what Habermas (1984) called “emancipatory” action, which Cranton (2009) summarized as leading to “freedom from constraints and oppression—either personal or social.” Adam revealed that acting on his emancipatory habits of mind, as well as fostering such transformation for others, became his foremost professional and personal priority. Adam emphasized, “If I don’t do it, it’s not going to happen.”

The Physiology of Committed Action

Adam's committed, emancipatory action was directed by his brain's motor cortex, which, according to Zull (2002) "directly triggers all coordinated and voluntary muscle contractions by the body, producing movement. It carries out the plans and ideas originating from the front integrative cortex including the actual production of language through speech and writing" (p. 22). This, Zull (2002) explained, "matches with the necessity for action in completion of the learning cycle. Active testing of abstractions requires conversion of ideas into physical action or movements of parts of the body" (p. 22).

As Adam intentionally sojourned into environments that triggered disorientation, required critical reflection, enabled rational dialogue, and demanded committed action, his motor cortex was the cognitive region that controlled his conversations and interactions that enabled him to experience the full cycle of perspective transformation from its beginnings in disorientation to its fruition in emancipatory action. His continued committed action would, through neuroplasticity, further rewire his brain's neuronal networks and synaptic junctions that sustain transformed habits of mind.

Synaptic Sustainability

"The adult human brain," such as Adam's, is according to Sylwester (2005), "the best-organized, most functional three pounds of matter known in the universe" (p. 31). Connected by nearly one million miles of nerve fibers, Jensen (2005) explained if the outer cortex layer of the grapefruit-sized mature brain were laid out flat, it would be about the size of an unfolded single page from a daily newspaper. These miles of nerve fibers contain neurons, or the "basic cells making up the brain and nervous system, consisting of cell bodies, long axon fibers which transmit impulses, and many shorter dendrite fibers which receive them" (Sousa, 2005, p. 288). Neurons communicate with each other through axons that terminate at synaptic junctions, which Sylwester (2005) described as "the narrow gaps between the axon terminals" and the dendrite receptors on the receiving neurons, "thus carrying . . . information from one neuron to another" (p. 156).

Through neuroplasticity, which Sousa (2005) described as the brain's lifelong ability to reorganize itself based on input, the very process of critical reflection may sustain among the brain's communicative synapses what Mezirow (2000) described as learning that assists in (a) elaborating existing frames of reference, (b) learning new frames of reference, (c) transforming points of view, and (d) transforming habits of mind.

Considered collectively, the brain's four cortices, according to Zull (2002) suggest a striking opportunity for whole-brained experiential learning, based on the (1984) Kolb learning cycle—including concrete experience, reflective observation, abstract conceptualization, and active testing. To this end, "deep learning, learning for real comprehension" explained Zull (2002), comes through a sequence of experience, reflection, abstraction, and active testing (p. 13). Such experience, emphasized Zull, "changes the wiring in our brain because it changes the activity in our neurons. When neurons are more active," continued Zull, "they can make more synapses" (2002, p. 116). "Balanced use of all parts of the brain is essential for the kind of learning" that provides us with new behavioral choices (Zull, 2002, p. 32) that are sustained through "long term potentiation," which Jensen (2005) described as when a neuron's response to another neuron has increased, or has learned to respond, in which case "each future event requires less work to activate the same memory network" (p. 16).

Sustaining Transformation

"We can create environments that nurture brain rewiring," emphasized Zull (2002, p. 5). Such conditions, which Herber (1998) summarized as disorienting trigger events, critical

reflection, rational dialogue, and action not only enable transformative learning, but are also biochemically compatible with the adult brain's structures. Transformative learning, then, appears to not only be compatible with the adult brain's structures, but may also be sustained through experientially developed neuronal networks that rewire the adult brain to learn to further “negotiate and act on our own purposes, values, feelings, and meanings rather than those we have uncritically assimilated from others—to gain greater control over our lives as socially responsible, clear-thinking decision makers” (Mezirow, 2000, p. 8).

An Invitation for Further Analysis

While this paper offers perhaps nascent and certainly incomplete and imperfect inquiry into the relationship between cognitive explanations of transformation and current understandings of neuroplasticity, it is intended to serve as an invitation for scholarly analysis of the physiology and cognitive neuroscience of perspective transformation. It is offered in a spirit of appreciation for the apparent relationships between cognitive neuroscience, cognitive interpretations of transformative learning theory, and the experiences of individuals who, like Adam, synaptically sustain what Cranton, (2009) called a “revision of previously unquestioned perspectives and assumptions based on critical reflection and critical self-reflection, leading to more open, permeable, and better justified perspectives” (p. 2).

References

- Boyd, R. D. (1991). *Personal transformations in small groups: A Jungian perspective*. New York: Routledge.
- Brookfield, S. D. (1995). *Becoming a critically reflective teacher*. San Francisco: Jossey-Bass.
- Brookfield, S. D. (2000). Transformative learning as ideology critique. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 125-148). San Francisco: Jossey-Bass.
- Cranton, P. (2000). Individual differences in transformative learning. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 181-204). San Francisco: Jossey-Bass.
- Cranton, P. (2006). *Understanding and promoting transformative learning: A guide for educators of adults*. San Francisco: Jossey-Bass.
- Cranton, P. (2009). Basic theoretical terms and concepts: Overview. Unpublished manuscript.
- Daloz, L. A. (2000). Transformative learning for the common good. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 103-123). San Francisco: Jossey-Bass.
- Habermas, J. (1984). *The theory of communicative action*. Boston: Beacon.
- Herber, M. S. (1998). *Perspective transformation in preservice teachers*. Unpublished doctoral dissertation, University of Memphis.
- Jensen, E. P. (2005). *Teaching with the brain in mind*. Alexandria: Association for Supervision and Curriculum Development.
- Jensen, E. P. (2008). A fresh look at brain-based education. *Phi Delta Kappan International*, 89 (6), 408-418.

- Mezirow, J. (1978). Perspective transformation. *Adult Education*, 100-110.
- Mezirow, J. (1991). *Transformative dimensions of adult learning*. San Francisco: Jossey-Bass.
- Mezirow, J. (2000). Learning to think like an adult. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 3-34). San Francisco: Jossey-Bass.
- Sousa, D. A. (2006). *How the brain learns*. 3rd Ed. Thousand Oaks: Corwin.
- Sylwester, R. (2005). *How to explain a brain: An educator's handbook of brain terms and cognitive processes*. Thousand Oaks: Corwin.
- Taylor, E. W. (2000). Analyzing research on transformative learning theory. In J. Mezirow (Ed.) *Learning as transformation: Critical perspectives on a theory in progress* (pp. 285-328). San Francisco: Jossey-Bass.
- Zull, J. E. (2002). *The art of changing the brain: Enriching the practice of teaching by exploring the biology of learning*. Sterling: Stylus.
- Zull, J. E. (2006). Key aspects of how the brain learns. *New Directions for Adult and Continuing Education*, 110, 1-10.