

Neurological Process of Development

Annie Cole
University of Portland

Abstract

Although prominent theories in college student development cover a breadth of developmental aspects and draw from various fields of study, the literature lacks a developmental theory that explains the neurological processes that occur during student development. This literature review uses Neuro-semantic Language Learning Theory (Arwood, 1983; 2011) as a foundation to explore the triangulation of neuroscience, cognitive psychology, and language learning literature to speak to the gap in student development literature. Literature for each of the three subjects (neuroscience, cognitive psychology, and language learning) is presented, analyzed, and compared to current literature on student development theory. The purpose of this literature review is to supplement existing student development theory and provide a more holistic understanding of student development. Implications and suggestions for application of literature to student affairs work are offered.

A History of Student Development Theory

Since the 1950's, higher education scholars have studied student development and key factors that influence students' lives (Kimball & Ryder, 2014). Student development theory emerged from the research to provide a framework for student affairs professionals to understand and serve students, resulting in an increase in college students' self-direction and complex task mastering (Miller & Prince, 1976). Student development is defined in multiple ways, including, "the ways that a student grows, progresses, or increases his or her developmental capabilities as a result of enrollment in an institution of higher education" (Rodgers, 1990, p. 27). Student development can also be understood as, "some kind of positive change that occurs in the student (e.g., cognitive complexity, self-awareness, racial identity, or engagement)" (Jones & Abes, 2011, p. 153), and "the organization of increased complexity" (Sanford, 1967, p. 47).

Between the 1950's and the present, the average college student profile has changed, prompting the ongoing study and evolution of student development theory. Beginning in the 1950's and 1960's, student affairs professionals relied on human development theories to guide their practice. Human behavior research grew rapidly during this time, and researchers focused on understanding the development of the individual to "see the world through their eyes" (Wilson, Damiani, & Shelton, 2002, p. 89). Human development theories lent valuable insight to college administrators, who sought to better understand the lives of their diverse students. Erikson's (1959) Theory of Psychosocial Development was a prominent theory during this time, and still exists as a foundation for many student development theories today. Erikson describes personal identity as one's sense of meaning and purpose. Identity develops through a series of personal assessments of values, roles, and beliefs during a stage of crisis, concluding with a

personal commitment to previous or new values, roles, and beliefs. Erikson highlights the importance of role experimentation as it promotes the assessment and commitment process to personally defined values and beliefs (Newman & Newman, 2015).

The 1960's and 70's brought new human development theories for student affairs professionals to draw from. Psychologists and sociologists began to narrow their general human development studies to focus on student development, leading to the first development theories specific to college students. Early psychological theories emphasized the need to both challenge and support students in a balanced way, while early sociology theories emphasized emotional support as a way to assist students seeking family independence (Patton et al, 2016). Perry's (1970) Cognitive-Structural Theory and Chickering's (1969) Seven Vectors Theory were two notable theories from which college administrators drew. Perry's theory delved into the realm of the ethical and intellectual growth of college students, a new area of expansion and growth in college student services. Chickering's (1969) Seven Vectors Theory stated that students develop uniquely across seven vectors, each of which impact student development individually and as overlapping vectors. The vectors include emotion management, developing interpersonal relationships, identity establishment, purpose development, integrity development, competence development, and developing interdependency with others (Chickering & Reisser, 1993). Chickering built upon Erikson's Theory of Psychosocial Development (1959) to understand the developmental issues faced by college students specifically. Chickering wrote *Education and Identity* (1969) with the intention of guiding college faculty in how to support student development through the creation of systematic college programming.

Theories in the 1980's and 1990's were created with the intention to understand specific student populations (i.e. gender-specific support theories) and student development during academic and personal hardships. Racial identity also became a new topic of research, and psychologists and sociologists together established the Minority Identity Development model in 1979 (Patton et al, 2016). Research from this point forward focused on understanding diverse student backgrounds and on how to create programs that best served unique student groups. Carol Dweck (1986) studied the impact of motivation on learning, while Gerdes and Mallinckrodt (1994) studied the effect of emotional, social, and academic adjustment on college attrition. Schlossberg's (1984) Transition Theory also emerged during this time. Schlossberg explained that adult life transitions are caused by events and non- events. A non-event is an expected event that does not occur, such as failing to obtain the grade one was hoping for. Schlossberg emphasized context as an important factor in determining how an event or non-event will cause change for an adult (Evans, Forney, & Guido-DiBrito, 2010).

In the early 2000's, Baxter Magolda developed Self-Authorship Theory (2001), which outlined the process of learning to create and trust one's internal voice during young adulthood. According to Magolda (2001), students move from dependence on external authority figures for knowledge to trusting and establishing internal belief and knowledge systems. Baxter Magolda's (2001) Self- Authorship Theory defines a development process through which college students start to define their own meaning; students diminish dependence on values and beliefs they have integrated from other sources, including their parents, friends, and experiences (King & Magolda, 2008). Self-authorship Theory explores the process of listening to one's internal voice and committing to personally defined values and beliefs (Baxter Magolda, 2008). Evans, Forney, and Guido-DiBrito similarly describe self-authorship as the ability to internally define

one's own identity, belief system, and relationship to others (2010).

In reflecting on the past five decades of history, it's clear that student development theory has expanded to give a clearer picture of student growth and change, understood through multiple perspectives and approaches. Although student development research has continued from the early 2000's into the present day, no additional theories have been established that appear to have influenced student affairs practice. As of 2019, student affairs professionals are still referring to the following prominent theories for guidance and professional development: Erikson's Theory of Psychosocial Development (1959), Schlossberg's Transition Theory (1984), Chickering's Seven Vectors Theory (1969), and Baxter Magolda's Self-Authorship Theory (2001).

Current student development theory, as reviewed in the contemporary textbook *Student development in college: Theory, research, and practice* (Patton et al, 2016) and outlined above, is limited to theories that consider development from observation of change over time. In these theories, development is defined using an older definition: development as behavior change in response to stimuli in the environment (Skinner, 1953). With the study of the neural processes behind behavior growing substantially since the 1990's (Nelson, Haan, & Thomas, 2015), it's important that student development theory incorporate this new research into the field and expand the scope of the literature on student development. The exclusion of neurological processes limits student affairs professionals' understanding of student development to a purely observational perspective. Alternatively, the inclusion of neurological processes expands the body of literature to demonstrate how students are growing neurologically, cognitively, and linguistically. The Neuro-Semantic Language Learning Theory (NsLLT) (Arwood, 1983; 2011) offers a new lens through which student affairs professionals can understand student development from an internal perspective.

Incorporating Neurological Processes of Student Development

Neuro-Semantic Language Learning Theory (NsLLT) (Arwood, 1983; 2011) summarizes the literature in neuroscience, cognitive psychology, and language learning theory into a framework that explains student development from a neuro-semantic (neurologically meaningful) lens. The literature from three overlapping fields emphasizes that student development is a process that unfolds according to a student's neurological interaction with their environment. Defining student development as an increase in neurological complexity and capacity (similar to Sanford's definition of student development, 1967), cognitive and neurological complexity is a continuous developmental process that occurs as sensory inputs are processed in the brain and changes are made at the cellular level (Zull, 2004). Development is a process of neuron circuit refinement through the strengthening and pruning of neural connections (Brice & Brice, 2009), which results in increased cognitive complexity and language function: a unique human capability to use language to solve- problems (Anderson, 2014) and express thinking (Arwood, 2011). As students develop neurologically, cognitively, and linguistically, the capacity to process new information through existing neural networks is increased (Nelson, Haan, & Thomas, 2015), resulting in a higher functioning, more complex brain. To further explain the foundation of NsLLT, a brief exploration of the relevant literature behind the framework from the fields of neuroscience, cognitive psychology, and language learning literature are outlined. Each of these fields of literature builds upon the previous field to

create a holistic understanding of development from a neuro-semantic (neurologically meaningful) lens.

Neuroscience

Neuroscience is the study of brain development from a neurobiological approach. Since the 1990's, neuroscience research has expanded rapidly due to the development of machines that track brain blood flow during neural processes, including positron emission tomography (PET) and functional magnetic resonance imaging (fMRI) machines (Aine, 1995). Through fMRI technology, researchers are able to obtain a deeper look inside the brain, viewing layers of cerebral cortex (Bazin, Weiss, Dinse, Schäfer, Trampel, & Turner, 2013).

Brain development begins very early in human life, shortly after conception. This process continues into young adulthood, spurred by the molecular and electrical exchanges that grow neural networks (Nelson, Haan, & Thomas, 2015). By adulthood, the brain contains 100 billion nerve cells called neurons (Goswami, 2004). Neuron growth continues to occur throughout one's lifespan as a result of life experiences and learning (Nelson, Haan, & Thomas, 2015). Each neuron is made up of an axon, capable of sending neurochemical messages to other neurons through synaptic connection, and a dendrite for receiving messages (Brice & Brice, 2009).

Neurons in the brain fire in response to meaningful environmental stimuli, sending a neurochemical signal from one synapse to another. As humans receive sensory input from the world around them, the input is processed through an area of the brain known as the sensory store. The sensory store is a cognitive psychology term used to describe the temporary processing point for sensory information prior to memory (Anderson, 2014). An input is processed through the sensory store and may be moved to short-term or long-term memory depending on meaning, attention, and rehearsal of the input (Anderson, 2014). When neurons fire in response to stimuli, they cause permanent change at the cellular level (Baars, 2010). Through repeated use of the same neuron, myelination (thickening) of the neuron cell occurs, increasing that neuron's capacity to fire again (Arwood, 2017). Stored information in the brain can later be accessed and shared out loud through language to express thinking (Arwood, 2011).

As a new input is received from the environment, it is processed through the filter of existing neural networks (Nelson, Haan, & Thomas, 2015). In cognitive psychology, this concept is known as schema, which is the representational structure of existing concepts in the brain including its related parts and attributes (Anderson, 2014). Multiple neurons can become connected into circuits, which result in the wiring together and firing together of those neurons (Barr, 2010). The brain works synergistically across multiple areas to perform most neurological processes, rather than depending on individual sections or cells in the brain (Lashley, 1929).

Brain development, specifically dendrite growth (the communication branches extending from each neuron), becomes more unique to each human after the age of five (Giedd, 1999). Because dendrite growth is a sign of neural firing in response to environmental stimuli, individual brains will develop uniquely depending on the environment and stimuli received. Language, which is an expression of thinking based on stored information in the brain (Arwood, 2011), is also unique to the individual and grows out of the environmental stimuli that the individual has experienced. This explains why college students may use different language, or

words, to express their thinking about the same idea; thoughts are based on neurologically stored memories that are unique to each individual's experience.

Cognitive Psychology

Building upon the foundation of neuroscience literature, cognitive psychology is the second of the three fields that contribute to the NsLLT framework of student development. Cognitive psychology is the study of all higher-level mental processes and capabilities (Lachman, Lachman, & Butterfield, 1979) including, "memory, perception, learning, thinking, reasoning, language, and understanding" (p. 6). This realm of psychology has shifted dramatically over the past 100 years, moving from the strict study of observable behavior (Watson, 1913) and stimulus response patterns (Skinner, 1953) to the expanded study of mental processes today. For example, cognitive neuroscience, "how cognition is realized in the brain" (Anderson, 2016, p. 10), is the study of the neurological structures and functions behind mental processes (Held, Knauff, & Vosgerau, 2006). While neuroscience offers a glimpse at the internal, biological processes of brain development, cognitive psychology attempts to observe and study the mental processes in action.

Within cognitive psychology, the study of the nature of mental states (beliefs, desires, and emotions) is termed Theory of Mind (Flavell, 2004). Theory of Mind research includes the study of various mental states and their relation to behavior, including motivation and self-worth (Covington, 1998), self-directed learning (Zimmerman, 1989), and mental malleability (Kegan & Lahey, 2009). A mental state can also refer to a belief system that someone holds. For example, Kegan and Lahey's (2009) research on mental development finds that adults can move from a socialized mind, depending heavily on authority figures for knowledge, to a self-transforming mind, capable of complex thought processes and comfortable holding multiple beliefs systems.

Studies in cognitive psychology also demonstrate how meaning, learning, and memory are related. In the context of memory development, studies show that humans extract meaning, not structure, from sentences (Wanner, 1968) and memory of meaningful images is greater than meaningless images (Bower, Karlin, & Duek, 1975). This matches neuroscience research that demonstrates only meaningful information causes neural firing in the brain (Anderson, 2014) and leads to memory. Neuroscience and cognitive psychology research continue to overlap in their findings, showing that nervous system changes (including the brain) and psychological changes are often related (Kolb, Gibb, & Robinson, 2003). This suggests that meaningful information, including relevant and contextual information, is most likely to be stored in memory for future recall.

Development, through the cognitive psychology lens, is an increased capacity to perform higher level mental processes. Development is acquired through the deep mental processing of information from a sensory pattern level to conceptual understanding (Arwood, 2017). During information processing, the depth of information processing is more important to the length of rehearsal at improving memory (Kapur, Craik, Tulving, Wilson, Houle, et al., 1994). For example, a student who is studying a new concept from class can utilize multiple parts of the brain through reading, writing, and thinking critically about the concept. These activities increase the depth of processing and memory better than repetition or the use of flashcards. This is consistent with neurological research and suggests that student affairs professionals can

increase student development by having students engage with complex concepts through reading, writing, and conversation. These strategies are much different than providing rules, patterns, or information out of context for students to memorize and repeat.

Language Learning Theory

Language Learning Theory is the last of the three fields to contribute to the NsLLT framework of student development. Under Language Learning Theory, language is often understood and studied by its parts: phonemes (word sounds), words or vocabulary (combined phonemes), grammar (order of words), and semantics (meaning of words) (Bruner, 1975). Anderson (2016) describes language as a unique human capability that has evolved over time in congruence with the human prefrontal cortex as a problem-solving function. Anderson goes beyond the structure and parts of language to describe the influence of language and thought on one another. Arwood (2011) describes language as an outward expression of inward thinking.

Starting early after birth, children begin to develop an understanding of others and themselves as agents in the world (Bretherton, 1991) and begin to pick up patterns and formulas in spoken language (Kuhl, 2000) including differences in spoken language sounds (Jusczyk, Friederici, Wessels, Svenkerud, & Jusczyk, 1993). As children learn new words, they incorporate them into their existing understanding of language (Brice & Brice, 2009), and then use the new words to better understand new experiences in the world around them. Children usually have the ability to use language abstractly by age 11 (Owens, 2005). For example, a student that can understand the concept of “table” as a way of tabling a conversation for another time is thinking abstractly.

Language is much more than repeating memorized vocabulary, and language development is different than language learning. Language development is the result of conceptual understanding, while language learning is the mechanical use of language (Adair-Hauck & Donato, 2002). This is why vocabulary tests are not strong indicators of language function. One study found that 33% of students’ vocabulary test scores did not match their word employability (ability to use the word intelligibly in a communication context) for the same words (Kremmel, 2016). Another study found that only one-half to three-quarters of total personal vocabulary is understood meaningfully (i.e. can be used intelligibly in communication) (Schmitt, 2014). In other words, having developed language means being able to understand and express concepts, not merely repeat the symbol (word) for an idea.

Contrary to the view of language being the ability to repeat vocabulary, the NsLLT describes language as an ability to access and utilize concepts formed in the brain neurobiologically over time (Arwood, 2011). Consider the language development process that occurs from childhood through adulthood. As a child experiences the world around them, the experiences are stored as memories in the brain. The memories begin to overlap cognitively and neurologically to form patterns about the world, and then eventually form ideas. Finally, if the child learns the meaning behind an idea and can apply a linguistic symbol (word) to it, then the word becomes something that the student can use to share their thinking out loud. In this way, language allows humans to function in the world, share ideas, and solve problems (Arwood, 2017). Older children and adults can think abstractly to access ideas, or concepts, in multiple ways. For example, a teenager who has acquired the language to understand the word

“table” can access the concept of “table” as a four-legged object that sits in a living room, as a periodic table referred to during chemistry class, or as an abstract way to table a conversation for another time.

Understanding the relationship between language development and neuroscience is important because brain systems underlie language functions (Ullman, 2004) and language shapes how new environmental stimuli is received in the brain (Brice & Brice, 2009). Cognitive mental states can also influence language acquisition and perception of environmental stimuli. For example, one study found that anxiety may influence participants to perceive life events in a negative way (Thomsen et al, 2016). These negative experiences are stored as memories and retrieved when new stimuli are being received, impacting participants’ perceptions. Previous experiences stored neurologically in the brain lay the foundation for how an individual will interpret a new life event. This is especially important to consider when working with college students, who are bringing their previous experiences into their perception of the college environment.

In line with neuroscience and cognitive psychology research, language difficulties have been found to correlate with limited cognitive abilities, especially memory and attention issues (Brice & Brice, 2009). To reduce language development difficulties, new ideas should be presented to students in context (i.e. in a story, in sequence) and adults in the student’s life should explain their thinking out loud as much as possible to help assist in the student’s development of new language concepts (Adair- Hauck & Donato, 2002). It’s also important to remember that language does not automatically develop with age; it develops according to environmental stimuli. For example, most American children learn color words (i.e. green, blue) by age five, but children who are not exposed to color words through school may not have this language (Brice & Brice, 2009). Language is a reflection of the ideas and concepts a person has been exposed to in the home, the school, and the community, not age or class standing.

Implications and Applications

In reviewing neuroscience, cognitive psychology, and language learning literature, one begins to see overlapping patterns in developmental processes. For example, meaningful context supports both cognitive development and language development, and cognitive neuroscience reveals how cognitive processes occur simultaneously with neurobiological processes. These overlapping processes can be applied to student development theory to demonstrate how the college student develops cognitively, neurobiologically, and linguistically at the same time.

Student development, understood through the NsLLT lens, occurs neurologically, cognitively, and linguistically as interaction happens between student and environment. As sensory inputs from the world are processed in the human brain, changes occur at the cellular level (Zull, 2004). Related environmental stimuli are stored in the brain in connected neural networks (Barr, 2010) which can be accessed later as a filter to interpret, and make meaning of, new information (Brice & Brice, 2009). Cognitively, as neurological structures increase in complexity and capacity, mental processes follow the same pattern. Metacognition (ability to think about thinking) increases as neural growth extends into the outer regions of the brain (Allen et al, 2017). Language develops neuro-biologically as a person learns to assign meaning to neurologically stored patterns of environmental stimuli, and then express thinking about that

stimuli (Arwood, 2011) or use language to perform complex mental tasks (Anderson, 2014). Language then functions to shape newly received environmental stimuli in the brain during sensory input (Brice & Brice, 2009). As students grow neurologically, they advance cognitively. As students grow cognitively and neurologically, their ability to learn and use language advances. Similar to Magolda's (2001) Self-Authorship Theory, the NsLLT views growth as the increased ability to apply one's own language to thinking. Cognitive and neurological complexity is occurring behind the scenes as self-authorship is happening.

The NsLLT framework of development is vastly different than prominent student development theories that are referenced in the opening paragraphs of this article. By using the NsLLT framework, student affairs staff and faculty can begin to understand the brain functions behind development and apply them to practice. Four implications emerge from the overlapping literature that should be considered in applying NsLLT theory to practice.

First, the overlapping NsLLT literature suggests that student development is not an automatic process that happens to students. Unlike Erikson's (1959) Theory of Psychosocial Development that involves developmental stages, the NsLLT posits that student development occurs at a unique pace dependent on the individual's interaction with their environment. If students are restricted in their ability to interact with meaningful environmental stimuli, they will be unable to change their brain at a cellular level (Zull, 2004) which restricts the expansion of neural circuits into connected networks (Barr, 2010) and the eventual acquisition of language. Students must have access to neurologically meaningful stimuli in the world around them (i.e. classroom, dorm room, at home) in order to increase in neurological complexity and capacity. Student affairs professionals can increase meaningfulness of stimuli by making sure conversation with students are focused on topics that are relevant, in context, and use language that is reflective of the students' current language level. This strategy can be used by advisors discussing degree requirements, resident advisors discussing conduct issues with students, and programming staff discussing student involvement in groups, activities, and events.

Second, the NsLLT literature suggests that student development is individual to each student; each student has a unique set of dendrite connections in their brain based on the environment they've interacted with (Giedd, 1999), meaning that each student will have a unique understanding of concepts and ideas (Arwood, 2017). Sometimes, students with low vocabulary scores are viewed as deficient, when in fact, their language is simply different based on their lack of exposure to dominant culture symbols and ideas (Brice & Brice, 2009). This would also be true of a student tested for vocabulary in a non-native language. Supporting student development means acknowledging differences exist for each person, and assessment of development should include individually identifying increases in neurological complexity for each student compared to their previous states of complexity. When working with students, staff and faculty should consider how their concepts of everyday things, like family, school, and career, might be different from their students' concepts based on past experiences. Each student is at a different level of developmental readiness to explore new concepts. Concepts that are common to student affairs staff may not be familiar to students. Moderating language to match that of the student allows maximum new language acquisition to occur and, therefore, student development to occur.

Third, the NsLLT literature suggests that student development is more than an outward expression of change. Prominent student development theories have tracked observable

behavior changes in students across time (Baxter Magolda, 2001; Chickering, 1969; Schlossberg, 1984), but they do so without reference to internal biological or neurological processes. The NsLLT offers an explanation behind the observed changes of student development theories. For example, Self- Authorship Theory (Baxter Magolda, 2001) explains that students learn to develop an internal voice over time. The NsLLT supports this theory and further explains that an internal voice could be understood as the ability to think about one's own thoughts (metacognition), a result of neurological growth (Allen et al, 2017). Baxter Magolda, Creamer, and Meszaros (2011) find that conceptual learning is approached differently by students who have developed an internal voice. A student who is not self-aware will focus on increasing knowledge, while a student who is self-authored will focus on questioning, reflecting on, and validating personal knowledge and making a conscious and considered choice on whether to change or adapt existing schema based on new environmental stimuli. The NsLLT research supports this finding, as students with increased neurological complexity and language function will be able to think and reflect on current and new knowledge. The goal for staff and faculty, then, is to support student in their self- authorship process by modeling critical thinking for students, asking questions that encourage self-reflection, and allowing students to express their thinking out loud to make sense of it. This will result in increased cognitive and neurological complexity, and an increased ability to think critically and reflect upon new ideas.

Fourth, the NsLLT literature suggests that context and meaning are important to student development. Schlossberg (1984) states that context determines how an event will cause change in a student. This is supported by cognitive psychology research, which finds context greatly influential in the mental processes of problem solving (Carraher, Carraher, & Schliemann, 1985). One study found that the language development process happens faster when children can use syntax, an understanding of the rules behind word structures (Jackendoff, 2002), to make meaning for new words (Golinkoff, Mervis, & Hirsch- Pasek, 1994). This suggests that student affairs professionals should offer students meaningful learning opportunities that are contextual and neuro-semantic (neurologically meaningful) to spur development, such as opportunities that ask students to reflect on their personal thoughts and experiences.

Conclusion

In summary, the NsLLT offers a new perspective of student development that is lacking in the current literature. Defining student development as an increase in neurological complexity and capacity, the NsLLT explains that students develop as sensory input is processed in the brain and changes the brain at a cellular level (Zull, 2004). Students bring neurologically stored memories to college with them, which create a cognitive and neurological lens through which each student interprets and makes meaning of the college experience. Students' cognitive, neurological, and linguistic development is happening simultaneously throughout college. As neurological structures increase in complexity through sensory experiences, students' cognitive ability to solve complex problems increases. As cognitive and neurological development increases, the ability to learn language advances. This interconnected research, summarized in the NsLLT, builds upon existing student development literature to offer a more in-depth look at student development from the inside.

Student affairs professionals can better understand holistic college student development

through the NsLLT lens and can apply this framework to direct work with students or student programming. Staff can increase the meaningfulness of conversation with students by discussing topics that are relevant and in context, using language that matches the student's current language level. Remembering that students are likely at different levels of development, staff can be sure to explore concepts that are at the student's level by asking questions and allowing the student to lead conversations. This will encourage the student to share their thinking out loud and will guide the staff member in how to structure the conversation meaningfully.

Additionally, staff can model the developmental process for students by allowing students to witness them during critical thinking processes. Modeling this behavior allows students to see what this process looks like and provides a mental picture of how to do this type of explorative thinking. When staff reflect on their own growth, it also invites students into a culture that supports this type of thinking, growth, and reflection.

Through the application of the NsLLT research to practice, student affairs professionals are able to support the whole student: cognitively, neurologically, and linguistically. By understanding the neurological processes that underlie student development, staff can understand why and how students are growing at different rates and in different ways during college. The NsLLT research fills a gap in the literature by explaining how internal human processes overlap with student development theories, such as Baxter Magolda's (2001) Self-Authorship Theory and Schlossberg's (1984) Transition Theory. Future research is needed to continue to understand how the NsLLT literature can be applied to student affairs practice and expand upon student development theory.

References

- Adair-Hauck, B., & Donato, R. (2002). The PACE model: A story-based approach to meaning and form from standards-based language learning. *The French Review*, 76(2), 265-276.
- Allen, M., Glen, J. C., Müllensiefen, D., Schwarzkopf, D. S., Fardo, F., Frank, D., Callaghan, M. F., & Rees, G. (2017). Metacognitive ability correlates with hippocampal and prefrontal microstructure. *NeuroImage*, 149(1), 415-423.
- Anderson, J. R. (2014). Representation of knowledge. In Anderson (Eds.), *Cognitive Psychology and Its Implications*. New York, NY: Worth Publishers.
- Arwood, E. (1983). *Pragmatism: Theory and application*. Gaithersburg, MD: Aspen.
- Arwood, E. (2011). *Language function: An introduction to pragmatic assessment and intervention for higher order thinking and better literacy*. London: Jessica Kingsley Publishers.
- Arwood, E. (2017). Lecture on neuroscience and learning. Personal collection of E. Arwood, University of Portland, Portland, OR.
- Baars, B. J. (2010). *Cognition, brain, and consciousness: Introduction to cognitive neuroscience* (second edition). Burlington, MA: Academic Press/Elsevier.
- Baxter Magolda, M. B. (2001). *Making their own way*. Sterling, VA: Stylus.
- Baxter Magolda, M. B. (2008). Three elements of self-authorship. *Journal of College Student Development*, 49(4), 269-270.
- Baxter Magolda, M. B., Creamer, E. G., & Meszaros, P. S. (2011) *Development and assessment of self-authorship: Exploring the concept across cultures*. Sterling, VA: Stylus Publishing.
- Bower, G. H., Karlin, M. B., & Duek, A. (1975). Comprehension and memory for pictures. *Memory*

- and Cognition*, 3, 216-220.
- Bretherton, I. (1991). Intentional communication and the development of an understanding of mind. In Frye & Moore (Eds.), *Children's theories of mind: Mental states and social understanding*. New Jersey: Lawrence Erlbaum Associates.
- Bruner, J. S. (1975). The ontogenesis of speech acts. *Journal of child language*, 2(1), 1-19.
- Carraher, T. N., Carraher, D. W., & Schliemann, A. D. (1985). Mathematics in the streets and in the schools. *British Journal of Developmental Psychology*, 3, 21-29.
- Chickering, A. W. (1969). *Education and identity*. San Francisco: Jossey-Bass.
- Chickering, A. W., & Reisser, L. (1993). *Education and identity* (second edition). San Francisco, CA: Jossey-Bass.
- Covington, M. V. (1998). *The will to learn: A guide for motivating young people*. Cambridge, UK: Cambridge University Press.
- Dweck, C. S. (1986). Motivational processes affecting learning. *American Psychologists*, 41(10), 1040-1048.
- Evans, N. J., Forney, D. S., & Guido-DiBrito, F. (2010). *Student development in college: Theory, research, and practice* (second edition). San Francisco, CA: Jossey-Bass.
- Erikson, E. (1959). Identity and the life cycle. *Psychological Issues*, 1, 18-164.
- Flavell, J. H. (2004). Theory-of-mind: Retrospect and prospect. *Merrill-Palmer Quarterly*, 50(3), 274-290.
- Gerdes, H., & Mallinckrodt, B. (1994). Emotional, social, and academic adjustment of college students: A longitudinal study of retention. *Journal of Counseling and Development: JCD*, 72(3), 281.
- Golinkoff, R., Mervis, C., & Hirsch-Pasek, K. (1994). Early object labels: The case for a developmental lexical principles framework. *Journal of Child Language*, 21, 125-155.
- Held, C., Knauff, M., & Vosgerau, G. (2006). *Mental models and the mind: Current developments in cognitive psychology, neuroscience, and philosophy of the mind*. Amsterdam, The Netherlands: Elsevier B. V.
- Jackendoff, R. (2002). *Foundations of Language*. New York, NY: Oxford Univ. Press Inc.
- Jones, S. R., & Abes, E. S. (2011). The nature and use of theory. In Schuh, Jones, & Harper (Eds.), *Student services: A handbook for the profession* (fifth edition). San Francisco, CA: Jossey-Bass.
- Jusczyk, P. W., Friederici, A. D., Wessels, J. M., Svenkerud, V. Y., & Jusczyk, A. M. (1993). Infants' sensitivity to the sound patterns of native language words. *Journal of Memory and Language*, 32, 402-420.
- Kapur, S., Craik, F. I. M., Tulving, E., Wilson, A. A., Houle, S., et al. (1994). Neuroanatomical correlates of encoding in episodic memory: Levels of processing affect. *Proceedings of National Academy of Sciences, USA*, 91, 2008-2011.
- Kegan, R. & Lahey, L. L. (2009) *Immunity to change: How to overcome it and unlock the potential in yourself and your organization*. Boston, MA: Harvard Business Press.
- Kimball, E. W., & Ryder, A. J. (2014). Using history to promote reflection: A model for reframing student affairs practice. *Journal of Student Affairs Research and Practice*, 51(3). 298-304.
- King, P. M., & Magolda, M. B. B. (2008). Toward reflective conversations: An advising approach that promotes self-authorship. *Peer Review*, 10(1), 8-11.
- Kolb, B., Gibb, R., & Robinson, T. E. (2003). Brain plasticity and behavior. *Current Directions in*

- Psychological Science*, 12(1), 1-5.
- Kuhl, P. K. (2000). A new view of language acquisition. *Proceedings of the National Academy of Sciences of the United States of America*, 97, 11850–11857.
- Kremmel, B. (2016). Interpreting vocabulary test scores: What do various item formats tell us about learners' ability to employ words? *Language Assessment Quarterly*, 13(4), 377-392.
- Lachman, R., Lachman, J. L., & Butterfield, E. C. (1979). *Cognitive psychology and information processing: An introduction*. New York, NY: Psychology Press.
- Lashley, K. S. (1929). *Brain mechanisms and intelligence*. Chicago, IL: University Press.
- Miller, T. K., & Prince, J. S. (1976). *The future of student affairs: A guide to student development for tomorrow's higher education*. San Francisco, CA: Jossey-Bass.
- Nelson, C. A., De Haan, M., & Thomas, K. M. (2015). *Neuroscience of cognitive development: The role of experience and the developing brain*. Hoboken, NJ: Wiley & Sons Inc.
- Newman, B. M., & Newman, P. R. (2015). *Development through life: A psychological approach* (twelfth edition.). Stamford, CT: Cengage Learning.
- Owens, R. E. (2005). *Language development: An introduction* (sixth edition). Boston, MA: Pearson Education.
- Patton, L. D., Renn, K. A., Guido, F. M., Quaye, S. J., Evans, N. J., & Forney, D. S. (2016). *Student development in college: Theory, research, and practice* (second edition). San Francisco, CA: Jossey-Bass.
- Perry, W.G. (1970). *Forms of intellectual and ethical development in the college years: A scheme*. New York, NY: Holt, Rinehart, and Winston.
- Rodgers, R F. (1990). Recent theories and research underlying student development. In Creamer & Associates (Eds.), *College student development: Theory and practice for the 1990s*. Alexandria, VA: American College Personnel Association.
- Sanford, N. (1967). *Where colleges fail: The study of the student as a person*. San Francisco, CA: Jossey-Bass.
- Schlossberg, N.K. (1984). *Counseling adults in transition: Linking Practice with Theory*. New York, NY: Springer Publishing Company, Inc.
- Schmitt, N. (2014). Size and depth of vocabulary knowledge: What the research shows. *Language Learning*, 64(4), 913-951.
- Skinner, B. F. (1953). *Science and human behavior*. New York, NY: Simon and Schuster.
- Thomsen, D. K., Matthiesen, S., Frederikson, Y., Ingerslev, H. J., Zachariae, R., & Mehlsen, M. Y. (2016). Trait anxiety predicts the emotional valence of meaning-making in life stories: A 10-year prospective study. *Personality and Individual Differences*, 102(1), 51-55.
- Ullman, M. T. (2004). Contributions of memory circuits to language: The declarative/procedural model. *Cognition*, 92, 231–270.
- Wanner, H. E. (1968). On remembering, forgetting, and understanding sentences: A study of the deep structure hypothesis. Unpublished doctoral dissertation, Harvard University, Cambridge, MA.
- Watson, J. B. (1913). Psychology as a behaviorist views it. *Psychological Review*, 20, 158-177.
- Wilson, T. D., Damiani, M., & Shelton, N. (2002). Improving the academic performance of college students with brief attributional interventions. In Aronson (Ed.), *Improving academic achievement: Impact of psychological factors on education*. San Diego, CA: Academic Press.

- Zimmerman, B. J. (1989). A social cognitive view of self-regulated academic learning. *Journal of Educational Psychology*, 81(3), 329-339.
- Zull, J. E. (2004). The art of changing the brain. *Educational Leadership*, 62(1), 68-72.