

PSYCHOLOGICAL AND NEUROBIOLOGICAL SUPPORT FOR LEARNING-STYLE INSTRUCTION: WHY IT WORKS

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ABSTRACT

Humans are complex, dynamic living systems, and living systems survive only if they get what they need from their environments (Ford, 1987). This is why learning-style instruction based on the Dunn and Dunn model (1992, 1993) is effective—students get what they need from their classroom environments. To unpack these statements, this article is divided into answers to two questions: (a) What characteristics distinguish the Dunn and Dunn learning-style model from other learning-style approaches? (b) What psychological theory and/or neurobiological research explains why these characteristics are effective?

Review of learning-style literature revealed that—in comparison to other learning style (LS) approaches—the Dunn and Dunn (1992, 1993) Learning-Style Model: (a) includes greater comprehensiveness, (b) is more extensively researched, and (c) demonstrates higher levels of consistent effectiveness (Dunn, Griggs, Olson, Beasley, & Gorman, 1995; Given, 1996). The question is, why? What characteristics distinguish it from other approaches? Analysis suggests that it is not one thing or another, but a cluster of attributes that psychology and neurobiology support as viable.

Distinguishing Characteristics of the Dunn and Dunn Learning-Style Model

Dunn and Dunn (1993) identified five LS domains (environmental, emotional, sociological, physiological, and psychological) with 21 elements distrib-

uted among them. While these elements produce comprehensiveness, how they are used makes the Dunns' approach unique. In brief: the teacher receives training in styles-responsive instruction and establishes an implementation plan. She creates different learning packages and various tactual materials which address the same learning objectives and content through different sensory modalities—visual, auditory, tactual, and kinesthetic—and different organizational structures—global and analytic. Once preparations are complete, students hear a story about different—but equally “good”—learning styles. Next, students complete a paper and pencil questionnaire about their own preferences for how they approach and complete new and difficult material.

Based on student preferences, teacher and students redesign the classroom to accommodate different preferences for lighting, seating, levels of activity and sound, independent and small-group work, interest centers and so forth. Benefits of each accommoda-

tion are carefully explained and learners are encouraged to select those that they believe will work best for them. Later, students evaluate and decide if their learning was more or less effective. Experimentation, self-assessment, and decision making are stressed while simple, firm classroom rules are maintained: no student's LS accommodations may interfere with or distract anyone else; accommodation abuses result in forfeiture of that privilege; grades must be at least as good as or better than those prior to the experiment; all assignments must be completed; and polite behavior is required.

Students are taught specific small-group strategies for learning and reviewing new information, such as Team Learning, Circles of Knowledge, Brainstorming, Case Study, and Group Analysis (Dunn & Dunn, 1992, 1993). Small-group work is structured to foster collaboration, respect for how others solve problems, peer learning, and peer tutoring. Content is important, but learning how to collaborate and learn are primary concerns. Characteristics such as respect for shared learning, affection, fun, quality work, persistence, responsibility and enhanced learning are hallmarks of small-group and independent activities. To demonstrate in-depth learning and increase retention, students develop instructional materials, share them with peers, and then, if necessary, correct their peers' errors before teacher review. This process provides content review for the creator and peers. Teacher-made tactual materials and learning packages serve at least two purposes: content is fashioned specifically for LS preferences, and students use them as models to design their own materials. "How to" wall posters and direction sheets encourage student construction of self-correcting materials and learning packages.

Distinguishing characteristics of the Dunns' model may be summarized as follows: (a) teacher-made materials are specific to LS needs; (b) students are assessed for LS preferences; (c) students use their LS assessments to explore how they learn best; (d) students and teacher-collaborate for classroom design; (e) students choose where they work, with whom, and with which materials and procedures; (f) instructional objectives and content are presented with various manipulative materials and learning packages; (g) students are held accountable for high standards and quality work; (h) classroom rules are respectful, clear and firm; and (i) emphasis is on teaching students how they learn and how to use their LS to learn effectively.

Psychological Theory that Explains Learning-Style Effectiveness

The above characteristics address critical psychological needs of learners as identified by Leonard (1968), Glasser (1965, 1969, 1990), and Kohn (1993, 1996). Leonard studied needs as motivating drives of humans: the need to be, to belong, to know, to do, and to get or *to have*. These overlap the Dunns' five domains: emotional, sociological, psychological, physiological, and environmental respectively. Specifically, implementation of the Dunn model permits students: *to be* who they are; *to have* their uniqueness honored; *to belong* in small and large groups; *to know* themselves as learners; *to do* by working with manipulative materials; and *to get* recognition by having their basic psychological needs met as far as possible within the classroom.

Glasser (1965) addressed basic psychological needs a bit differently. He said all human beings are born with five basic genetically-determined needs: survival, love, power, fun, and freedom. His suggestions on how to satisfy these needs include: (a) focus on personal interactions by using personal pronouns; (b) focus on what students do that works; (c) focus on present strengths; (d) focus on accommodations in terms of whether they are helping; (e) accept no excuses for lack of success and help students plan for improvement; and (f) eliminate verbal punishment—even when plans fail to work as intended.

Survival is the satisfaction of basic biological needs for food, clothing, and shelter. It also pertains to emotional safety, including a sense of self-worth. Self-worth, stated Glasser, is being responsible for successful completion of self-determined tasks. The Dunns' learning materials have multiple built-in self-evaluations to ensure goal attainment and development of self-worth. Further, self-monitoring gives opportunities to compare self to others which, Glasser believes, helps children see themselves as unique, special, and one-of-a-kind. Failure to reach the standard provides opportunity for self-praise when work and behaviors *are* acceptable. Styles-responsive instruction responds to these needs and suggestions. Thus, students develop their own internal controls without the need for teacher-imposed discipline.

Kohn (1996) believes children have natural predispositions to develop self-controls and internalized commitments to cultural norms and values. Whereas

classroom discipline squelches these predispositions, a style-responsive classroom allows them to flourish, because, as Kohn wrote:

. . . teachers who assume that children are capable of acting virtuously can . . . set into motion a self-fulfilling prophecy . . . if a teacher trusts her students to make decisions, they will act very differently from those in her colleague's classroom if left on their own, typically, they will act responsibly and go right on with their learning. (p. 8)

Self-control provides a *modus operandi* for interactions in all settings, whereas teacher imposed discipline "*actively interferes with what they [teachers] are trying to accomplish*"—namely, student responsibility, self-constructed learning, and positive self-direction (Kohn, 1996, p. xii). Successful teachers *concentrate on goal-directed curriculum, respectful collaboration, and self-correcting opportunities* rather than on discipline (Kohn, 1996). All three of these are intrinsic to the Dunns' model.

Neurobiological Explanations for Learning-Style Effectiveness

Learning is complex because neural tissue that makes learning possible is exceedingly complex. For example, the cortex of the brain—the bark-like outer layer is about as big and as thick as a dinner napkin and contains an estimated 10 billion neurons (Edelman, 1992). Each neuron receives connections from other nerve cells making about one million billion connections or synapses. Gerald Edelman, Nobel prize recipient for his work on how the brain functions, said if synapses were counted one per second night and day, it would take 32 million years to complete the task. How the brain, mind and body act interdependently to create learning style is not known, but the Dunns' five learning style domains provide a few clues.

Emotional Domain

No one knows where motivation, concern for task completion (responsibility), and persistence are located in the brain, but LeDoux (1996), professor at the Center for Neural Science at New York University, believes the four basic emotions—fear, anger, disgust, and joy—are located in different emotional

systems. Basic emotions drive motivation, persistence and responsibility either for negative or positive reasons. LeDoux's work focused on fear, which is mediated by the amygdala—an almond-sized structure toward the brain's center. Fear of bad grades, reprimand, or punishment can motivate students to persevere, but fear tends to decrease student effectiveness rather than increase it (Alkon, 1992; Hart, 1983; LeDoux, 1996). Further, students may get the job done, but fail to develop self-motivation in the process.

The Dunns advocate motivation through joy of choices, decision making, and self-assessment. This is important because the amygdala acts like a permanent tape recorder—especially when significant events occur during critical development. Traumatic experiences with an unforgiving, punitive teacher, for example, can be etched in memory which then colors all future schooling experiences and/or interactions with persons whose characteristics resemble those of the culprit. Based on LeDoux's (1996) work and that of Alkon (1992), chief of the Neural Systems Laboratory at the National Institute of Health, it is conceivable that children forced to learn in ways antagonistic to their strengths can register unpleasant memories of schooling that are difficult to erase. A respectful learning environment where student strengths and the joy of learning are capitalized can be powerful positive motivators opposite that of fear.

Psychological Domain

Since the split-brain research on epileptic patients, much has been written about the role of each hemisphere in learning (Gazzaniga, 1992). Even though language, analytic thought, logic and sequencing are primarily produced in the left hemisphere and creative thought, music, random or simultaneous order are characteristic of the right hemisphere, learning is a coordinated dance of neuronal electro-chemical activity between the two. Even so, there is a tendency to rely more on one than the other.

Several learning-style studies (Dunn, Bruno, Sklar, & Beaudry, 1990; Dunn, Cavanaugh, Eberle, & Zenhausern, 1982; Hannaford, 1996) identified characteristics typical of global right-brain learners and analytic left-brain learners. Global learners prefer music, mapping, conversation, soft light, informal design, working with one or more peers, and snacks while studying, whereas analytic learners prefer the opposite. Global learners tend to be impulsive; whereas analytic learners demonstrate reflection. In a styles-

responsive classroom, these differences are valued equally; whereas traditional schooling primarily honors analytic learners.

Social Domain

The need for companionship evolved over eons of time to serve specific purposes: (a) to achieve closeness to those who are genetically linked; (b) to obtain praise, admiration and/or sexual attention; or (c) to engage in reciprocal favors (Wright, 1994). The relationship of evolution to social preferences—working alone, with peers, or an authority—is unclear, but evolution's role suggested that social preferences may have a neurological base. However, social interactions can change brain functioning. For example, serotonin (a neurotransmitter or chemical messenger) is a "product of social environment" (Wright, 1994, p. 243), and it "plays a major role in . . . the biology of mood, emotion, and other functions mediated by the limbic system" (Restak, 1993/1994, p. 24). Serotonin levels change, dependent upon perceived leadership and perceived power. This is nature's way of preparing people to exert leadership and of equipping them to function as leaders once that status is attained (Wright, 1994). In the Dunns' model, small groups provide safe opportunities for serotonin production and attainment of social status. Thus, high serotonin production may result from frequent leadership opportunities, and this alone could enhance students' positive attitudes toward school.

Dawkins (1976/1989), lecturer in zoology at Oxford, wrote that genes replicate life while *memes* transmit culture. As coined by Dawkins, a meme is a unit of *imitation* which gets planted in the mind and acts like a parasite. Memes in a Dunn and Dunn LS classroom are positive belief statements about strong ability to learn, high capacity to meet standards of achievement, and clear responsibility for learning how to learn. These memes, therefore, parasitize the mind and evolve into reality for students.

Physiological Domain

Learning is first developed through the senses, and LS preferences may relate to stimulation needed to activate them. Studies on hyperactivity, for example, show that frontal brain lobes of hyperactive children are less active than in "normal" youngsters, and hyperactive children move to excite neuronal activity rather than in response to it (Hannaford, 1996; Zametkin, Nordahl, Gross, King, & Semple, 1990).

Neurons function in either on or off positions, and adequate stimulation is needed to trigger electro-chemical processes (Edelman, 1992). Preference for mobility, therefore, may serve to stimulate inactive brain cells so cognition can occur. Similarly, preferences for visual, auditory, tactual, or kinesthetic learning may be in response to levels of neuronal arousal that permit learners to concentrate on specific learning tasks. Further, fatigue and disinterest may result from attempts to learn in non-preferred ways due to conscious effort and sheer determination required to stimulate neuronal activity in those non-preferred modalities.

Alkon (1992) wrote that genetics pre-designs brains to prefer certain patterns of sensory stimulation, but experiences during critical periods cause developmental and learning-induced changes in neural networks to expect consistent satisfaction or deprivation. Once changed, networks help determine all future interests and experience. Modality preferences, therefore, may be the result of environmental experiences as much as they are genetic. In fact, "it is likely that environmental influences could change the basic neural architecture of the brain" to create more than 50% difference in how we learn (Gazzaniga, 1992, p. 50). The Dunns' practice of stimulating secondary and tertiary modality preferences is in keeping with the need for sensory stimulation at a modulated pace. This practice could ultimately strengthen non-preferred modalities and increase learning capability.

Environmental Domain

Although far more environmental elements exist than those listed in the Dunn and Dunn model, sound versus quiet, bright versus dim lighting, warm versus cool temperatures, and formal versus informal furniture design, have clear linkage to the physical domain in terms of body comfort and preferred sensory modalities. Sensory nerves in the eye's retina contain light-receptor cells that receive visual images from the surroundings. Approximately 95% of the receptor cells are peripheral *rods* that are stimulated by dim light and used for three-dimensional sight. *Cones*, the remaining 5%, are clustered in a small area, stimulated by bright light, and used for two-dimensional work such as reading. The ratio of rods to cones suggests that evolution designed the eye for more three-dimensional peripheral focus than two-dimensional, narrow focus (Hannaford, 1996). Dunn and Griggs (1995) reported that "most young children are tactual and/or kinesthetic preferents" (p. 8) which

suggests greater reliance on rods and three-dimensional learning. The importance of this finding is seen in the fact that about 20% of visual input travels to the vestibular system within the inner ear where it assists with balance, and to the reticular activating system in the brain stem which monitors input for passage to the neocortex. Also, more than 90% of vision takes place in the brain from association with touch and proprioception (the body's sense of itself in space) which is a child's way of discovering the world (Hannaford, 1996).

"Low light relaxes and permits better concentration for 8 out of 10 children who do not read well" (Dunn and Dunn, 1993, p. 28). Thus, a close association among dim light, tactual/kinesthetic sensory preferences, and limited academic achievement seems to exist. The fact that the Dunns' approach emphasizes three-dimensional materials and lighting appropriate to student preferences may account for a major portion of its success.

Temperature preferences are biological and seem unrelated to other preferences, whereas preference for formal or informal seating arrangements seem to relate directly to the stimulation needs. "Proprioception . . . is one of our most important ways of knowing" (Hannaford, 1996, p. 42), and it is developmentally linked to the vestibular system which "monitors our ability to sit in a chair, listen to information and take notes." (p. 44). LS research demonstrates that adjusting to seating needs contributes substantially to raising students' academic achievement and enhancing their positive attitudes toward school (Dunn, Beaudry, & Klavas, 1989). Apparently, preferred seating is in response to vestibular needs for balance and/or stimulation.

Preference for sound or quiet while learning is another element that often distinguishes between global and analytic learners. Global learners prefer sound while studying, which may keep the creative right-brain calmly occupied so the left hemisphere can concentrate on linguistic learning without interruption. The analytic left-brain learner may prefer quiet because sound stimulates the less active right brain and causes interruptions to the left-brain concentration. Settings that provide for quiet and sound as needed offer the best auditory environment for learning.

Summary

Throughout this article, speculations of what makes the Dunn and Dunn Learning Style Model ef-

fective were drawn from psychological theory and neurobiological research. Clearly, human learning involves a complex of living systems with differing needs. The science of teaching is to provide positive environments that address these varying needs overtly. The Dunn and Dunn LS approach is unique in this regard. Provisions for different ways of learning in each of five domains provide students opportunities to satisfy their basic psychological and biological instructional needs. As a result, enhanced self-worth increases self-control, positive attitudes toward learning, and increased academic achievement. Psychological theory and neurobiological research, therefore, provide valuable insights regarding why the Dunn and Dunn Learning Style Model works.

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