Two Ways of Knowing

Linda Kreger Silverman

Socrates, the founder of the inductive method (Watson, 1978), was a master at analytical reasoning. Plato, his student, believed in the reality of abstract Forms perceivable only through "the mind's eye," and imperfectly represented in everyday life (Plato's Republic, Jowett trans., 1871/1944, p. 258). Aristotle, Plato's student, denied the Platonic Forms, and turned to biological classification in his search for truth. Like Plato, Aristotle believed that imagery was important, but he added the element of sequentiality: "we recall these images by ordering them in sequence, associating them with one another according to the principles of similarity, contrast, and contiguity" (cited in Wittrock, 1978, p. 61). The threads of analytical, sequential reasoning versus nonsequential, geometric visions of reality create a fascinating dialectic of differing world views throughout the history of psychology. Consider Locke's associationism, Pavlov's classical conditioning, Watson's behaviorism, Skinner's operant conditioning, and Bloom's taxonomy compared with Kant's *a priori Anschauungen*—“the spatial arrangement of objects given in perception" (Boring, 1950, p. 248); the gestalt psychologists—Wertheimer, Kohler, Koffka; Piaget's assessment of formal operational thought; and Guilford's structure-of-intellect model. Some of the greatest minds in psychology conveyed their ideas in analytical sequences of ideas, while others tried to communicate images and geometrical relationships. Is it possible that the clashes in conceptualization can be traced to differences in cerebral processing modes of the theorists?

In an attempt to answer that question, we turn to the field of neurophysiology. Well before the turn of the century, John Hughlings Jackson, a pioneer in brain research, hypothesized that the processing of visual information, perception, and visual imagery are all the province of the right cerebral hemisphere, whereas the processing of auditory information, verbal expression, and propositional thinking are the domain of the left hemisphere (Taylor, 1932/1958). It is interesting to note that Hughlings Jackson's formulation of a hierarchy of levels in the evolution of the nervous system, from simple to complex and from automatic to voluntary, was also pivotal in the development of Dabrowski's theory. Bogen (1969) asserted that the duality of the hemispheres is the basis for many other dualities throughout history—the yin and yang of human experience. He summarized the ways in which the two hemispheres have been described since the mid-nineteenth century: the "major" hemisphere characterized as expressive, linguistic, executive, symbolic, verbal, discrete, logical, analytic and propositional, and the "minor" hemisphere described as visual, visuospatial, kinesthetic, imaginative, perceptual, synthetic, preverbal, nonverbal, diffuse, and appositional.

The deduction that the right and left hemispheres specialize in different functions has been fairly well accepted in the last three decades. "The left cortical hemisphere...specializes somewhat in a propositional, analytic-sequential, time-oriented serial organization well adapted to learning and remembering verbal information" (Wittrock, 1978, p. 65), whereas "the processing of visual images, spatial relationships, face and pattern recognition, gesture, and proportion are seen to be specialized in the right hemisphere" (West, 1991, p. 14).

> A converging body of evidence from unilaterally brain-damaged patients, from investigatings [sic] of normal people, and from split-brain research points to the conclusion that the left hemisphere is vastly superior and dominant to the right in linguistic processing, that it thinks logically, deductively, analytically, and sequentially, that its superiority derives from fundamental differences in the way it processes, decodes, encodes, and arranges information. The right hemisphere is superior and dominant to the left in visuospatial construction, in recording the literal properties of the physical world, in visualizing the relationships of objects in space, and probably, in reaching accurate conclusions in the absence of logical justification. (Levy, 1980, p. 253)

Benbow and her associates have found evidence that intellectually gifted students have enhanced right hemispheric functioning (Benbow, 1986; 1992; O'Boyle & Benbow, 1990). Referring to the work of Geschwind and Behan (1982), in which left-handedness and immune disorders were correlated with enhanced right-hemispheric development, Benbow (1986) found that "80% of mathematically and/or verbally extremely precocious students were left-handed, myopic, and/or had allergies" (p. 724). Summarizing two decades of research, Benbow (1992) reported:

> For the chimeric face task, the right hemisphere was markedly more active than the left, especially at the temporal lobe, while for the average ability students the left hemisphere was somewhat more active. For the verbal task (noun/verb determination), the right hemisphere of the extremely precocious was somewhat more active with the opposite pattern found for the average ability subjects. These electrophysiological data corroborated the behavioral findings of O'Boyle and Benbow (1990a), and support their hypothesis of enhanced right hemisphere processing involvement being a correlate of intellectual precocity....
>
> In this context, it is interesting to note that some of the characteristics that long have been found to describe intellectually talented students...are also thought to characterize the cognitive functions or contributions of the right hemisphere to problem-solving (e.g., see things holistically, deep comprehension, advanced moral reasoning, and humor)....The right hemisphere is thought to be better at dealing with novelty than the left hemisphere.
>
> In summary, evidence is beginning to emerge indicating that the organization of cognitive functions within the left and right hemispheres in the intellectually precocious differs from that found for individuals with more average abilities. The intellectually precocious exhibit enhanced right hemispheric functioning. (p. 104)

However, not all researchers are in complete agreement with the localization of brain functions. For example, Gazzaniga (1985) holds that the left hemisphere, the seat of language processes for the majority of the population, controls general cognitive functioning. He has a modular view of brain organization, similar to Howard Gardner's (1983).

> Clearly what is important is not so much where things are located, but that specific brain systems handle specific tasks. We begin to see that the brain has a modular nature, a point that comes out of all of the data.... That is, it is not important that the left brain does this or the right brain does that. But it is highly interesting that by studying patients with their cerebral hemispheres separated certain mental skills can be observed in isolation. It is a hugely significant point. (Gazzaniga, 1985, pp. 58-59)

It must be kept in mind that there is a complex interaction between the two hemispheres, particularly for higher level thought processes. Wittrock (1978) reminds us that "no dichotomy of function does justice to the sophistication and complexity of the human brain" (p. 66).

Alexander Luria (1973), a leading neuropsychologist, also questioned the localization of verbal functions in the left hemisphere and perceptual or nonverbal functions in the right hemisphere. Like Gazzaniga, he attributed greater cognitive power to the left hemisphere, perceiving it as the source of volitional control of behavior, with the right hemisphere responsible for subconscious, automatic processes not under volitional control. Luria distinguished between simultaneous (all-at-once) and successive (sequential) processing, but he placed successive processing in the fronto-temporal regions of the brain and simultaneous processing in the occipital-parietal region. Simultaneous processing is essential to the discovery of relationships between components and the integration of many stimuli at once, often with spatial overtones (Kaufman, 1984), while successive processing enables the serial ordering of information.

Das, Kirby and Jarman (1979) developed a successive-simultaneous battery based on Luria's theory and validated the model with several studies of children. The simultaneous/sequential distinction became the basis of one of the leading assessments of children's intelligence: *The Kaufman Assessment Battery for Children* (K-ABC) (Kaufman & Kaufman, 1983). A study of gifted young children (ages 4-6) conducted with the K-ABC (Hafenstein, 1986) found intellectual giftedness to be more strongly correlated with simultaneous than sequential processing, and highly gifted children were strong in both types of processing. Sequential processing was related to reading recognition and simultaneous processing with reading comprehension.

From a completely different perspective, Raymond Cattell (1963) proposed a two-factor theory of intelligence—fluid and crystallized abilities—based on factor analytic evidence of the structure among primary mental abilities. Fluid intelligence is general reasoning ability, particularly the process of perceiving relations in figural and spatial material, whereas crystallized intelligence is the product of acculturation—education, training and practice—such abilities as verbal and quantitative reasoning, sequential memory, vocabulary, and reading comprehension. "This kind of ability uses verbal mediation, sound inference, and sequential steps of logic in problem solving" (Harvey & Seeley, 1984, p. 76). Cattell (1963) proposed that fluid intelligence is physiologically determined, but his collaborator, Horn (1976), and many other researchers who accept the basic theory, (e.g., Snow, 1981; Thorndike, 1963), reject the implication that fluid abilities are innate. Cattell's theory of fluid and crystallized abilities strongly influenced Sternberg's (1985) triarchic theory of intelligence and became the basis of another major intelligence test: the *Stanford-Binet Intelligence Scale, Revision IV* (Thorndike, Hagen & Sattler, 1986).

Harvey and Seeley (1984) used Cattell's theory in their analysis of the abilities of youth in a juvenile detention center. Fifteen percent of the youth scored in the top third percentile on selected subtests of the WISC and WAIS, and the gifted offenders demonstrated higher fluid than crystallized abilities.

> This pronounced elevation of the nonverbal areas of ability is evidenced among the gifted students in this study.... The fluid ability of these students had the greatest contribution to the gifted classification.... The traditional classroom situation appeared to have suppressed these students' high fluid abilities in the process of their learning of academic skills. (p. 77)

Fluid intelligence sounds very much like Luria's simultaneous factor and the visual-spatial abilities attributed to the right hemisphere. Crystallized intelligence seems to incorporate Luria's successive factor, and the linguistic competencies attributed to the left hemisphere. Regardless of their location in the brain, there appear to be two factors—two basic ways of knowing—that need to be taken into account in educating gifted children: spatial or fluid abilities and sequential or crystallized abilities. Hughlings Jackson (in Taylor, 1932/1958) proposed that the left hemispheric abilities are related to audition and that the right hemispheric abilities related to vision. Spatial and visual are often combined as a single factor: "spatial-visualization ability" (Lohman, 1989) and the connection between sequencing and audition has been established in studies of impaired auditory processing (Northern & Downs, 1994), and the development of reading skills (N. Jackson, in press). The eye is considered a "synthetic organ," since it mixes different wavelengths of light so that we perceive a single color, while the ear is an "analytical organ," since it analyzes different frequencies of sound waves so that we can detect the individual components (Carlson, 1995, pp. 171-172). Temporal (time-sequenced) information is processed auditorily and spatial information is processed visually.

Visual-Spatial and Auditory-Sequential Learners

Two basic learning styles—visual-spatial and auditory-sequential—have been found in gifted children through psychometric assessment (Silverman, 1989a; 1989b). Highly gifted children excel at both types of learning. In 1980, a pattern of visual-spatial strengths was observed in children whose scores fell beyond the norms in the manual. Item analyses revealed that it was exceptional performance on visual-spatial items on the

Stanford-Binet Intelligence Scale (Form L-M) (Terman & Merrill, 1973) that enabled some children to attain extremely high IQ scores. A second group was identified in 1981 who had very high visual-spatial abilities coupled with significantly lower auditory-sequential abilities. They could perform well beyond age level on memory for abstract designs, spatial orientation, visualization, and mathematical induction problems, but they could not repeat five random digits, repeat sentences accurately, or name the days of the week in order. The majority of children in the second group were underachieving in school, with marked weaknesses in spelling, computation and writing skills. In addition, a correlation was found between this second pattern and chronic otitis media (ear infections) within the first three years of life (Silverman, 1989a). The sequential weaknesses observed were often tied to weak auditory processing abilities, confirmed in later audiological evaluations.

Over time, the term *visual-spatial learner* has become synonymous with the second group of children who are strong on visual-spatial items and weak on auditory-sequential items. From the descriptors of sequential and spatial learners listed in Table 7, it becomes apparent why the educational system works more effectively for sequential learners than for spatial learners, and why sequential learners are more often selected for gifted programs than spatial learners (Dixon, 1983; Silverman, 1989a).

Insert Table 5 about here

Contrary to the suppositions that these learners are less able in verbal reasoning (e.g., Dixon, 1983; Gardner, 1983; West, 1991), gifted visual-spatial learners usually obtain higher scores on verbal than on nonverbal measures (Silverman, in press). They excel in the Verbal Comprehension Factor (Vocabulary, Similarities, Information and Comprehension) of the Wechsler Intelligence Scales and in verbally loaded intelligence tests, such as the *Stanford-Binet Intelligence Scale (Form L-M)*. Their primary weakness tends to be in sequential processing, as indicated by significantly lower scores on subtests with high sequential loadings (e.g., Digit Span, Coding, and Arithmetic). Lohman (1994), in an article aptly entitled, "Spatially Gifted, Verbally Inconvenienced," has a similar argument with the verbal/spatial dichotomy:

> The problem is erroneously labeled a discrepancy between verbal and spatial abilities, which it is not. The key is not verbal ability, but fluency in retrieving words, particularly on the basis of their sound patterns, or fluidity in assembling novel utterances. On the spatial side, it is the ability to generate and manipulate gestalten or whole patterns, usually of a fairly concrete sort, but in a fluid and flexible way. (p. 252)

Visual-spatial learners describe their learning process as "thinking in images," while auditory-sequential learners appear to think in words. Spatial learning is all-at-once and sequential learning is step-by-step. At times, gifted spatial students have been referred to as "inverted learners" or "upside-down learners" because they learn difficult, abstract material easily and the easy, sequential skills are difficult for them to master (West, 1991). Areas of strength for visual-spatial learners often include construction toys (e.g., Legos), puzzles and mazes, chess, mathematical reasoning, map reading, geometry, topology, science, computer programming, metaphoric thinking, and interdisciplinary studies. Some gifted spatial learners excel in the fine arts or mechanical abilities rather than mathematics, science and technology. Still others with highly developed empathy or intuition demonstrate unusual emotional, moral or spiritual sensitivity. Areas of weakness may include phonics, spelling, handwriting, foreign languages, rote memorization, timed situations, verbal fluency under pressure, and attention when information is presented verbally without visual aids.

Auditory-sequential learners are good listeners, are comfortable with step-by-step approaches to instruction, tend to be rapid processors of verbal information, and are generally able to express themselves well verbally. Schools are tailored to this kind of learning style. In contrast, visual-spatial learners are astute observers, think holistically in images, may arrive at conclusions without going through a series of steps (which makes it difficult for them to show their work), and may take longer to express their imaged perceptions in words. They often feel out of step in traditional educational settings. Gifted auditory-sequential learners are more likely to be high achievers in academic subjects, to be selected for gifted programs, to be recognized by their teachers as having high potential, and to be considered leaders. Gifted visual-spatial learners are more often counted among underachieving and disenfranchised groups, twice exceptional children (giftedness combined with learning disabilities), dyslexics, children with attention deficit disorders, and creative children from minority groups.

Auditory-sequential learners can often be recognized by scholastic success. Visual-spatial learners usually need diagnostic testing in order to determine if the degree of disparity between their strengths and weaknesses is severe enough to indicate a learning disability. Students who score 16 or above on the Block Design subtest of the Wechsler tests (WISC, WAIS, or WPPSI), in the gifted range on the abstract visual reasoning section of the *Stanford-Binet Fourth Edition*, or in the superior range on any assessment of visual-spatial abilities (e.g., the *Matrix Analogies Test*, Raven's *Progressive Matrices*, the *Mental Rotations Test*, etc.) have documented giftedness in the spatial domain. High Block Design scores combined with significantly lower Digit Span scores, or Performance IQs significantly higher than Verbal IQs, are usually indicative of a visual-spatial pattern of learning.

A new instrument for students, teachers and parents is in the development stages: *The Visual-Spatial Identifier* (VSI). It is being constructed by an interdisciplinary group of psychologists, neuropsychiatrists, sociologists, reading specialists, gifted program coordinators, speech pathologists, artists, tutors, and parents. Thirty-seven positive characteristics of the visual-spatial learning style and 66 concomitant school problems have been generated. The descriptors comprise eight clusters: (1) visual rather than auditory; (2) spatial rather than sequential; (3) holistic rather than detailed; (4) focused on ideas rather than format; (5) pattern-seeking; (6) divergent rather than convergent; (7) sensitive; and (8) asynchronous (exhibiting large disparities between strengths and weaknesses) (Silverman, in press). The following are some sample questions from the student version, *The VSI, Student Report*:

1. I am an excellent visualizer.
2. I think primarily in images instead of words.
3. I have trouble expressing myself in words.
4. I learn better from seeing than from listening.

(Silverman, in press)

Three pilot studies have been conducted to date with (1) children and adults referred to the Gifted Development Center; (2) children referred to a clinic for attentional deficits; and (3) middle school students who excelled in mathematics. Initial results indicate that there is considerable agreement between parental report and self-report on the two different instruments, and that the wording of some of the items is too complex for many children. The self-report is currently under revision.

Spatial children appear to develop in a different manner from the norm. Normally, children progress at around age nine from a phase of eidetic imagery to what has been considered a more sophisticated linguistic phase (Bruner, Goodnow & Austin, 1966; Luria, 1961). Lohman (1994) believes that "high-spatial individuals preserve in adulthood imagery abilities that are lost to most individuals as they mature" (p. 255), and that those with heightened imagistic abilities have a potential for "visual-spatial creativity of a high order" (p. 255). He suggests that high level creativity is fostered in children who are slower in language development, who are homeschooled during their early school years, and who are furnished with construction toys, such as wooden cubes, geometric puzzles, and mechanical models. "Research suggests that the decline in the relative strength of visual-spatial abilities is not entirely due to disuse, but to their incompatibility with sequential modes of processing" (Lohman, 1994, p. 260). Bruner (1973) recommends programs that stimulate visual thinking and problem solving. And Lohman wistfully concurs: "I wonder what my life would be like had my education given as much attention to the development of my visual-spatial abilities as to my verbal abilities" (p. 263).

How do auditory-sequential learners learn best? Apparently, these students adapt and thrive in most educational environments. How do visual-spatial learners learn best? The following guidelines can assist teachers in adapting lessons to capitalize on visual-spatial strengths:

1. Present ideas visually on the chalkboard or on overheads. "A picture is worth a thousand words." Use rich, visual imagery in lectures.
2. Teach the student to visualize spelling words, math problems, etc. An effective method of teaching spelling is to write the word in large, colored print and present it to the student at arm's length, slightly above eye level. Have her close her eyes, visualize the word, then create a silly picture of the word in her mind. Then have her spell it backwards (this demonstrates visualization), then forwards, then write it once.
3. Use inductive (discovery) techniques as often as possible. This capitalizes on the visual-spatial learner's pattern-finding strength.

4. Teach the student to translate what he or she hears into images, and record those images using webbing, mind-mapping techniques, or pictorial notes.
5. Incorporate spatial exercises, visual imagery, reading material that is rich in fantasy, and visualization activities into the curriculum. Spatial conceptualization has the ability to go beyond linear thinking because it deals more readily with immense complexities and the interrelations of systems.
6. To accommodate introverts, allow the student to observe others before attempting activities. Stretch wait time after questions and have all students write answers before discussing. Develop a signal system during class discussions that allows introverts to participate.
7. Avoid drill, repetition, and rote memorization; use more abstract conceptual approaches and fewer, more difficult problems.
8. Teach to the student's strengths. Help the student learn to use these strengths to compensate for weaknesses. Visualization and imagination are the visual-spatial learner's most powerful tools and should be used frequently.
9. Allow the student to use a computer for assignments, and, in some subjects, for instruction. Teach the student how to use a keyboard effectively.
10. Give untimed power tests. Students with severe processing lags can apply to take their college board examinations untimed if the disability is documented through IQ and achievement testing within three years of the exams, and if teachers have provided extended time for tests.
11. Give more weight to the content of papers than to format. These students often suffer from deficits in mechanics: spelling, punctuation, paragraphing, etc.
12. Allow the student to construct, draw or otherwise create visual representations of a concept as a substitute for some written assignments.
13. If a bright student struggles with easy, sequential tasks, see if he can handle more advanced, complex work. Acceleration is more beneficial for such a student than remediation.
14. Expose the visual-spatial learner to role models of successful adults who learn in a similar manner. Many of the most celebrated physicists were visual-spatial learners. Biographical sketches of famous visual-spatial learners can be found in *The Spatial Child* (Dixon, 1983), *In the Mind's Eye* (West, 1991), and the spatial intelligence chapter in *Frames of Mind* (Gardner, 1983).
15. Be emotionally supportive of the student. Visual-spatial learners are keenly aware of their teachers' reactions to them, and their success in overcoming their difficulties appears directly related to their perception of the teacher's empathy.

Some good books on spatial learning are West's (1991) *In the Mind's Eye,* and Dixon's (1983) *The Spatial Child*,. For more detailed information on meeting the needs of spatial learners in the classroom, see Silverman (1989a; 1989b).

Many highly gifted children prefer the visual-spatial approach to learning, but they can also switch back and forth between the two modes easily, and tend to rely on their well-developed sequential abilities when they cannot immediately apprehend a concept by means of spatial perception. Correlations have also been noted between visual-spatial learning preference and introversion (Dixon, 1983; Lohman, 1994; Riding, 1983; Silverman, 1989b). "Children who showed a preference for imagistic processing were much more likely to be introverted, whereas those who showed a preference for verbal elaboration were more likely to extraverted" (Lohman, 1994, pp. 256-257). The emergent pattern is that gifted spatial learners are likely to favor the visual modality, to be intuitive, to prefer perceiving to judging, and to be more introverted than extraverted. They tend to demonstrate high degrees of overexcitability, particularly imaginational, emotional, sensual, and psychomotor. Gifted sequential learners are more likely to favor the auditory modality and are equally apt to be introverts or extraverts. Most of them will be intuitive, but some will prefer sensing, and a large number, particularly high school students, will be organized, planful Js rather than organizationally impaired Ps. They will probably score higher on intellectual, emotional and imaginational overexcitabilities than on sensual and psychomotor.

It must be kept in mind that while these correlations hold for the majority of children assessed, some sequential learners prefer vision to audition, some spatial learners prefer audition to vision, and some visual-spatial learners are predominantly extraverted. There is also great variation in patterns of overexcitability. The most difficult children to diagnose are those who have weaknesses in both auditory and visual modalities. They are often labeled "kinesthetic learners," since they need concrete, tactile experiences to help them compensate for weaknesses in the major modalities.

School can be an unpleasant experience for visual-spatial learners. Yet, their learning style may be uniquely suited for our technological future (West, 1991). With appropriate detection and classroom modifications, these students can be highly successful, particularly as they tackle more complex subject matter in high school and college. Visual-spatial learners show promise as future engineers, architects, pilots, mathematicians, scientists, computer programmers or technicians, entrepreneurs, artists, musicians, mechanics, human relations professionals, or spiritual leaders. They are our quintessential "late bloomers." Their chances of blooming are greater when they have teachers who recognize their promise, and adapt teaching strategies to fit their learning style.

It would be ideal if all teachers could modify their teaching styles to take into account all 24 of Dunn and Dunn's (1975) environmental, sociological, physical and psychological elements, as well as the different learning needs of all 16 types on the MBTI, and all the possible permutations and strengths of Dabrowski's five overexcitabilities. However, it might be simpler to start with the dichotomy between auditory-sequentials and visual-spatials and assume that the current program is working effectively for the majority of the first group. The 15 strategies listed above can be incorporated one at a time to observe their effectiveness.

References

Ackerman, C. M. (1993). Investigating an alternate method of identifying gifted students. Unpublished master's thesis, University of Calgary, Calgary, Alberta.

Ackerman, C. M. (in press). Identifying gifted adolescents using personality characteristics: Dabrowski's overexcitabilities. Roeper Review.

Ammirato, S. P. (1987). Comparison study of instruments used to measure developmental potential according to Dabrowski's theory of emotional development. Unpublished doctoral dissertation, University of Denver, Denver, CO.

Barbe, W. B., Swassing, R. H., & Milone, M. N. (1979a). The Swassing-Barbe Modality Index: Zaner-Bloser Modality Kit. Columbus, OH: Zaner-Bloser.

Barbe, W. B., & Swassing, R. H., with M. N. Milone. (1979b). Teaching through modality strengths: Concepts and practices. Columbus, OH: Zaner-Bloser.

Benbow, C. P. (1986). Physiological correlates of extreme intellectual precocity. Neuropsychologia, 24, 719-725.

Benbow, C. P. (1992). Mathematical talent: Its nature and consequence. In Colangelo, S. G. Assouline, & D. L. Ambroson (Eds.), Talent development: Proceedings of the 1991 Henry B. and Jocelyn Wallace National Research Symposium on Talent Development (pp. 95-123). Unionville, NY: Trillium Press.

Bireley, M. (1991). Learning styles: One way to help gifted adolescents understand and choose lifestyles. In Bireley, M., & Genshaft, J. Understanding the gifted adolescent: Educational, developmental, and multicultural issues (pp. 189-200). New York: Teachers College Press.

Black, J. D. (1980). Publisher's foreword. In Myers, I. B., with Myers, P. B. Gifts differing (pp. ix-xii). Palo Alto, CA: Consulting Psychologists Press.

Bogen, J. E. (1969). The other side of the brain. II: An appositional mind. Bulletin of the Los Angeles Neurological Society, 34, 135-162.

Boring, E. G. (1950). A history of experimental psychology (2nd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Bradway, K. (1964). Jung's psychological types. Journal of Analytical Psychology 9, 129-135.

Breard, N.S. (1994). Exploring a different way to identify gifted African-American students. Unpublished doctoral dissertation, University of Georgia, Athens, GA.

Bruner, J. S. (1973). Beyond the information given. New York: W. W. Norton.

Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1966). A study of thinking. New York: John Wiley.

Buerschen, T. (1995). Researching an alternative assessment in the identification of gifted and talented students. Unpublished research project, Miami University, Oxford, OH.

Calic, S. (1994). Heightened sensitivities as an indicator of creative potential in visual and performing arts. University of Georgia, Athens, GA.

Card, C. N. W. (1994). Discover the power of introversion: What most introverts are never told and extraverts learn the hard way. Gladwyne, PA: C. O. Type and Temperament Press.

Carlson, N. R. (1995). Foundations of physiological psychology (3rd ed.). Boston: Allyn & Bacon.

Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. Journal of Educational Psychology, 54, 1-22.

Dabrowski. K. (1937). Psychological bases of self-mutilation. Genetic Psychology Monographs, 19, 1-104.

Dabrowski, K. (1964). Spoleczno-wychowawcza psychiatria dziecieca (2nd ed.) (Social-educational child psychiatry.) Warsaw: Panstwowy Zaklad Wydawnictw Szkolnych. (Original work published 1959)

Dabrowski, K., with A. Kawczak & M. M. Piechowski (1970). Mental growth through positive disintegration. London: Gryf.

Das, J. P., Kirby, J., & Jarman, R. F. (1979). Simultaneous and successive cognitive processes. New York: Academic Press.

Dauber, S. L., & Benbow, C. P. (1990). Aspects of personality and peer relations of extremely talented adolescents. Gifted Child Quarterly, 34, 10-15.

Delbridge-Parker, L. (1988). Two perspectives on gifted students: Time one of a longitudinal study of academically gifted Iowa students, and program evaluation of CY-TAG, a summer residential program for highly gifted seventh and eighth grade students. Unpublished doctoral dissertation, Iowa State University, Ames.

Delbridge-Parker, L., & Robinson, D. C. (1989). Type and academically gifted adolescents. Journal of Psychological Type, 17, 66-72.

Dixon, J. P. (1983). The spatial child. Springfield, IL: Charles C. Thomas.

Domroese, C. (1993). Investigating an alternate method for identifying gifted students. Research project, Oak Park Elementary School District #97, Oak Park, IL.

Doyle, Sir A. C. (1930). The complete Sherlock Holmes. New York: Doubleday. (Original work published 1892)

Dunn, R. (1983). Learning style and its relation to exceptionality at both ends of the spectrum. Exceptional Children, 49, 496-506.

Dunn, R., & Dunn, K. (1975). Learning style inventory. Lawrence, KS: Price Systems. (Revised edition, with G. Price, 1979).

Ely, E. (1995). The overexcitability questionnaire: An alternative method for identifying creative giftedness in seventh grade junior high school students. Unpublished doctoral dissertation, Kent State University, Kent, OH.

Falk, R. F., Manzanero, J. B., & Miller, N. B. (in press). Developmental potential in Venezuelan and American artists: A cross-cultural validity study. The Creativity Research Journal.

Falk, F., Piechowski, M. & Lind, S. (1994). Criteria for rating the intensity of overexcitabilities. Unpublished manuscript, Department of Sociology, University of Akron.

Farris, D. (1991). Type tales. Palo Alto, CA: Consulting Psychologists Press.

Felder, R. F. (1982, October). Developmental potential of chemical engineering and gifted education graduate students. Paper presented at the National Association for Gifted Children, New Orleans, L

Gallagher, S. A. (1985). A comparison of the concept of overexcitabilities with measures of creativity and school achievement in sixth grade students. Roeper Review, 8, 115-119.

Gallagher, S. A. (1990). Personality patterns of the gifted. Understanding Our Gifted, 3(1), 1, 11-13.

Gardner, H. G. (1983). Frames of mind: The theory of multiple intelligences. New York: Basic.

Gazzaniga, M. S. (1985). The social brain: Discovering the networks of the mind. New York: Basic.

Geschwind, N., & Behan, P. (1982). Left-handedness: Association with immune disease, migraine, and developmental learning disorders. Proceedings of the National Academy of Science, USA, 79, 5097-5100.

Gottfried, A. W., Gottfried, A. E., Bathurst, K., & Guerin, D. W. (1994). Gifted IQ: Early developmental aspects. The Fullerton longitudinal study. New York: Plenum.

Guisewite, C. (1994). Hallmark stickers. Kansas City, MO: Hallmark Cards.

Hafenstein, N. L. (1986). The relationship of intellectual giftedness, information processing style, and reading ability in young gifted children. Unpublished doctoral dissertation, University of Denver.

Hall, C. S., & Lindzey, G. (1970). Theories of personality (2nd ed.). New York: John Wiley.

Harvey, S., & Seeley, K. R. (1984). An investigation of the relationships among intellectual and creative abilities, extracurricular activities, achievement, and giftedness in a delinquent population. Gifted Child Quarterly, 28, 73-79.

Helson, R. (1965). Childhood interest clusters related to creativity in women. Journal of Consulting Psychology, 29, 352-361.

Hoehn, L., & Bireley, M. K. (1988). Mental processing preferences of gifted children. Illinois Council for the Gifted Journal, 7, 28-31.

Hollingworth, L. S. (1939). What we know about the early selection and training of leaders. Teachers College Record, 40, 575-592.

Horn, J. L. (1976). Human abilities: A review of research theory in the early 1970s. Annual Review of Psychology, 27, 437-485.

Jackson, N. (in press). Strategies for modeling the development of giftedness in children: Reconciling theory and method. In R. Horowitz & R. Friedman (Eds.), The gifted and talented: Theories and reviews. Washington, DC: American Psychological Association.

Jackson, P. S. (1995). Bright star: black sky. Origins and manifestations of the depressed state in the lived experience of the gifted adolescent. A phenomenological study. Unpublished master's thesis, Vermont College, Norwich University, Norwich, VT.

Jung, C. G. (1938). Psychological types or the psychology of individuation. (H. G. Baynes, Trans.). London: Kegan Paul, Trench, Trubner & Co., Ltd. (Original work published 1923)

Kaufman, A. S. (1984). K-ABC and giftedness. Roeper Review, 7, 83-88.

Kaufman, A. S., & Kaufman, N. L. (1983). Kaufman Assessment Battery for Children. Circle Pines, MN: American Guidance Service.

Keefe, J. W., & Monk, J. S. (1986). Learning style profile. Reston, VA: National Association of Secondary School Principals.

Keirsey, D., & Bates, M. (1978). Please understand me: Character and temperament types. Del Mar, CA: Prometheus Nemesis Books.

Kolb, D. A. (1976). Learning style inventory. Boston: McBer.

Lawrence, G. (1982). People types and tiger stripes: A practical guide to learning styles (2nd ed.). Gainesville, FL: Center for Applications of Psychological Type.

Levy, J. (1980). Cerebral asymmetry and the psychology of man. In M. C. Wittrock (Ed.), The brain and psychology. New York: Academic Press.

Lewis, G. (1984). Alternatives to acceleration for the highly gifted child. Roeper Review, 6, 133-136.

Lohman, D. F. (1989). Human intelligence: An introduction to advances in theory and research. Review of Educational Research, 59, 333-373.

Lohman, D. F. (1994). Spatially gifted, verbally inconvenienced. In N. Colangelo, S. G. Assouline, & D. L. Ambroson (Eds.). Talent development: Proceedings from the 1993 Henry B. and Jocelyn Wallace National Research Symposium on Talent Development (pp. 251-264). Dayton, OH: Ohio Psychology Press.

Luria, A. (1961). The role of speech in the regulation of normal and abnormal behavior. New York: Liveright.

Luria, A. (1973). The working brain: An introduction to neuropsychology. (B. Haigh, trans.). New York: Basic Books.

Lysy, K. Z., & Piechowski, M. M. (1983). Personal growth: An empirical study using Jungian and Dabrowskian measures. Genetic Psychology Monographs, 108, 267-320.

MacKinnon, D. W. (1962). The nature and nurture of creative talent. American Psychologist, 17, 484-495.

MacKinnon, D. W. (1965). Personality and the realization of creative potential. American Psychologist, 20, 273-281.

Maker, C. J. (1975). Training teachers for the gifted and talented: A comparison of models. Reston, VA: Council for Exceptional Children.

Manzanero, J. (1985). A cross-cultural comparison of overexcitability profiles and levels of emotional development between American and Venezuelan artists. Unpublished master's thesis, University of Denver, Denver, CO.

Meckstroth, E. (1991, December). Coping with sensitivities of gifted children. Paper presented at the Illinois Gifted Education Conference, Chicago, IL.

Meisgeier, C., & Murphy, E. (1987). Murphy-Meisgeier Type Indicator for Children. Palo Alto, CA: Consulting Psychologists Press.

Miller, N. B., Silverman, L. K., & Falk, R. F. (1994). Emotional development, intellectual ability and gender. Journal for the Education of the Gifted, 18, 20-38.

Myers, I. B. (1962). Manual: The Myers-Briggs type indicator. Palo Alto, CA: Consulting Psychologists Press.

Myers, I. B., & McCaulley, M. H. (1985). Manual: A guide to the development and use of the Myers-Briggs Type Indicator. Palo Alto, CA: Consulting Psychologists Press.

Myers, I. B., with Myers, P. B. (1980). Gifts differing. Palo Alto, CA: Consulting Psychologists Press.

Nelson, K. C. (1992). Kazimierz Dabrowski: Poland's Gifted 'Outsider'. In N. Colangelo, S. G. Assouline, & D. L. Ambroson (Eds.). Talent development: Proceedings of the 1991 Jocelyn Wallace National Research Symposium on Talent Development (pp. 357-361). Unionville, NY: Trillium Press.

Nixon, L. (in press). Factors predispositional of creativity and mysticism: A comparative study of Charles Darwin and Therese of Lisieux. Advanced Development, 7.

Northern, J. L., & Downs, M. P. (1994). Hearing in children (4th ed.). Baltimore, MD: Williams & Wilkins.

O'Boyle, M. W., & Benbow, C. P. (1990). Enhanced right hemisphere involvement during cognitive processing may relate to intellectual precocity. Neuropsychologia, 28, 211-216.

Perrin, J. (1982). Learning style inventory: Primary version. Jamaica, NY: Learning Styles Network, St. John's University.

Piechowski, M. M. (1974). Two developmental concepts: Multilevelness and developmental potential. Counseling and Values, 18(2), 86-93.

Piechowski, M. M. (1979). Developmental potential. In N. Colangelo & R. T. Zaffrann (Eds.), New voices in counseling the gifted (pp. 25-57). Dubuque, IA: Kendall/Hunt.

Piechowski, M. M. (1992). Giftedness for all seasons: Inner peace in a time of war. In N. Colangelo, S. G. Assouline, & D. L. Ambroson (Eds.), Talent development: Proceedings of the Henry B. and Jocelyn Wallace National Research Symposium on Talent Development (pp. 180-203). Unionville, NY: Trillium Press.

Piechowski, M. M. (1995). OE origins. The Dabrowski Newsletter, 1(4), 2-4.

Piechowski, M. M., & Colangelo, N. (1984). Developmental potential of the gifted. Gifted Child Quarterly, 28, 80-88.

Piechowski, M. M., & Cunningham, K. (1985). Patterns of overexcitability in a group of artists. Journal of Creative Behavior, 19(3), 153-174.

Piechowski, M. M., & Miller, N. B. (1995). Assessing developmental potential in gifted children: A comparison of methods. Roeper Review, 17, 176-180.

Piechowski, M. M., Silverman, L. K., & Falk, R. F. (1985). Comparison of intellectually and artistically gifted on five dimensions of mental functioning. Perceptual and Motor Skills, 60, 539-549.

Piirto, J. (1990). Profiles of creative adolescents. Understanding Out Gifted, 2(3), 1, 10-12.

Piirto, J. (1992). Understanding those who create. Dayton, OH: Ohio Psychology.

Price, G. E., Dunn, K., Dunn, R., & Griggs, S. (1981). Studies in students' learning styles. Roeper Review, 4(2), 38-40.

Plato's Republic. (1944). (B. Jowett, trans.) New York: Vintage Books. (Original work published 1871)

Provost, J. A. (1988). Procrastination: Using psychological type concepts to help students. Gainesville, FL: Center for Applications of Psychological Type.

Rankel, M. D. (1994, October). Creativity through Dabrowski's eyes. The Dabrowski Newsletter, pp. 2, 4.

Renzulli, J. S., & Smith, L. H. (1978). Learning styles inventory. Mansfield, CT: Creative Learning Press.

Riding, R. J. (1983). Extraversion, field independence, and performance on cognitive tasks in twelve-year-old children. Research in Education, 29, 1-9.

Roedell, W. C., Jackson, N. E., & Robinson, H. B. (1980). Gifted young children. New York: Teachers College, Columbia University.

Rogers, M. T. (1986). A comparative study of developmental traits of gifted and average children. Unpublished doctoral dissertation, University of Denver, Denver, CO.

Rogers, M. T., & Silverman, L. K. (1988). Recognizing giftedness in young children. Understanding Our Gifted, 1(2), 5, 16-17, 20.

Rowe, M. B. (1974). Relation of wait-time and rewards to the development of language, logic, fate control: Part II rewards. Journal of Research in Science Teaching, 11, 291-308.

Runions, T. (1988). The individualized school. Unpublished manuscript.

Schiever, S. W. (1985). Creative personality characteristics and dimensions of mental functioning in gifted adolescents. Roeper Review, 7, 223-226.

Silver, H. F., & Hanson, J. R. (1978). The Hanson-Silver learning preference inventory. Moorestown, NJ: Institute for Cognitive and Behavioral Studies.

Silver, H. F., & Hanson, J. R. (1980). User's manual: The TLC learning preference inventory. Moorestown, NJ: Institute for Cognitive and Behavioral Studies.

Silverman, L. K. (1982). [Overexcitabilities of gifted education graduate students.] Unpublished raw data.

Silverman, L. K. (1983). Personality development: The pursuit of excellence. Journal for the Education of the Gifted, 6(1), 5-19.

Silverman, L. K. (1985). [Myers-Briggs Type Indicator scores for graduate students in gifted education]. Unpublished raw data.

Silverman, L. K. (1986). Parenting young gifted children. Journal of Children in Contemporary Society, 18, 73-87.

Silverman, L. K. (1989a). Invisible gifts, invisible handicaps. Roeper Review, 12, 27-42.

Silverman, L. K. (1989b). The visual-spatial learner. Preventing School Failure, 34(1), 15-20.

Silverman, L. K. (1993a). Counseling families. In L. K. Silverman (Ed.), Counseling the gifted and talented (pp. 151-178). Denver: Love.

Silverman, L. K. (1993b). A developmental model for counseling the gifted and talented. In L. K. Silverman (Ed.), Counseling the gifted and talented (pp. 51-78). Denver: Love.

Silverman, L. K. (in press). Toward the construction of an instrument to assess visual-spatial learners. In N. Colangelo & S. G. Assouline (Eds.) Talent development: Proceedings from the 1995 H. B. and Jocelyn Wallace National Research Symposium on Talent Development. Dayton, OH: Ohio Psychology Press.

Silverman, L. K., & Ellsworth, B. (1980). The theory of positive disintegration and its implications for giftedness. In N. Duda (Ed.), Theory of positive disintegration: Proceedings of the third international conference (pp. 179-194). Miami, FL: University of Miami School of Medicine.

Snow, R. E. (1981). Toward a theory of aptitude for learning: Fluid and crystallized abilities and their correlates. In M. P. Friedman, J. P. Das, & N. O'Connor (Eds.), Intelligence and learning (pp. 345-362). New York: Plenum Press.

Sorell, G. T., & Silverman, L. K. (1983). [Emotional development of women in mid-life.] Unpublished raw data.

Stewart, E. D. (1981). Learning styles among gifted/talented students: Instructional technique preferences. Exceptional Children, 48, 134-138.

Sternberg, R. J. (1985). Beyond IQ: A triarchic theory of human intelligence. Cambridge: Cambridge University Press.

Taylor, J. (Ed.). (1958). Selected writings of John Hughlings Jackson. New York: Basic Books. (Original work published 1932)

Terman, L. M., & Merrill, M. A. (1973). The Stanford-Binet Intelligence Scale: Manual for the Third Revision Form L-M. Boston: Houghton Mifflin.

Thomas, A., Chess, S., & Birch, H. G. (1968). Temperament and behavior disorders in children. New York: New York University Press.

Thorndike, R. L. (1963). The concepts of over- and under-achievement. New York: Columbia University, Teachers College.

Thorndike, R. L., Hagen, E. P., & Sattler, J. M. (1986). The Stanford-Binet Intelligence Scale: Fourth edition. Technical manual. New York: Riverside.

Tolan, S. S. (1995, May). Honoring the mind. Keynote address presented at the Hollingworth Center for Highly Gifted Children Conference, Boston, MA.

Watson, R. I. (1978). The great psychologists (4th ed.). New York: Lippincott.

West, T. G. (1991). In the mind's eye: Visual thinkers, gifted people with learning difficulties, computer images, and the ironies of creativity. Buffalo, NY: Prometheus Books.

Wittrock, M. C. (1978). Education and the cognitive processes of the brain. In J. S. Chall & Allan F. Mirsky (Eds.), Education and the brain (pp. 61-102). The seventy-seventh yearbook of the National Society for the Study of Education, Part II. Chicago: University of Chicago Press.

From Silverman, L. K. (1998). Personality and learning styles of gifted children. In J. VanTassel-Baska (Ed.), Excellence in educating gifted & talented learners (2nd ed., pp. 29-65). Denver: Love.