Identifying Visual-Spatial and Auditory-Sequential Learners: A Validation Study

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At the beginning of the 20th century, students sat in rows, and learned the same lessons in the same manner as their classmates. The only means of differentiation was pace of learning. In one-room schoolhouses, children were often allowed to progress to the next level when they had completed the current one. The concept of continuous progress was particularly beneficial for gifted students; it is recently being rediscovered.

An educational innovation toward the end of the century was the recognition that students learn differently from each other. With this revelation came the introduction of personality types, learning styles, and multiple intelligences as means of adapting to the individual differences of the student body. As we enter a new millennium, *differentiation* has become enormously important in the delivery of services to all students. Most K-12 educators have attended workshops in which they learned about their own preferred personality type or learning style, and the various types, styles and intelligences of their students. The educational work force as a whole is consciously attempting to adapt teaching methods to the individual differences of students. However, the diligent teacher may become overwhelmed by the complexity of the models that have been offered for individualizing instruction.

One of the first of these instructional models evolved from the development of an instrument to assess dimensions of personality. The *Myers-Briggs Type Indicator (MBTI)* (Myers, 1962), developed by Katharine Cook Briggs and her daughter, Isabel Briggs Myers, was based on Jung's theory of personality types (Jung, 1938). The MBTI has been used extensively in studies of the gifted: students enrolled in gifted classes (Delbridge-Parker, 1988; Gallagher, 1990; Hoehn & Bireley, 1988); National Merit Finalists (Myers &

McCaulley, 1985); students enrolled in ivy league colleges (Myers, 1962); and creative men and women (Helson, 1965; MacKinnon, 1962). The four sets of personality preferences assessed by the MBTI are introversion vs. extraversion; intuitive vs. sensing; feeling vs. thinking; and perceiving vs. judging, resulting in16 possible personality types.

In 1983, Howard Gardner introduced seven kinds of intelligence, and the list has recently expanded to 9 (Gardner, 1999), with the addition of naturalistic and existential. Spiritual intelligence is also under consideration, but is currently subsumed under existential intelligence, as Gardner believes there is insufficient ground at present to grant it full status. The search for new intelligences continues. Gardner's (1983) *Frames of Mind* exerted a powerful impact on educational practice toward the end of the 20th century. The concept of multiple intelligences, however, is not new. The late Calvin Taylor (1968), a prominent gifted educator, proposed a multiple talent approach that was a precursor to Gardner's paradigm, as was Guilford's (1967) theory of the structure of intellect. Both of these earlier models were embraced by gifted education, and served as a basis for identifying and programming for gifted students in various locales. The father of creativity, J. P. Guilford, proposed the largest number of intelligences. Guilford's structure-of-intellect model consisted of five operations, four contents, and six products. Each of the 120 cells of Guilford's cube was thought to represent a different intelligence, and the number grew to 150, when he split figural content into auditory-figural and visual-figural.

Several learning styles inventories have been developed, some by leaders in gifted education (e.g., Barbe, Swassing & Milone, 1979; Renzulli & Smith, 1978). Dunn and Dunn (1975), who authored the most popular learning styles inventory, proposed 4 environmental, 4 emotional, 6 sociological, 7 physical, and 3 psychological elements that need to be taken into account when deriving a student's learning style. While this painstaking analysis has been very helpful to many teachers, it is quite time-consuming, and generates at least 41, 472 different combinations of the 24 elements!

All of this groundbreaking work has laid a solid foundation for understanding individual differences, but it has been a daunting task to remember all of the components of any of these frameworks, let alone adapt to all the possible combinations. The visual-spatial/auditory-sequential dichotomy is a much more accessible structure for educators. The model developed over the last 21 years from clinical observations and analysis of the psychometric patterns of 3,500 gifted children. Two basic learning styles are posited: auditory-sequential learners for whom school tends to be a positive experience and visual-spatial learners for whom school is often a negative experience. As teachers are already meeting the needs of one of the two groups, it only necessitates learning how to serve one neglected group of students: visual-spatial learners. The purpose of this paper is to outline these two modes of learning and to describe the development and validation of an instrument to assess these learning styles.

Visual-Spatial vs. Auditory-Sequential

For the auditory-sequential learner, learning is step-by-step, following a logical progression from beginning to end. For the visual-spatial learner, learning comes through imagery of the whole concept. Visualization provides the organizational construct for assimilating and processing new ideas. Auditory-sequential learners are good listeners, learn sequentially, are rapid processors, and think in words. Visual-spatial learners are astute observers, learn holistically, need more time to process information, and think in pictures. These are the essential distinctions between the two learning styles.

The strongest modality for auditory-sequential learners is audition. Auditory strengths are important for the development of linguistic competence. When children suffer severe hearing loss in early childhood, they often experience language delays and difficulty with auditory comprehension. They may understand the meaning of nouns, but be slow to develop syntax. Language involves both comprehending and producing sequences of words. Therefore, there is a connection between good listening skills and good sequencing ability. Coherent speech entails numerous motor sequences. One of the primary qualities of audition is timing. Children with good audition and auditory processing have a good sense of timing and of time.

Auditory-sequential learners excel in phonemic awareness, which facilitates the acquisition of reading skills, and they have well-developed auditory short-term memory (working memory). They remember what they hear, can follow complex sets of oral directions, and memorize easily—even rote information, such as the multiplication tables. They are generally able to express themselves well because of their verbal fluency. Verbal fluency is the ability to access words easily, efficiently, and quickly (Lohman, 1994), thus providing greater ease at public speaking and impromptu presentations. Fluency also enables them to be more verbally assertive, getting their ideas across in a group. This generally leads to a strong sense of self-efficacy in our highly verbal society.

In an invited presentation for the 1993 Wallace Symposium entitled, "Spatially Gifted, Verbally Inconvenienced," Lohman (1994) contended that lack of verbal fluency should not be construed as lack of verbal ability:

> 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)

Sequencing skills are essential for school success. The scope and sequence of the curriculum and traditional methods of teaching favor the sequential learner. Auditory-sequential students are able to show their work easily because they took a series of steps that they can retrace. They tend to be orderly, well-organized, and to follow the sequence of events necessary for high academic performance.

Visual-spatial learners often struggle in the areas in which auditory-sequential learners succeed. They are visually, rather than auditorally oriented: they need to see a concept in order to understand it. They excel at spatial tasks, such as geometry, map reading, geography, mazes, chess, construction activities, knowledge of mechanics, and three-dimensional puzzles. Activities such as these are not fundamental to school success, although they may be essential for high levels of creative production in adult life (West, 1991). These children understand space better than time, and often lose track of time. They are holistic, rather than detail-oriented. They focus on ideas and may miss formatting requirements, such as punctuation, capitalization, spelling, grammar, and syntax. It is easy for them to recognize patterns. They may be excellent at mathematical reasoning, but make careless mistakes in calculation. They are divergent rather than convergent thinkers, often generating unusual solutions to problems. They tend to be hypersensitive and intense—vulnerable to teasing and to teachers' attitudes towards them. They often have marked disparities between their spatial strengths and sequential weaknesses.

Differences between these two learning styles are elaborated in Table 1:

Insert Table 1 here

Gifted Visual-Spatial Learners

The visual-spatial learner construct came about through the study of gifted children who excelled in visual-spatial items on psychometric assessments. Gifted visual-spatial learners demonstrate extraordinary abilities with visual-spatial tasks, imagistic thinking, complex systems, humor, empathy, music, artistic expression, or creative imagination. Most individuals in the exceptionally gifted range (IQ scores of 160 or above) appear to have remarkable spatial abilities. More than 500 (14%) of the 3,500 children we have assessed in the last 21 years score in the exceptionally gifted range. Exceptionally gifted children have facility with both auditory-sequential and visual-spatial abilities. Their auditory-sequential strengths enable them to master academic work quickly, but they often prefer visual-spatial processing.

The visual-spatial learners described in this paper have pronounced discrepancies between their excellent performance on visual-spatial tasks and relatively weaker performance on auditory-sequential items. They perform well beyond age level on puzzles, mazes, copying block designs, counting three-dimensional arrays with hidden blocks, visual closure tasks (e.g., recognizing partially drawn pictures or noticing missing parts of pictures), and similar tasks. These individuals may not always score in the gifted range on assessments, because cognitive tests are geared more for verbal and sequential learners. There are fewer items that tap visual-spatial abilities on most intelligence scales, and these items are usually timed, so children have to be fast as well as proficient. Reflective children may not score well on the visual-spatial items in Wechsler scales due to the speed factor (Kaufman, 1992). Children who think in images need more time to translate those images into words.

Gifted visual-spatial learners possess certain natural advantages in learning concepts, in contrast to learning skills. The advantages of this learning style include:

- Perceiving the whole quickly
- Finding patterns easily
- Thinking graphically
- Understanding dimensionality

These students face disadvantages in mastering material in the normal classroom setting where standard classroom techniques are used. They may experience difficulty with verbal instructions, sequential problem solving, and with drill and practice. An image is not improved through drill and practice.

Gifted auditory-sequential learners are more likely than equally gifted visual-spatial learners 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. By way of contrast, gifted visual-spatial learners are more likely than auditory-sequential learners to underachieve (Gohm, Humphreys, & Yao, 1998). Many twice exceptional learners (both gifted and learning disabled) are spatially oriented; their lack of sequencing skills often undergirds their learning disabilities (Silverman, 1989). Gifted visual-spatial learners are often counted among creative students, artists, musicians, mathematicians, future engineers, and computer specialists. Those whose auditory-sequential deficits interfere with mastery and speed of reading, writing, spelling, calculation, and rote memorization, are rarely perceived as gifted or provided with opportunities to develop their gifts.

Strongly auditory-sequential gifted students are easily identified. Strongly visual-spatial gifted students with adequate abilities in the auditory-sequential realm develop compensation strategies to enable them to be successful. Strongly visual-spatial gifted students with serious deficits in auditory-sequential processing are under-identified as gifted, underserved in the classroom, underachieve academically, and are more likely to drop out of school. Visual-spatial abilities may atrophy through disuse (Lohman, 1994). They are needed for higher-order thinking skills in upper level courses. Through appropriate teaching strategies, visual-spatial strengths can be rediscovered and reawakened.

In 1983, John Dixon wrote:

> Research on the nature of spatial ability has come such a long way in the last century that one would expect it to have considerable impact on the way educators understand giftedness in children. Yet, with few exceptions, when one looks at the spectrum of programs for gifted children, one senses that the accumulated knowledge on spatial ability has been given little if any consideration and has no impact on the planning of these programs. …Spatial ability is one of the primary ways in which giftedness is manifested in many children. We can hardly move forward in our understanding of giftedness until we have focused on the implications of this. (p. ix)

Hemispheric Dominance: Sequential vs. Spatial

There are two major processing modes: sequential and spatial. Children who are left hemispheric dominant tend to be verbal, sequential, analytic, and time-oriented. Children who are right hemispheric dominant tend to be visual, perceptive, synthesizing, and spatially oriented.

> Just as the left hemisphere evolved language, a symbolic system surpassing any single sensory modality, perhaps areas in the right hemisphere evolved ways of representing abstractly the two- and three-dimensional relationships of

> the external world grasped through vision, touch, and movement. …The ability to visualize a complex route or to find a path through a maze seems to depend on the right hemisphere. Although it is usually characterized as more spatial than the left, it is probably more accurately described as more manipulospatial, that is, possessing the ability to manipulate spatial patterns and relationships. (Springer & Deutsch, 1998, pp. 306-307)

These two ways of knowing—analytical, sequential reasoning versus nonsequential, geometric visions of reality—have created a fascinating dialectic of differing worldviews throughout the history of psychology. Consider Plato's Forms vs. Aristotle's taxonomic classification systems; Kant's *a priori Anschauungen*—"the spatial arrangement of objects given in perception" (Boring, 1950, p. 248) vs. Locke's associationism; the holistic paradigm of the gestalt psychologists—Wertheimer, Kohler, and Koffka, vs. the behavioristic theories of Pavlov, Watson, and Skinner; Guilford's structure-of-intellect cube vs. Bloom's taxonomy. While some schools of psychology were based on analytical sequences of ideas, others grew out of images and geometrical relationships. These differences in perspective parallel differences in brain organization of individuals who are predominantly left hemisphere dominant and those who are predominantly right hemisphere dominant.

Bogen (1969) asserted that the duality of the hemispheres is the basis for many other dualities throughout history. For over a hundred years, the left hemisphere was considered the "major" hemisphere, the seat of thought, while the right hemisphere, often referred to as the "minor" hemisphere, was believed to regulate the autonomic nervous system and to have very little to do with thinking. The "major" hemisphere was characterized as expressive, linguistic, executive, symbolic, verbal, discrete, logical, analytical and prepositional, and the "minor" hemisphere was described as visual, visuospatial, kinesthetic, imaginative, perceptual, synthetic, preverbal, nonverbal, diffuse, and appositional.

However, one early pioneer in brain research, John Hughlings Jackson, hypothesized in the late 19th century that the right hemisphere played a much greater role in the thought process. Jackson wrote 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 prepositional thinking are the domain of the left hemisphere (J. Taylor, 1932/1958). Jackson's hypothesis was confirmed with the advent of split-brain research in the early 1970s. Jerre Levy and her colleagues conducted much of the early work that brought about a new understanding of hemispheric differences (Springer & Deutch, 1998). According to Levy (1980),

> 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. (p. 253)

Benbow and her associates, employing a chimeric face task developed by Jerre Levy, found evidence that intellectually gifted students have enhanced right hemispheric functioning (Benbow, 1986; O'Boyle & Benbow, 1990). 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)

Further evidence of heightened right-hemispheric abilities in the gifted was reported in another study (Benbow, 1986). 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).

Many gifted students are left-hemispheric dominant, have mixed dominance, or have great facility with both hemispheres. But academic success appears to be related primarily to left hemispheric strengths. Children who are analytical, sequential, deductive (can justify their conclusions), highly expressive, and verbally fluent (excel in speed of processing and production of verbal information), have a much easier time in school than children who lack these intellectual skills. Enhanced right hemispheric processing is not problematic in and of itself; only when it is combined with weak left hemispheric processing does it lead to patterns of underachievement. What factors, then, tend to weaken the left hemisphere?

Two Major Modalities: Auditory and Visual

The left hemisphere develops later than the right hemisphere *in utero* and in infancy, and processes higher auditory frequencies (Ornstein, 1997). These higher frequencies are critical to the development of linguistic competence. One of the first clinical observations that led to the visual-spatial construct was that gifted children who had suffered *recurrent otitis media* (chronic ear infections), especially during the first few years of life, had enhanced visual-spatial abilities and weaker auditory-sequential abilities. This group had depressed IQ scores and were at higher risk for underachievement than their more fortunate siblings who had suffered fewer bouts of otitis (Silverman, 1996). The auditory-sequential tasks that posed considerable difficulty included repeating random number sequences, repeating sentences *ver batim*, telling the days of the week in order, doing mental arithmetic, and recounting the details of short passages.

Marion Downs (1985), the originator of auditory screening tests in infants (Northern & Downs, 1994), demonstrated how sounds in the higher frequency range are blocked when infants and toddlers experience chronic otitis media with middle ear effusion. Children whose auditory channel has reduced efficiency during the critical learning period of the first three years are more likely to rely on their visual modality as their main means of gathering information. This strengthens the visual-spatial abilities of the right hemisphere at the expense of the auditory-sequential skills of the left hemisphere. The neglected skills include auditory comprehension (listening), verbal fluency, deductive reasoning, and fine motor planning.

The connection between left hemispheric dominance, auditory-sequential skills, and fine motor planning is not immediately apparent. Recent research by Doreen Kimura (1993) and her colleagues sheds light on this complex relationship.

> Why is the hemisphere that controls speech also the one that usually controls a person's dominant hand? Is it a coincidence, or is there a profound relationship that should tell us something about what is involved in both speech and manipulative skills? ...
>
> Doreen Kimura has presented data from a large number of patients with unilateral cerebral pathology that have led her to the conclusion that the left cerebral hemisphere, compared with the right hemisphere, is specialized for motor control of both oral and manual musculature, regardless of whether the movements are communicative in nature or not….
>
> It is possible that the evolutionary advantages offered by the development of a hand skilled at manipulation also happened to be a most useful foundation on which to build a communication system, one that at first was gestural and utilized the right hand but later came to utilize the vocal musculature. As a result, the left hemisphere came to possess a virtual monopoly on control of the motor systems involved in linguistic expression, whether by speech or writing. (Springer & Deutsch, 1998, pp. 304-305)

Kimura's research helps explain our observation that visual-spatial learners often have difficulty mastering handwriting and tend to resist writing assignments. Surprisingly, we have found that many gifted children who exhibit poor handwriting appear to have artistic talent. They can reproduce images and figures with far greater facility than sequences of letters. Scores on the *Developmental Test of Visual-Motor Integration* (Beery, 1997), or the *Bender Visual-Motor Gestalt Test* (Bender, 1938), both of which require the reproduction of complex figures, rarely reflect the degree of difficulty these students have with written production in school. This supports the hypothesis that the right hemisphere is more involved in artistic production than in written communication (Edwards, 1979).

The left hemisphere is particularly vulnerable to insult during labor and delivery. Some of the suspected risk factors for gifted children include a cord wrapped around part of the child's body (cutting off oxygen supply to the brain), prematurity, fetal distress, meconium in the amniotic fluid, stress caused by an excessively large head attempting to get through the birth canal, exceptionally long labor, and use of more than 4 hours of Pitocin to induce labor. Gifted infants often have larger than average heads (Hitchfield, 1973), which may lead to more difficult birthing and longer labor. Our clinical records show that mothers of exceptionally gifted children (160 IQ and above) tend to have longer than average labor, more Pitocin than the 3 to 4 hours known to be safe, and more emergency C-sections due to fetal distress. A significant number of the visual-spatial learners in our sample had difficult, complicated births, and demonstrated sensory-motor integration dysfunction with concomitant handwriting difficulties.

It is possible to be a visual-spatial learner with impaired vision or an auditory-sequential learner with impaired audition. Blind individuals may visualize as their main mode of learning, and deaf individuals may auditorize. It is a challenge to assess the intelligence and learning style of an individual who suffers from weaknesses in either modality, and nearly impossible to gain accurate information on the abilities of individuals who have weaknesses in both major modalities. The latter group is likely to be labeled "kinesthetic," "haptic," or "tactile" learners, as these individuals must rely on touch or information from their bodies as their main modality of learning when their eyes and ears fail to provide accurate sensory data. As "kinesthetic" is subsumed under right hemispheric processing (Bogen, 1969), instructional methods recommended for visual-spatial learners also appear to be applicable to this third group.

An Instrument to Assess Visual-Spatial Learners

Clinical observations led to the development of the visual-spatial learner construct in 1982. Among the early clinical indicators of this learning style are:

- ability to do advanced puzzles;
- love of construction with Legos and other building materials;
- fascination with numbers and counting;
- interest in mazes, chess, geography, map reading, map making, and other spatial activities;
- at least one parent engaged in a visual-spatial field, such as art, technology, or aeronautics.

Major symptoms of auditory-sequential weaknesses include more than nine ear infections before the age of three years; poor phonemic awareness; difficulties with spelling; resistance to writing assignments; and poor organizational skills.

In 1992, an interdisciplinary team was brought together at the Gifted Development Center to create an instrument to identify visual-spatial learners. At various points, the team was composed of a neuropsychiatrist, a psychologist specializing in attention deficit disorders, a behavioral optometrist, an occupational therapist, a speech pathologist, teachers and tutors of visual-spatial learners, reading specialists, social psychologists, psychologists specializing in the gifted, coordinators of gifted programs, artists, and parents of visual-spatial learners. The goal of the team was to develop an instrument that could be used to identify a broad range of visual-spatial learners, regardless of level of intelligence or concomitant diagnoses (e.g., attention deficit disorder).

The Visual-Spatial/Auditory-Sequential Identifier: Self-Report and *The Visual-Spatial/Auditory-Sequential Identifier: Observer Report* developed as a result of eight years of volunteer work by this committee. The first drafts of these instruments were presented at the 1995 Henry B. and Jocelyn Wallace National Research Symposium (Silverman, 1999).

A preliminary study was conducted in 1995-1996 with 65 visual-spatial learners and their parents or teachers. Through the generosity of the Morris S. Smith Foundation, two validation studies of the instrument were undertaken in 1997 and 1998, with 56 and 62 subjects, respectively—evenly divided between auditory-sequential and visual-spatial learners. For purposes of these investigations, auditory-sequential subjects were defined as individuals whose Digit Span scores were significantly higher (1 s.d.) than their Block Design scores on the *Wechsler Intelligence Scale for Children*. Visual-spatial learners were defined as individuals whose Block design scores were at least 7 points higher (>2 s.d.) than their Digit Span scores. It was hypothesized that Digit Span would be a fairly accurate measure of auditory-sequential strengths and that Block Design would represent a fairly accurate measure of visual-spatial strengths. This hypothesis was eventually rejected, due to confounding variables. Digit Span includes Digits Backward, which is quite accessible to the visualization strengths of visual-spatial learners. As Block Design is heavily loaded on abstract reasoning, it emerged as a strength for the entire gifted sample.

In the second pilot study, conducted with the original subjects, Digit Span was further refined to include only Digits Forward. The instruments were revised to incorporate the results of the pilot studies and expert opinion. A group of gifted fifth graders in Antioch School District in Illinois, working under the direction of Gifted Program Coordinator, Michele Kane, reviewed the self-report and recommended changes in wording for greater clarity. The observer report was revised to be more consistent with the self-rating instrument, employing the simpler language recommended by the fifth grade students. One-third of the items were reworded so that they were positive for auditory-sequential learners. The name of the questionnaire was changed to reflect both learning styles. The revised instrument was completed as a retest by the subjects who had participated in Pilot I. Analysis of the results of Pilot II pointed to the conclusion that five factors were not adequately controlled in our sample:

- age (6 – 25)
- gender (significantly more males than females)
- race and ethnicity (predominantly white)
- socio-economic status (upper middle class)
- level of intelligence (gifted)

Pilot III was conducted in April of 1999 to correct these shortcomings.

Pilot III involved an entire middle school of 447 fifth and sixth grade students at Baker Central School in Fort Morgan, Colorado. In this setting, age was tightly controlled; the vast majority of the students ranged from 10 to 12 years of age, with a few 13 year olds. Baker has a close gender balance, with 55% girls and 45% boys. It also has an ethnically diverse student body: nearly 40% of the students are of Hispanic origin. Less than 2% of the school represents other ethnic groups. In contrast to the upper middle class SES of the Gifted Development Center sample, Baker Central is composed of children of the full SES spectrum. The IQ distribution was assumed to fit the normal curve of distribution.

The questionnaires were translated in Spanish and retranslated back into English from the Spanish version to assure that each translation was accurate. In this way, an equivalent set of Self and Observer Reports was constructed for students and parents who preferred to respond in Spanish. Bilingual personnel assisted in the data entry and reading of comments on the forms. All students and their parents were asked to complete the questionnaires, and teachers were asked to rate all of their students. After collection of the data, so as not to bias its collection, Steve Haas, the Projector Director, and I provided a half-day in-service to the faculty at Baker Central School on the characteristics of visual-spatial learners and auditory-sequential learners. The teachers were then asked to identify subjectively a handful of the most visual-spatial and most auditory-sequential students in each class. These ratings were also entered into our database.

This constituted a multi-trait (visual-spatial and auditory-sequential), multi-factor, multi-method study, incorporating:

- ❖ self-ratings by students
- ❖ observer reports by parents
- ❖ observer reports by teachers
- ❖ subjective assessment by teachers

In addition, the Spanish and English versions were subjected to the same multi-trait, multi-factor, multi-method test. As several of the teachers who completed the questionnaires before the in-service training did not have a clear understanding of the purpose of the study, 246 of the observer reports collected from teachers had to be eliminated. Usable information was available on 198 students from all three sources: the self-report, the parent report and the teacher report. Questions were eliminated that

- ❖ had been left out by 50 or more respondents;
- ❖ displayed an extreme mean (more than 3.5 or less than 2.5); or

- lacked sufficient variability (s.d. less than 1.2)

Twenty-one of the 36 questions emerged from those three filters as capable of discriminating between auditory-sequential and visual-spatial learners. For each of the 198 students remaining in the test sample, all of his or her responses were totaled and divided by 21 to obtain a mean score. Mean scores were also derived from the corresponding parent and teacher forms for each of those students. Students were then grouped in a variety of ways to permit comparisons. In each group, all the mean scores were averaged to obtain a group mean (e.g., the mean for boys was 2.9733 and the mean for girls was 2.7194). Comparisons among groups could then be made. (See Table 2 below.)

Insert Table 2 here

One of the most interesting comparisons involves those students subjectively identified by teachers as visual-spatial (V-S) and auditory-sequential (A-S), and those not identified as either. Group averages were found for these three groups which fit a neat linear model, with a correlation (r^2) of 0.95.

Further statistical analysis was carried out on the data to find questionnaire items with the best reliability and correlations. Another seven questions were discarded, leaving the following 14:

1. I hate speaking in front of a group.
2. I think mainly in pictures instead of words.
3. I am good at spelling. (reversed)
4. I often lose track of time.
5. I know more than others think I know.

6. I don't do well on tests with time limits.
7. I have neat handwriting. (reversed)
8. I have a wild imagination.
9. I like to take things apart and find out how they work.
10. I hate writing assignments.
11. I solve problems in unusual ways.
12. It's much easier for me to tell you about things than to write about them.
13. I have a hard time explaining how I come up with my answers.
14. I am well organized. (reversed)

Alpha scores, measuring reliability of a particular item with the overall score, were calculated. The total alpha with 554 cases (consisting of a mix of student, parent, and teacher forms) was 0.7046, where the target of 0.80 would have shown solid reliability. Obviously, this indicates that further refinement of the identifier is needed. Table 3 below indicates the reliability analysis of each of the remaining 14 items.

Insert Table 3 here

Finally, the correlations analysis also gave mixed but encouraging results. The data were grouped in a number of different ways:

- ❖ By race and ethnicity: White, Hispanic, Black and American Indian
- ❖ By type of questionnaire: Completed by student, parent, or teacher
- ❖ By gender (sex)
- ❖ By age

- By "V-S vs. A-S": Subjective identification by teachers. For this analysis, the large group of unidentified students was left out.
- By scaled score: The total score for each questionnaire by adding up all the responses to the 14 questions.

We then ran correlations of each of these six kinds of information with each of the other six and developed a 6 x 6 matrix of Pearson correlations. There were 15 possible combinations. The results are shown in Table 4 below. Of the 15 combinations, six gave statistically significant correlations, although sometimes only marginally. The correlation of "V-S vs. A-S" (subjective teacher evaluations) with "Scale," however, produced a notable 0.517 correlation.

Insert Table 4 here

The next research question to be addressed concerns the generalizability of the data collected at Baker Middle School. We have plans to repeat the study in other school districts in Colorado, Utah, and Texas. Studies with different age groups will be undertaken to determine the age constraints of the questionnaire. The questionnaire is still in its development stage. No scoring protocol has been constructed. It will be released after sufficient study has been undertaken to ensure its validity and reliability.

Helpful Techniques for Visual-Spatial Learners

The following 25 guidelines can be used by classroom teachers to enhance learning and enjoyment of school by their visual-spatial students:

1. Teach to the students' strengths: imagination, creativity, visualization and pattern recognition. Help them use their strengths to compensate for their weaknesses.
2. Present ideas visually on the chalkboard or on overheads. Use videos, posters, charts, graphs, computer software, diagrams, and manipulatives liberally.
3. Let them observe others before attempting new tasks. Show examples of the finished product requested.
4. Present an overview of the subject being taught. Use metaphors and analogies to give a sense of the whole.
5. Use a sight approach to reading rather than phonics. Supplement with word patterns, roots and affixes, decoding as puzzle solving.
6. Use books rich in visual imagery to enhance interest and ability in reading. (Be aware that some visual-spatial learners may need initial help in learning to visualize.)
7. Employ a computer for both instruction and student writing assignments. Teach keyboarding as soon as possible.
8. Avoid timed tests. Give power tests, which will better reveal mastery.
9. If a bright student struggles with easy, sequential tasks, experiment with more advanced, complex work. Acceleration is more beneficial to these students than remediation.
10. Teach students to visualize spelling words, math facts, etc. They will remember what they see and may forget what they hear.
11. Give more weight to content of papers than to format. Teach mechanics apart from response to content.

12. Have them discover their own methods of problem solving instead of teaching step by step. For instance, give them some division problems with the answers and allow them to figure out how the answers were arrived at. Then have them see if their method works with new problems.
13. Avoid drill, repetition and rote memorization. Use more conceptual approaches and fewer, more difficult problems.
14. Be emotionally supportive. These learners are keenly aware of their teachers' reactions to them. Success is related to perceptions of teachers' empathy.
15. Allow time for formation of answers and word retrieval. Support well thought-out answers above fast ones.
16. Emphasize creativity, imagination, new insights, new approaches rather than just acquisition of knowledge. Creativity should be encouraged in all subject areas.
17. Group visual-spatial learners together for instruction.
18. Engage students in independent studies or group projects, which involve problem finding and problem clarification, as well as problem solving.
19. Allow them to construct, draw or otherwise create visual representations of concepts.
20. Silent reading is preferable to oral reading. Ask comprehension questions and allow them to find answers through reading silently at least part of the time.
21. Teach them to retrieve material in their visual memory banks by looking up.
22. They will do better when allowed to display what they know in their own way. For example, with flash cards, spread the cards out and allow them to pick out what they know, instead of drilling them on the cards one at a time to see if they are right or wrong.

23. Memorization of facts is a weakness. Use visualization and mnemonics as aids.
24. Humor and playfulness actually increase learning. Use them liberally, but avoid sarcasm and teasing.
25. Play "What's My Rule?" These pattern finders are good at discovering rules and principles. (Maxwell, 1998)

Conclusion

Auditory-sequential abilities correlate with school success and school comfort. Visual-spatial abilities correlate with creative production in adult life. Some of the most brilliant creators in history (e.g., Faraday, Maxwell, Einstein, Edison, Tesla, da Vinci, etc.) apparently had difficulty with auditory-sequential abilities, such as reading, spelling, calculation and handwriting (West, 1991). In the 20^{th} century, when schools focused primarily on these left-hemispheric abilities entailed in literacy, creative students usually did not emerge as scholars. However, in the 21^{st} century, when schools become more technologically oriented, when the emphasis is on concept formation, problem finding, gathering of information, pattern recognition, and creative expression, visual-spatial learners may blossom into excellent students.

Many visual-spatial learners have been badly wounded in the traditional school system. They have been made to feel stupid, lazy, defiant, and unworthy because their learning style has not been fully understood and appreciated. The damage to these children's self-esteem can be healed if they have the chance to work with caring, sensitive teachers who recognize their true potential. Children respond to those who believe in them. If they receive encouragement, their performance may improve dramatically as they get older. Many spatially oriented learners suddenly blossom in puberty (Dixon, 1983). For others, success occurs in high school, college or adult life. One possible reason for this late blooming pattern is that the material finally becomes challenging enough to force the integration of the two hemispheres (Levy, 1982). Most visual-spatial adults compensate well for sequential weaknesses and may excel in such areas as computer technology, aeronautics, physics, engineering, cartography, photography, art, architecture, design, music, dance, theater, mechanics, and mathematics. They are the creative thinkers and visionaries in many fields.

It is our hope that when the Identifier is refined, teachers will be able to identify easily the visual-spatial learners in their classrooms. This should facilitate greater responsiveness to these atypical students. When teachers employ the visual and holistic techniques outlined above, auditory-sequential students also profit. Their creativity is enhanced, as well as their ability to adapt to the technological advancements of the 21st century. The technological age favors visual learners. Thus, this model has the potential of serving all students, preparing both types of learners for a future beyond literacy.

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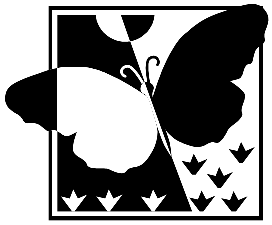

Table 1
Characteristics Comparison

The Auditory-Sequential Learner	The Visual-Spatial Learner
Thinks primarily in words	Thinks primarily in pictures
Has auditory strengths	Has visual strengths
Relates well to time	Relates well to space
Is a step-by-step learner	Is a whole-part learner
Learns by trial and error	Learns concepts all at once
Progresses sequentially from easy to difficult material	Learns complex concepts easily; struggles with easy skills
Is an analytical thinker	Is a good synthesizer
Attends well to details	Sees the big picture; may miss details
Follows oral directions well	Reads maps well
Does well at arithmetic	Is better at math reasoning than computation
Learns phonics easily	Learns whole words easily
Can sound out spelling words	Must visualize words to spell them
Can write quickly and neatly	Prefers keyboarding to writing
Is well organized	Creates unique methods of organization
Can show steps of work easily	Arrives at correct solutions intuitively
Excels at rote memorization	Learns best by seeing relationships
Has good auditory short-term memory	Has good long-term visual memory
May need some repetition to reinforce learning	Learns concepts permanently; does not learn by drill and repetition
Learns well from instructions	Develops own methods of problem solving
Learns in spite of emotional reactions	Is very sensitive to teachers' attitudes
Is comfortable with one right answer	Generates unusual solutions to problems
Develops fairly evenly	Develops quite asynchronously
Usually maintains high grades	May have very uneven grades
Enjoys algebra and chemistry	Enjoys geometry and physics
Masters other languages in classes	Masters other languages through immersion
Is academically talented	Is creatively, mechanically, technologically, or emotionally gifted
Is an early bloomer	Is a late bloomer

Table 2
Group Comparisons

	Mean	Median
White		
Male	2.9733	3.0000
Female	2.6610	2.6190
Hispanic		
Male	2.8447	2.8095
Female	2.7194	2.7143
Males		
Self-Rating	3.0235	3.0000
Teachers' Rating	2.8862	2.8571
Parents' Rating	2.8329	2.8095
Females		
Self Rating	2.7669	2.8095
Teachers' Rating	2.6019	2.5476
Parents' Rating	2.7198	2.6905

Table 3
Alpha Scores

- Alpha scores measure reliability of a particular item with the overall score.
- Alpha scores of grater than .80 are considered solid indicators of reliability.

Overall Reliability Statistics

Number of Cases	Mean	Standard Deviation	Alpha
554	2.841	0.616	0.7046

Reliability Analysis of Individual Items

Item	N of Cases	Mean	Std. Dev.	Alpha (if item deleted)
1	554	2.8375	1.4813	.7007
2	554	2.7365	1.2510	.7005
3	554	2.8917	1.3750	.7041
4	554	2.7455	1.4175	.6673
5	554	2.8773	1.4204	.6824
6	554	2.7383	1.3878	.6795
7	554	2.9134	1.3406	.6840
8	554	3.2310	1.2560	.7097
9	554	2.6462	1.4612	.6922
10	554	2.6318	1.4300	.6621
11	554	2.6444	1.2199	.6911
12	554	3.1769	1.2861	.6819
13	554	2.8123	1.2732	.6921
14	554	2.8953	1.3379	.6919

Table 4
Cross Correlations

	Race	Type	Sex	Age	V-S/A-S	Scaled Score
Race	1.000	-.025	-.031	.071	-.055	-.015
Type	-.025	1.000	-.014	-.031	-.087	-.224*
Sex	-.031	-.014	1.000	.193*	.186*	.300*
Age	.071	-.031	.193*	1.000	.002	.088*
V-S/A-S	-.055	-.087	.186*	.002	1.000	**.517***
Scale	-.015	-.224*	.300*	.088*	**.517***	1.000

V-S/A-S indicates the teachers' subjective placement of students in either the auditory-sequential learner category or the visual-spatial learner category.

*Items marked with an asterisk are considered to have significant correlations.

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Identifying Visual-Spatial and Auditory-Sequential Learners: A Validation Study

Linda Kreger Silverman

Abstract

The visual-spatial learner construct emerged from analyzing test protocols of 3,500 gifted children over a period of 20 years. Many of the children who excelled in spatial-visualization tasks had experienced a high incidence of otitis media (ear infections) in early childhood, and evidenced weaknesses in tasks involving auditory processing and sequencing. These children were at risk for underachievement. Auditory and sequential processing appear critical to school success. For the last 8 years, a multidisciplinary team has developed and validated a set of instruments that can be used to identify those who excel at visual-spatial tasks and those who excel at auditory-sequential tasks. A multi-method, multi-factor, and multi-source study was conducted in 1999 with 447 5th and 6th grade students, their parents, and teachers, utilizing observational report and self-report scales in English and Spanish. The results supported the construct and the ability of a subset of the questions to differentiate the two patterns of learning.