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Publisher: Routledge

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Roesper Review

Publication details, including instructions for authors and subscription information:
<http://www.tandfonline.com/loi/uror20>

Physiological uniqueness: A new perspective on the learning disabled/gifted child

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Available online: 20 Jan 2010

To cite this article: Marlene Bireley, Marlin Languis & Ted Williamson (1992): Physiological uniqueness: A new perspective on the learning disabled/gifted child, Roesper Review, 15:2, 101-107

To link to this article: <http://dx.doi.org/10.1080/02783199209553477>

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Physiological Uniqueness: A New Perspective on the Learning Disabled/Gifted Child

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Previous studies have established that the LD/G population has educational needs that cross over between gifted education and special education. This study reinforces those findings and furthers understanding of the physiological basis of the LD/G condition through the use of brain imaging and vision testing for hyperacuity and contrast sensitivity. Results from these latter techniques suggest that the interaction of high ability and learning disability results in brain and vision patterns unique to the LD/G group.

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The decade of the eighties was marked by an increasing interest in the atypical gifted who are described generally as consisting of minorities, the economically disadvantaged, gifted females, and the gifted/disabled. In these populations, the identification of giftedness may be masked by other characteristics and prejudices. Among the disabled population, the most intense interest appears to be in that group who are handicapped by a learning disability (LD/G). Two reasons may account for this interest. First, as a "high incidence" disability group, the number of learning disabled children is greater than

those with physical disability. Second, by definition, the specific disabilities of this group are the "valleys" of functioning, while the "peaks" of ability are expected to reach at least average or above average levels. Many physically disabled populations, by contrast, are skewed toward below average intelligence because of the underlying etiology which affects both physical and intellectual capability (Bireley, 1991).

A considerable body of knowledge has accumulated about the psychological and educational functioning of LD/G subgroup. Studies of intellectual patterning (Barton & Starnes, 1989; Brown & Yakimowski, 1987; Fox, 1983; Schiff, Kaufman, & Kaufman, 1981; Silverman, 1989) and educational intervention strategies (Baldwin & Garguilo, 1983; Baum, 1984, 1988; Daniels, 1983; Fox, Brody, & Tobin, 1983; Whitmore, 1980) are plentiful.

The results of the intellectual studies are contradictory. Most show a higher Verbal score tendency (Brown & Yakimowski, 1987; Fox, 1983; Schiff, Kaufman, & Kaufman, 1981; Silverman, 1989), while others have found a superiority in Performance (Barton & Starnes, 1989). When the so-called Kaufman third factor (1979), Freedom from Distractibility (consisting of the mean scores of the Arithmetic, Digit Span, and Coding subtests of the WISC-R), is discussed or available from data, it appears to be lower than either the verbal or perceptual ability tapped by the other WISC-R subtests (Brown & Yakimowski, 1987; Schiff, Kaufman, & Kaufman, 1981; Silverman, 1989).

Educational interventions lean toward a prescriptive approach which combines the structured, task-analytic skills of special education with the holistic, problem-solving orientation of gifted education (Baldwin & Garguilo, 1983; Baum, 1983, 1988, Davis & Rimm, 1989, Fox, Brody, & Tobin, 1983). Only Whitmore (1980) seems to eschew task analysis in favor of a "gifted" curriculum, while Daniels (1983) draws more

purely from special education. The paradox first noted by Tannenbaum (Tannenbaum & Baldwin, 1983) and described by Silverman as "the harder the task, the better they do; it's the easy work they can't master" (Silverman, 1989, p.39) most certainly fits our impression of this unique group and summarizes well their most typical educational needs.

While the above research describes the psychoeducational characteristics of the LD/G population and various approaches to their educational needs, we are studying them through physiologically based measures. Foremost among these techniques is that of brain imaging, used extensively in medical diagnosis and research, but to a lesser degree to assess brain functioning as it relates to psychoeducational behavior. The specific procedure used in our pilot study was topographic brain mapping using a 20 channel computerized EEG system.

Throughout the 1980's, Languis and his associates at The Ohio State University used this technology to develop understanding of the brain functioning of the learning disabled child and young adult (e.g. Languis, 1986; Languis and Wittrock, 1985; Languis, 1988, Naour & Languis, 1986, and Simmons, Languis, & Drake, 1989). Compared with normally achieving peers matched for age, sex and intelligence, learning disabled students consistently display different patterns in the following five areas:

- **Greater asymmetries.** Brain electrical activity typically is symmetrically balanced between the right and left hemispheres. Students with learning difficulties tend to have greater activity on one side or area of the brain in comparison to corresponding areas.
- **Reduced amplitude (size) of evoked potential waveforms especially for auditory tasks.** Evoked potentials are created by averaging brain activity to repeated, time locked, task events. Students with learning difficulties tend to be erratic in attending to task events and process them in a less consistent way. As a result, the averaged waveforms are smaller in size.
- **Latency irregularity.** Latency refers to the time between when the task event is presented and when the brain response occurs. Students with learning disorders sometimes show delays in processing and in general show greater variation in latency.
- **Less integrated and consistent brain electrical activity moment by moment.** The morphology (shape) of brain electrical patterns is smooth, well integrated and focused in students who are processing well. In students with learning problems, the processing pattern moment by moment is irregular, inconsistent and lacks clear focus.
- **Inappropriate response to nontarget task events.** A distinctive brain response, called a P300, is produced when a randomly occurring infrequent target task event occurs interspersed among more frequent nontarget events. The target event may be a high tone in an auditory task, or a red triangle in a visual task. But the P300 is not and should not be produced for nontarget events. In students who have difficulty in discriminating between important and unimportant information and who are distractible, a P300 is often produced inappropriately for nontarget as well as for target events.

In addition, two specific, critical measurements were found to be important in these studies: (1) the N100, an evoked waveform which peaks about 100 milliseconds after an auditory stimulus, is associated with selective attention, and (2) the P300, an evoked potential that occurs when a conscious response is made to a target event. In normal processing the

P300 waveform is produced for target task events but not for nontarget events. Languis and his associates found significantly reduced N100 and P300 amplitudes in learning disabled populations when compared with peer controls. In addition, the P300 was produced inappropriately for nontarget events in many of the LD students.

More recently, the method was used to study gifted children without disability (Languis, Bireley, Brigner and Holland, 1990). The academically gifted students showed a generally higher level of arousal and faster brain wave frequencies than peer controls. The pilot study of LD/G children described here was a natural extension of these previous studies.

This study also explored another way of looking at the LD/G population, that is, as persons who have atypical vision, specifically hyperacuity and high contrast sensitivity. The vision data presented here can be described as in the pioneer stage. Williamson, in previously unpublished work, has been studying two phenomena known as hyperacuity and contrast sensitivity function. In his work with handicapped children and adults, he has found a tendency for these conditions to be present in persons suspected of being or identified as learning disabled.

In the case of hyperacuity, it would appear that most LD individuals "see better" than the average person, although glasses may be required to permit the individual to have a clear image on the retina. Once a clear image has been achieved, with or without glasses, the acuity of the total visual system can be assessed. To do this, Williamson uses an 1887 version of the Snellen Chart which allows assessment to 20/5 rather than the typical 20/20. The skill required to name the letters on the Snellen Chart is termed "edge detector" function or the ability to detect the boundaries between black and white at every place where the letter meets the paper. Williamson hypothesizes that what tests as superiority of this function on the separated, individual letters of the Chart results in visual overload when the person is confronted by "busy" patterns such as those found on walls, cloth, or escalators, or in normal reading in which letters are grouped closely into words. This overload may result in dizziness, visual fatigue, and (Williamson hypothesizes) distractibility that may be mistaken for Attention-deficit Hyperactive Disorder (ADHD). The fourteen characteristics that are used to identify ADHD include several that could be associated with visual problems (e.g., distraction by extraneous stimuli and difficulty sustaining attention to tasks or play activities) (APA, 1987, p.56).

In the case of contrast sensitivity, Williamson uses a test designed by Dr. Arthur P. Ginsburg (1984), formerly head of the United States Air Force Aviation Vision Laboratory. This test which requires Ss to detect increasingly gray/white pattern contrasts is described in detail below. The normative data for adults (Ginsburg, Evans, Cannon, Owsley, & Mulvanny, 1984) set the normal range for adults at four to six correct contrasts per set of nine. Recent findings reveal that 3 to 7 year olds barely reach the lower limits of the adult norms (Scharre, Cotter, Block, & Kelly, 1990). In a 1986 study in Detroit, 83 school children attending a summer remedial program were administered this instrument by Williamson. Fifty percent of these students were more sensitive to differences in contrast than was found in Ginsburg's normative group. In the 1986-87 academic school year, he tested ten middle school students identified and placed in an LD classroom. All were found to exceed the norms.

Since Williamson's work is reminiscent of the work of

Irlen (1983), literature on her approach was reviewed. She had identified unusual sensitivity of the retina to particular frequencies of the light spectrum and labelled this condition "scotopic sensitivity." She claimed that persons with scotopic sensitivity suffered from blurring or movement of print, restricted span of focus, and problems with focusing over an extended period of time. She minimized these problems through the use of noncorrected tinted lenses in a range of tints determined by the needs of the individual. Irlen's claims have been met with some skepticism since her results are primarily based on clinical rather than data-based, experimentally controlled studies. However, in the December, 1990, *Journal of Learning Disabilities*, three studies reported that the use of the Irlen lenses resulted in a diminution of visual complaints (Blasky, Schieman, Parisi, Ciner, Gallaway, & Selznick, 1990) and increased competency in reading rate, accuracy, and comprehension in reading impaired children (ages 9 to 15) when compared with controls who were given a variety of placebo lenses or no lenses at all (O'Connor, Sofo, Kendall, & Olsen, 1990; Robinson & Conway, 1990). These clinical results, like our own, are, at the least, intriguing, and, at the best, promising.

Recently published research suggests an additional dimension to the understanding of visual processing in students with learning disorders. Livingston Rosen, Drislane and Galaburda (1991) reported physiological and anatomical differences in the magnocellular part of the visual processing system of dyslexics and normals. The magnocellular part of the visual processing system is responsible for fast processing of visual information, such as maintaining an integrated visuo-perceptual field when saccades occur. They found that when a pattern reversal, visual evoked potential task was administered very rapidly (30 pattern reversals per second) in a low contrast condition, the magnocellular layer in the dyslexic brains could not "keep up" while the normal brain processing remained intact. Microscopic examination of the magnocellular layer in the brains of other dyslexics post mortem revealed smaller and more disorganized brain cells. The researchers suggested that the anomaly in the visual processing of dyslexics may provide insight into their reading difficulties.

Method

Subjects

Subjects in this pilot study consisted of 11 children (9 males and 2 females), ages 8 to 14 (mean 12) at the time of brain mapping, who had participated in an ongoing study of LD/G children being carried out by the senior author. All were residents of the Miami Valley region surrounding Dayton, Ohio. They were selected because a considerable body of psychoeducational data had been gathered about them and because they and their parents were willing to participate in the brain mapping process.

Wechsler Intelligence Scale for Children-Revised (WISC-R) (Wechsler, 1974). This well-known individual intelligence test has been the basis for most of the studies previously completed on the test patterns of LD/G children. In addition to the typical reporting of Verbal, Performance, and Full Scale discrepancies, the current work focused on the three factors identified by Kaufman (1979) as Verbal Comprehension (VC) (Information, Similarities, Vocabulary,

and Comprehension); Perceptual Organization (PO) (Picture Completion, Picture Arrangement, Block Design, and Object Assembly); and Freedom from Distractibility (Arithmetic, Digit Span, and Coding). The latter has been described by Bannatyne (1974) as a Sequencing factor.

Woodcock-Johnson Psychoeducational Battery-Tests of Achievement (WJPB-A) (Woodcock & Johnson, 1977). (Now available in Revised version.) This individually administered achievement battery is widely used in Ohio to identify children by the state ability/achievement formula. Seven of the 11 subjects had been administered the Reading, Mathematics, and Written Language Clusters and one had been given only the Reading and Mathematics Clusters.

Brain Atlas III Brain Mapping. Data for brain mapping on the Brain Atlas III are collected from 20 sensor locations on the scalp identical to those used routinely in medical applications of the EEG. The sensors are sewn into a lightweight, nylon aviator type cap and the subject is seated at a computer terminal and asked to perform decision making functions while the test is in progress. Brain electrical activity is measured at each scalp site 256 times per second and is displayed moment by moment on integrated multicolored brain maps. The brain maps show regions of varying brain electrical activity somewhat like isotherms that are displayed on a weather map.

Each child was mapped for about three hours. They completed tasks in visual, auditory, and multisensory decision making by depressing a computer key in response to an "oddball" paradigm. For instance, in one task a series of pictures were displayed on the screen. Most of the pictures were identical, but randomly a different picture (the target) appeared. When a different picture was seen, the child was instructed to depress the key. In the most complex task, a computer adaptation of the Stroop Test, the key was to be depressed when the visual, auditory, and color stimuli of a color word matched (e.g., the word "blue" was written in blue color while the word "blue" was heard on the headset.)

Snellen Chart- extended to 20/5. This chart is traditionally used in vision testing to determine resolution or clarity of sight. The chart used in this study is a reproduction of one used in 1887. It extends to 20/5, i.e., it can evaluate persons who can see at 20 feet what individuals with "normal" vision can only see at 5. Typically, Snellen Chart testing ceases at 20/20.

Contrast Sensitivity Vision Test (Ginsburg, 1984). The chart used in this test consists of five rows of nine circular patches that contain patterns of gray bars oriented 15 degrees to the left, vertically, or 15 degrees to the right. As the row of patches is viewed from the left to the right, the contrast of the gray bars becomes increasingly fainter. Ss are asked to determine the orientation of those bars for which they can detect the gray/white contrast.

Procedure and Data Analysis

The data gathering was accomplished in part by each of the authors. The senior author had gathered the psychoeducational data between 1986 and 1988 as part of a larger study of LD/G children. Brain mapping and vision testing were completed by Languis and Williamson, respectively, in the summer of 1989.

The mean, standard deviation, and range of the *WISC-R* scores were computed as was a t test for correlated samples (MacSS program, 1986) to determine significance of the Verbal, Performance, and Full Scale differences. The

scatter ranges of the subtests were then determined by subtracting the lower from the higher Verbal and Performance IQ regardless of direction and the lowest from the highest sub-scale score among the Verbal and Performance subtests. Finally, the scatter ranges were determined within and between the three Kaufman factor clusters (VC, PO, and FD).

The standard scores of the Reading, Mathematics, and Written Language Clusters of the *WJPB-A* were compared using a *t* test for correlated samples.

The brain mapping data analyses were performed using the data bank available within the system. The brain mapping system has the capability of comparing individual functioning over time, of compiling group data, or of comparing individuals or groups with previously collected normative data using the Statistical Probability Mapping statistic.

The mean and standard deviations were determined for both the *Snellen* and *Contrast Sensitivity Vision Tests*.

Results

Intelligence. The Full Scale WISC-R IQ's for the group ranged from 120 to 141 with a mean of 129.1, the Verbal IQ's ranged from 125 to 141 with a mean of 132, and the Performance IQ's ranged from 100 to 142 with a mean of 119.73 (See Table 1). The differences between the Performance and the Full Scale and Verbal means were significant at the .001 and .01 levels, respectively. Following the research trail which began with Schiff, Kaufman, and Kaufman (1981), various other inter- and intratest differences were examined. This group's mean of a 10.27 (SD 2.37) point Verbal/Performance discrepancy fell midway between the

Variables	Mean	SD	Range	t	p
Full Scale IQ	129.1	6.22	120 to 141		
Verbal IQ	132	5.93	125 to 141		
Performance IQ	119.7	11.03	100 to 142		
F vs. V				1.358	NS
F vs. P				-4.679	< .001
V vs. P				2.98	< .01
VC Factor ¹	15.43				
Information	14.91	1.3	13 to 17		
Similarities	16.27	2.05	12 to 19		
Vocabulary	16.18	1.83	13 to 19		
Comprehension	14.36	3.07	9 to 19		
PO Factor	14.06				
Picture Completion	14.00	2.28	11 to 18		
Picture Arrangement	14.18	1.94	11 to 17		
Block Desig	14.00	2.32	10 to 17		
Object Assembly	14.7	3.02	10 to 18		
FD Factor	10.35				
Arithmetic	12.46	1.81	10 to 16		
Digit Span	10.22	2.17	6 to 13		
Coding	8.36	3.6	5 to 18		

¹VC=Verbal Comprehension Factor; PO=Perceptual Organization Factor; and FD=Freedom from Distractibility Factor.

Table 1

14.07 discrepancy reported by Barton and Starnes (1989) and the 9.2 reported by Schiff et al (See Table 2). Since over half of all children whose IQs exceed 124 show a V/P discrepancy of more than nine points (Silver & Clampit, 1990) (Table 2), none of these these differences can be considered significant.

When the intrascale ranges of the Verbal (including Digit Span) and Performance Scales were determined, means were 7.46 (SD2.07) and 7.82 (SD3.34), respectively, exceeding the significant level of 7 points reported by Sattler (1990). All 11 subjects had a 6 point or greater high/low subtest discrepancy (mean 8.45); a 6 point discrepancy between any two subtests is significant at the .01 level (Sattler, 1990).

Variable	Standard Score	SD	Range	t	p
Reading	97.1	6.14	84 to 107		
Mathematics	110.5	9.84	95 to 114		
Written Language	96.1	9.1	85 to 112		
Rd. vs. Math				-2.82	<.05
Rd. vs. WL				.19	NS
WL vs. Math				-2.57	<.05

Table 3

It was when the three Kaufman factors were examined that the most meaningful patterns emerged. The Verbal Comprehension mean was 15.43; the Perceptual Organization mean was 14.06; and the Freedom from Distractibility mean was 10.35. Using the Clampit and Silver (1986) tables, the difference between the VC and PO means was not significant, but both the VC and PO composites differed from the FD mean at the .01 level (Table 2). When comparing high and low subtest scores, the lowest third factor score usually is contrasted with a high abstract verbal ability subtest score, often resulting in a 7 point or higher spread. When this third factor (relating to attentional deficit, memory, and/or sequencing weaknesses) was removed from the other Verbal and Performance subtests and treated separately, intra-factor ranges became quite narrow (4.46, SD 2.25 for VC; 3.37, SD 1.29 for PO, and 5.37, SD 2.46 for FD). We have concluded that verbal comprehension and perceptual organization abilities are quite consistent and superior in our sample. It is the FD factor that must be of concern in both the identification and programming phases of educating the LD/G student.

Achievement. For the eight Ss who had been administered the *WJPB-A*, the mean standard scores reported on the Reading, Mathematics, and Language Clusters were 97.1 (range 88 to 107), 110.59 (range 95 to 130), and 96.1 (range 85 to 112), respectively (Mathematics significantly differed from each of the others at the .05 level) (See Table 3). In all but one case, the mathematics score exceeded the other two; in

Factors	Discrepancy	Significance
Verbal/Performance	10.2	NS ¹
Intrascale Verbal	7.4	.01
Intrascale Performance	7.82	.01
Intrafactor -Kaufman VC	4.46	.05
Intrafactor-Kaufman PO	3.37	NS
Intrafactor-Kaufman FD	2.4	NS

¹All levels of significance according to Sattler (1990).

Table 2

four cases the reading score exceeded the language score, in three the reverse was true; and, in one case, no language score was reported.

Brain Mapping. Five specific tendencies were noted from the brain mapping patterns of the pilot group. They included:

- The pilot group exhibited a much higher level of cortical arousal in the resting EEG over frontal, central, parietal and occipital areas of the brain than either peer controls or LD students of average ability (.001 level). This pattern was found in the eyes open and even more strongly in the eyes closed condition. A strong central theta, associated with a "readiness to learn" state was observed in these subjects. Focused theta brain activity has been found in mammals and humans under conditions of relaxed alertness.
- Visual perceptual processing patterns were dramatically higher in the LD/G group. The occipital peak amplitude of the N100 FVEP (a visual evoked potential) waveform was approximately three times that of peer controls, double that of learning disabled peers of average intelligence, and slightly higher than academically gifted learners without learning disability. The differences between the LD/G group and controls were statistically significant at the occipital sites. This same strength also was observed in more complex ERP tasks. (It was this finding that precipitated the inclusion of vision testing in the study.) The visual processing was measured using a standard rate of light flashes (1.7 per second) in administering the visual evoked potential.
- Auditory processing patterns in the auditory ERP were delayed and asymmetrical (toward the right hemisphere) in the LD/G group compared with peer controls. These patterns were observed in both the N100 (selective attention) and P300 (decision making-stimulus evaluation) waveform components. This pattern was interpreted as a weakness and a learning disorder in cognitive processing of auditory stimuli.
- Sensory processing patterns for verbal, visual and auditory baseline processing patterns in the Stroop cognitive interference task indicated a stronger sensory processing modality strength for visual stimuli presented in color compared with the same stimuli presented in black and white. When the auditory, verbal, and visual sensory inputs were combined, the processing pattern was characterized by strong processing in the posterior, right parietal lobe. This pattern may suggest a visuo-spatial orientation to processing complex task stimuli in the pilot group.
- A computer administered version of the Category Test (adapted from the Halstead-Reitan Battery) was included in the study. These subjects displayed less focused frontal lobe activity when performing this test than did a heterogeneous middle school age control group. Luria's (1980) neuropsychological model suggests that the frontal region of the brain is the center for planful human thinking. Performance on this and other categorization and memory recall tasks indicated that the group was not using efficient or adaptive and flexible planning strategies.

Vision Testing. Vision testing had not been anticipated at the time brain mapping was scheduled. However, the particular pattern of results elicited by the visual tasks of the brain mapping was so consistent with the previous findings of Williamson (personal communication, 1989) that he was asked to evaluate the group. Nine Ss were available for evaluation. On the Snellen Test, the group had a mean visual acuity of 20/9.8 with all exceeding 20/20. They universally exceeded the

Contrast Sensitivity norms as well with a mean of 7.87 (SD .354) compared to the average adult 4 to 6 range found by Ginsburg et al (1984).

Discussion

The data gathered from this group of LD/G children present a psychoeducational picture comparable to groups previously reported in the literature. While our Ss were significantly higher in Verbal than Performance scores, they were drawn from a larger sample (N=48) (Bireley, unpublished data, 1986-88) whose mean scores slightly favored Performance abilities. The lower performance mean in the pilot group was depressed by two scores of 100 and 105, but the composite PIQ mean on the other nine was 123.56, well within the superior range and comparable to our larger group mean of 125.15. Those two children were interesting in that they were slow processors with very belabored speech patterns. The other nine Ss were quicker to react, exhibiting many traits attributed to both gifted and ADHD children. In any event, the equivocality in this area continues and it seems sensible to simply state that both patterns (higher V than P and higher P than V) exist in this population and that limited useful information is gained from this comparison.

It is, however, in the comparison of the three Kaufman factors that some meaning emerges. It would appear that our subjects were adept in verbal comprehension, a strength not necessarily reflected in their schoolwork. The two strongest verbal subtests (Similarities and Vocabulary) are less reflective of applied intelligence than are the two lower ones (Information and Comprehension) which are described as factual-related and practical, life-related, respectively (Kaufman, 1979). All four Perceptual Organization tests were nearly identical in strength (a mean range of 14 to 14.7). The two children with low performance scores appeared to be more disadvantaged by the time constraints of the performance tests than by any visual-perceptual or motor deficit. Finally, as noted above, the so-called distractibility or sequencing factor appeared to be generally deficient in this group. If one prefers to relate this deficiency to distractibility, it can be noted that nine of the 11 Ss had diagnoses of and/or were described by psychologists in terms related to ADHD. The second option, a sequencing disability, most certainly corresponds with the common spelling weakness of the group. Finally, Williamson hypothesizes that the Coding subtest that is a part of this factor is a difficult visual task for children with hyperacuity because of the high edge contrast demands of the task. Indeed, when the results were inspected, the mean of 8.36 on Coding was nearly two points lower than the second lowest mean of 10.22 on Digit Span, a short-term memory task highly affected by distractibility! Regardless of one's interpretation, the third factor weakness is reality.

Achievement data are interesting in that the mathematics mean score was above average, although below the level predicted by the intelligence scores; reading scores ranged from low average to above average; and written language tended to be low average. If ability/achievement discrepancy is used as the basis for determining learning disability, this group clearly qualifies. The need for remedial or compensatory support in the area of written language may be particularly acute because of the greater emphasis on reading and mathematics.

Finally, the brain mapping and vision testing results pre-

sented here tend to verify several observations that have been made about gifted and learning disabled children. The higher level of cortical arousal noted in the brain mapping might be related to a high readiness for learning. It is certainly reminiscent of the psychomotor overexcitability described by Dabrowski and Piechowski (1977) as high energy and restlessness. Dabrowski and Piechowski noted that, when channeled, such energy can lead to a high development of potential; when unexplained, it may lead to feelings of difference from one's peers.

The skewing of auditory processing toward the right hemisphere indicates a cognitive disorder that may have classroom implications. For those students in which this phenomenon occurs, the processing of auditory input (including language) may first be attempted through the visual-spatial portion of the brain before it is appropriately channeled to the left temporal region of the brain. This slight delay may result in an inability to "keep up" with classroom interaction or the tendency to respond slowly when called to do so. Such children may be considered inattentive or "dull" or may be given other equally negative labels. This finding certainly corresponds with Daniels' (1983) contention that LD/G children "lack speed of reaction, especially in language" (p. 14).

The amplitude of the visual processing pattern has been discussed in some detail before. If the high amplitude observed in the brain mapping and the atypical visual functions uncovered by Williamson are but two manifestations of the same characteristic, this trait is one that has gone virtually undetected in previous literature about either gifted or learning disabled children. Since the normative data previously gathered by Languis on both learning disabled and non-disabled gifted children supports an increase in amplitude in both groups when compared with normal peers, the even larger increase in the LD/G group may reflect an interactive effect between the two conditions. One purely speculative explanation might be that the high cortical arousal of the gifted interacts with the visual acuity and sensitivity of the learning disabled to form these unusually high readings. In view of the patterns reported by Livingston, et al. (1991) for dyslexics, it would be of interest to administer the pattern reversal visual evoked potential task at the faster rate and at reduced contrast to the same subjects used in this study.

Finally, the diffuse frontal lobe activity displayed by this group indicates that, while intellectual capability exists and is testable psychometrically, some higher level cognitive functions (in this case, categorization and memory recall) may not be used as efficiently as is typical of the non-disabled person. The specific introduction of cognitive strategies for problem solving may be needed to overcome this deficiency.

Summary and Recommendations

The data presented here must be considered preliminary because of the small size of this volunteer sample and no claims are made for generalizability. However, in other ongoing projects, we have gathered additional psychoeducational and brainmapping data on larger samples and, where such information exists, have compared our data with the results of others. The consistency of results in all of these endeavors supports our belief that certain physiological characteristics do exist in the learning disabled/ gifted population and that these differences require educational treatment different from that now available in either "typical" gifted or learning

disabilities programs. This conclusion is no different from that made by Whitmore (1980) over a decade ago and by those who have since added to our knowledge of this unusual group of children. We do have several specific recommendations based upon our findings. They include:

- Given the third factor (distractibility/sequencing) deficit of this group, it is recommended that identification of giftedness be accomplished by extracting these subtests from the WISC-R IQ's and using the prorating tables provided in the manual for four subtests. The resulting scores will more nearly reflect the intellectual ability of the individual. The more non-intellective third factor behaviors *must* be dealt with educationally, but, in our opinion, spuriously decrease the WISC-R IQ for identification purposes. When applied to our 11 subjects, the Verbal, Performance, and Full Scale IQs raised to 134.5, 127.8, and 135.1 respectively (compared to 132, 119.7, and 129.1). Applying the same procedure to the gifted group reported by Brown and Yakimowski (1987) resulted in increases of less than two points per score (131.6 to 133 for Verbal, 124.2 to 126 for Performance, and 131.3 to 133 for Full Scales IQs.)
- Providing remedial and compensatory strategies for LD/G children must not be terminated when reading skill is sufficient for classroom functioning. A serious written language deficiency will continue to exist in most LD/G children. We recommend long term support for writing skills, early and intensive teaching of word processing skills, and ongoing advocacy on their behalf so that children will be allowed to use such skills for the completion of significant school assignments from an early age.
- Team planning, team teaching, and/or dually trained personnel are critical. Gifted educators, who are experts in thematic teaching, must work with learning disability specialists so that the deficiencies pinpointed by the latter can be taught in a challenging context more appropriate for these children than isolated drill and practice activities.
- In spite of large vocabularies, LD/G children may need more time to process incoming auditory verbal information. Teachers in all classrooms, but especially teachers of the gifted used to dealing with quick verbal interactions, must be cognizant of this processing lag and provide ways for such individuals to keep up. "Buddy" notetakers, review of critical points, and patience in waiting for responses are but a few compensatory techniques.
- Direct teaching of efficient learning and problem solving strategies must be taught to this group. Graphic organizers, self-talk problem solving sequences, study skills, and memory enhancers are examples of such skills. (See Beyer, 1987; Reid, 1988; and *Breakthroughs*, 1990, for examples.)
- For children who appear to have high visual functioning, fluorescent lights should be avoided, paper should be non-white and non-gloss, and visual stimuli such as "busy" wall or cloth patterns should be minimized. Some of Williamson's clients have had success in studying with low wattage pink or red bulbs and/or by using a non-gloss plastic (not acetate) overlay on reading material. In our clinical experience, children who will be helped by an overlay may see immediate improvement in their ability to deal with the printed page. One of our subjects, when given this opportunity, declared that "the print stopped moving!"
- Many LD/G children may have ADHD. Behavioral interventions and medical attention for this condition are imperative. Many young "learning disabled" children who bring their attention deficit under control are more than capable

of making normal or superior school progress with little remediation. Those who fall behind because of unidentified ADHD must deal with learning gaps as well as attention deficit.

- Finally, attention to issues of self-concept and self-esteem are critical. The discrepancies that exist in the functioning of the LD/G individual are often attributed to laziness, inattentiveness, and willfulness. It is important that specific information about this problem be shared with the child as well as with all significant adults in his/her environment. Some of the problems of this condition can be overcome, some can be contained by compensatory skills, and some must be dealt with as life-long weaknesses. Lending emotional support to the individual who is developing a coping repertoire must be considered as having equal priority with educational programming.

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