



## Perceptual Domain Case Study

“It was difficult to recommend strategies for Tamara’s learning ... but now the team has a starting point that will make a difference.”



intervene.

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**Tamara's grades in her other courses are A's and B's.**

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Meet Tamara ... a 14-year-old 9th grader at Washington Junior High School. Tamara's parents requested a complete psychoeducational evaluation because Tamara consistently achieves poor grades in math despite long hours of studying. They have been investigating possible reasons for her failure and believe that she may suffer from a nonverbal learning disability.

Tamara received a D- in Algebra I for the first marking period, and she has failed two tests since the beginning of the second marking period. Tamara's grades in her other courses are A's and B's. In 7th and 8th grade, Tamara received mostly A's and B's, but D-'s in math. Tamara's mother believes that Tamara is trying her best and that her grades do not reflect the effort that Tamara puts into learning mathematics. Tamara's parents describe her as an active, happy child (except when she has to work on math homework) who has many friends and a wide range of interests. Tamara's mother described Tamara's early development as being free of problems and progressing at a normal pace. Tamara's mother and father made no mention of health problems or physical conditions that might be impacting Tamara's learning at this time.

During the assessment sessions, Tamara displayed an engaging smile and a pleasant disposition that made it easy to interact with her at all times. She was sincere and articulate in her responses to questions about school and home and described her involvement in school activities, such as swim team and chorus, with enthusiasm and obvious enjoyment. Her conversational skills were good as was her sense of humor. All of Tamara's interactions were socially appropriate and the overall impression that Tamara projected was that of a happy, positive, well-adjusted child who is engaged with her interests and environment.

When providing oral responses to test items, Tamara effectively communicated her thoughts, but tended to keep her responses very short. Tamara demonstrated good comprehension of all directions given to her and did not appear to have any difficulties understanding what was said to her.

Because of the isolated academic difficulty Tamara is encountering with mathematics, Tamara's assessment included an evaluation of possible nonverbal learning disability. The core and supplemental subtests of the WISC-IV Integrated were administered, along with selected process approach subtests from the WISC-IV Integrated, and the two mathematics subtests of the *Wechsler Individual Achievement Test®—Second Edition (WIAT®—II)*. The syndrome of nonverbal learning disabilities posits primary neuropsychological deficits in visuospatial abilities, secondary deficits in executive functioning abilities, and tertiary deficits in reasoning accompanied by deficits in mathematics reasoning, but not necessarily in basic mathematics rote procedures and calculations. Thus, the additional WISC-IV Integrated subtests selected for administration were **Block Design Multiple Choice** and **Spatial Span** to explore basic visuospatial abilities, **Elithorn Mazes** to explore executive functions involving a visuospatial task, and the process approach arithmetic tasks to mathematics problem-solving and calculations with comparable item sets.

Tamara's efforts with these specific elements of the comprehensive psychoeducational assessment earned her the following scores:

**WECHSLER INTELLIGENCE SCALE FOR CHILDREN<sup>®</sup>—FOURTH EDITION INTEGRATED (WISC<sup>®</sup>—IV INTEGRATED)**

	Composite Score	Percentile Rank
<b>SCALE</b>		
Full	106	66

**INDEXES**

Verbal Comprehension	116	86
Perceptual Reasoning	92	30
Working Memory	110	75
Processing Speed	97	42

**VERBAL COMPREHENSION SUBTESTS**

	Scaled Score	Percentile Rank
Similarities	16	98
Vocabulary	10	50
Comprehension	13	84
Information	11	63
Word Reasoning	12	75

**PERCEPTUAL REASONING SUBTESTS**

Block Design	8	25
Picture Concepts	10	50
Matrix Reasoning	8	25
Picture Completion	6	9

**WORKING MEMORY SUBTESTS**

Digit Span	11	63
Letter–Number Sequencing	13	84
Arithmetic	13	84

**PROCESSING SPEED SUBTESTS**

Coding	9	37
Symbol Search	10	50
Cancellation	10	50

**PERCEPTUAL DOMAIN PROCESS SUBTESTS AND SCORES**

Block Design No Time Bonus	9	37
Block Design Multiple Choice	8	25
Block Design Multiple Choice No Time Bonus	13	84
Elithorn Mazes	9	37

**WORKING MEMORY DOMAIN PROCESS SUBTESTS AND SCORES**

Spatial Span Forward	12	75
Spatial Span Backward	12	75
Written Arithmetic	6	9

**PROCESSING SPEED DOMAIN PROCESS SUBTESTS AND SCORES**

Cancellation Random	9	37
Cancellation Structured	12	75

**WECHSLER INDIVIDUAL ACHIEVEMENT TEST<sup>®</sup>—SECOND EDITION (WIAT<sup>®</sup>—II) SUBTESTS**

	Standard Score	Percentile Rank
Math Reasoning	114	
Numerical Operations	89	

The significantly large 24-point difference between Tamara's Verbal Comprehension Index scaled score of 116 and her Perceptual Reasoning Index scaled score of 92 is consistent with many popular conceptualizations of the nonverbal learning disabilities. The scaled scores Tamara earned on the **Picture Completion**, **Block Design**, and **Matrix Reasoning** subtests also seemed to support, at least on the surface, the presence of a relative weakness that could be visual-perception based. However, careful consideration of Tamara's performance on the WISC–IV Integrated process approach subtests combined with closer examination of *how* Tamara performed on the visual perceptual-based subtests led to very different conclusions about the source of Tamara's relative difficulties with these tasks. When these interpretive factors were taken into consideration, the hypothesis that Tamara has relative visual perception deficits and relatively poorer reasoning with nonverbal visual material consistent with the syndrome of nonverbal learning disability was much less tenable.

Administration of the **Block Design Multiple Choice (BDMC)** subtest was extremely helpful in understanding Tamara's capabilities with basic visual perceptual organization processes and the manner in which she applies these processes to elementary perceptual tasks. For each item of the BDMC subtest, Tamara had to choose from four red-and-white geometric designs the one that exactly matched a model design at the top of the page. Each design alternative was fragmented into parts that resembled the faces of blocks making it more difficult to perform the perceptual matching of the alternatives to the model. The items progressed from two-dimensional four-block designs to two-dimensional nine-block designs to representations of three-dimensional two- and four-block designs. Performance of the BDMC subtest was scored in two ways. The BDMC score was based on awarding two points for any correct response provided in five seconds or less and one point for a correct response provided within six to 30 seconds. The **Block Design Multiple Choice No Time Bonus (BDMCN)** score included no bonus points for speed of performance and awarded each correct response only one point. Tamara's BDMCN scaled score of 13 indicated highly effective basic visual perceptual organization and discrimination abilities as Tamara accurately identified the correct matching design on all 25 items including the much more difficult three-dimensional items. This perfect accuracy performance only translated into a scaled score of 13 because of the lower ceiling on the no bonus point version of the BDMC task for older children such as Tamara.

When perceptual processing and response speed were included in item scoring, Tamara's performance relative to the 14-year-old norm sample was much less effective, only yielding a BDMC scaled score of 8. Tamara obtained extra points for quick responses on only six of the 25 items. All six of these items involved highly symmetric design models and response options that lent themselves to quick visual processing of overall design organization for quick matching. For items that provided less in the way of design gestalt cues for matching, Tamara required much more time to process the individual details of the models and the response alternatives before providing a response. Although Tamara utilized her basic visual processing skills in a relatively slow manner, she always produced correct matches.

Tamara's performance on the **Block Design** subtest yielded a scaled score of 8, identical to her BDMC score. Although Tamara obtained a low average score, she was able to successfully complete three of the four hardest items on the test, including the last two most difficult items. Even the best performers in the 14- to 16-year age range of the norm sample only infrequently accomplished this feat. Inconsistent with this high level of performance was the fact that Tamara was unable to correctly complete two relatively easy items (Items 8 and 10). In reviewing Tamara's performance across all items, a clear pattern emerged regarding Tamara's approach to item solutions. In most cases, Tamara demonstrated a strong preference to initiate performance from a global, pattern orientation as she pushed all of the blocks together to produce the required four- or nine-block overall configuration. After doing this, Tamara would then work out the details of specific block placements by analyzing patterns formed by two-block units relative to the overall design, and using these smaller "whole designs" to guide individual block placement.

This strategy was somewhat slow but effective for all of the models that formed symmetric designs (including the two most difficult items), as the overall pattern could be easily organized and utilized to direct the division of the whole into smaller patterns. When the design model (Items 8, 10, and 12) was asymmetrical, however, Tamara persisted in her efforts to initiate task performance by moving from whole to parts. This resulted in a great deal of time lost as Tamara tried to divide the overall design into relatively symmetric two-block parts with very little success, especially when trying to connect these two-block units. For all three items that used asymmetric design models, Tamara had accurately placed no more than half of the blocks before the time limit had expired.

while providing occasional incorrect responses to less difficult items (Items 13, 15, 18, 21). When reviewing Tamara's incorrect choices for these items, she consistently chose alternate responses that reflected an understanding of the basic principle underlying problem solution, but a lack of consideration of individual details that would have enabled her to eliminate her preferred choice and, instead, select the correct response. Tamara consistently demonstrated good reasoning abilities with this task, but occasionally failed to grasp the significance of important details resulting in overall performance that translated into a low average score.



### ... Tamara's performance on the WISC-IV Integrated process approach subtests combined with closer examination of how Tamara performed on the visual perceptual-based subtests led to very different conclusions ...

Through careful observation of Tamara's performance and analysis of the resulting item scores, it was determined that Tamara's low average score was not due to any relative lack of basic visual perceptual abilities, lack of manual dexterity, or lack of ability to reason or problem-solve with nonverbal visual material. Rather, it was due to an inability to find and apply a strategy to effectively deal with analysis of details when she encountered visual information that did not include a strong overall organizational framework to guide efforts at detail analysis.

Difficulties with the analysis of details were also observed in Tamara's performance of the **Matrix Reasoning** subtest where she earned a scaled score of 8. Throughout her performance on the Matrix Reasoning subtest, Tamara demonstrated a relatively slow and deliberate work pace consistent with her efforts on the Block Design tasks she attempted. She was able to correctly solve many of the more difficult items (Items 22, 23, 24, 26, 28)

On the **Picture Completion** subtest Tamara obtained a low scaled score of 6, as she frequently experienced a great deal of difficulty looking beyond the overall pattern or gestalt of the pictured object or scene in order to identify a missing element. In many instances, Tamara would spend 15–20 seconds looking at a picture before emphatically stating that there was nothing missing.

Tamara was also administered the **Elithorn Mazes** subtest because it requires the use of executive control processes to direct completion of a visual task, an ability thought to be compromised in children with Nonverbal Learning Disabilities. For each test item, Tamara had to draw a path beginning at the bottom of a maze through a specified number of dots to an exit at the top of the maze within a specified amount of time. The path for each maze had to be planned out before responding could begin because backtracking through the maze to correct a wrong turn was not permitted. For mazes incorrectly completed within 60 seconds on the first trial, a second trial was given using the same maze

with the errors from the first try there on the page to provide feedback about the incorrect path. Tamara demonstrated long latency times, as she appeared to be carefully planning out paths before beginning to draw. She engaged in a great deal of motor planning, air tracing various alternative paths prior to beginning to draw her chosen path. Tamara was able to correctly complete all but the most difficult item, and required a second trial only on the second hardest item. Because Tamara engaged in prolonged periods of preplanning, she usually did not earn bonus points for quick performance. Tamara's efforts produced an Elithorn Mazes scaled score of 9.

Overall, Tamara's performance on the tasks that comprise the Perceptual domain of the WISC-IV Integrated reflected strong basic visual perceptual abilities and effective reasoning with nonverbal visual information despite the relatively low scores she earned on some of these tasks. Tamara's relative difficulties with perceptual tasks were rooted in her slow work pace, and difficulties with analyzing

details when a strong organizational framework was not present to guide her analysis and sometimes overlooking important details while formulating solutions to reasoning problems.

The **Spatial Span** tasks were also administered to Tamara because they involve spatial visualization abilities thought to be compromised in children with nonverbal learning disability. The Spatial Span tasks were administered using a white board with 10 square blue blocks attached in random locations to the surface of the board. For each forward span item, the psychologist touched a series of blocks, and Tamara was required to touch the same blocks in the same order as the psychologist. For each backward span item, the psychologist touched a series of blocks, and Tamara was required to touch the same blocks in reverse order. Tamara experienced no difficulties with the Spatial Span Forward task, earning a scaled score of 12. Tamara also did very well with the Spatial Span Backward task, earning a scaled score of 12 with this task, as well. Tamara's performance with the Spatial Span tasks did not suggest that she experienced any difficulties engaging or effectively using spatial visualization or spatial memory processes.

Tamara was administered the WISC-IV **Arithmetic** subtest and performed quite well when required to listen to practical mathematics word problems and solve them without the use of pencil or paper, earning an Arithmetic subtest scaled score of 13. Because Tamara performed so well with the standard Arithmetic subtest, the process approach variations, Arithmetic Process Approach A and Process Approach B, were not administered. However, since Tamara exhibited so many difficulties with analysis of details in many of the Perceptual domain tasks, the Written Arithmetic process approach variation of the Arithmetic subtest was administered.

The **Written Arithmetic** task is composed of the formulas that represent the accurate set-up and solution of the word problems of the Arithmetic subtest. The child must understand the mathematical symbols and procedural rules regarding the sequence in which the operations are performed as well as be able to perform the calculations to get the correct response. The mathematics problems are arranged in numerical order across several pages of a response booklet. Tamara was given 15 minutes to complete as many of the calculations as she could while using a pencil. Tamara worked very quickly through the

basic operations items but shifted to a very slow pace when faced with more complexly structured items. Overall, Tamara required 13 minutes to complete all of the items. The results of this task were very informative as they were in great contrast to Tamara's effective performance with the Arithmetic subtest. Tamara incorrectly solved the calculations for five items that she had answered correctly without the use of pencil and paper in the word problem format. The errors that Tamara made on these five problems are quite revealing. When confronted with a row of four similarly formatted basic problems, Tamara quickly completed all four of these problems as addition calculations, but the third problem was a subtraction problem, resulting in an incorrect response ( $10 - 3 = 13$ ). For the algorithm  $(8 - 4) + 2$ , Tamara ignored the parenthesis on the right and added  $4 + 2$ , then subtracted  $8 - 6$  to obtain 2. In later problems, she performed calculations with similar parenthetical terms correctly. For  $\$1.00 - (2 \times \$0.40)$ , Tamara misread the  $\$0.40$  as  $\$4.00$  and completed the calculation as  $\$1.00 - \$8.00 = -\$7.00$ . For  $17/2$ , Tamara did not include a decimal point in her response, recording the answer as 85. For  $300/(3 + 2)$ , Tamara multiplied  $3 \times 2$  instead of adding  $3 + 2$  and completed the calculation as  $300/6 = 50$ . Although Tamara demonstrated a solid understanding of both basic and advanced mathematics operations, Tamara's inconsistent attention to and/or accurate use of details in some very basic calculation procedures resulted in errors on relatively easy items and a below average score (Written Arithmetic scaled score 6).

The extremely large difference between Tamara's Arithmetic scaled score of 13 and her Written Arithmetic scaled score of 6, clearly illustrated a striking contrast between Tamara's well developed practical mathematics problem-solving skills and her inability to perform basic calculations in a consistent, efficient manner.

Tamara's performance on the **WIAT-II Math Reasoning and Numerical Operations** subtest was very similar to the results obtained on the WISC-IV Integrated Written Arithmetic subtest. The WIAT-II Math Reasoning subtest was used to assess Tamara's knowledge and application of mathematics concepts across a broad range of content areas such as quantity, geometry, money, and time. This subtest required Tamara to view pictorial representations or written descriptions of each math problem and then figure out how to solve the problem and perform the necessary calculations. Tamara was allowed to use a pencil and paper to work out problems and no time limits were imposed on any of the problems. Tamara earned a WIAT-II Math Reasoning standard score of 114, indicating well-developed skill at applying mathematics concepts and operations to practical problems. Despite her score in the upper end of the average range, Tamara provided incorrect responses to three relatively easy problems as a result of errors in very basic calculations.

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The **WIAT-II Numerical Operations** subtest required Tamara to perform mathematical calculations using addition, subtraction, multiplication, and division with whole numbers, fractions, and decimals and to solve some basic algebraic equations. Tamara was given a pencil and paper to work out calculations, and no time limits were imposed on any of the items. Tamara dutifully applied her efforts to the calculation problems working quickly through the very simple basic operations, but shifting to an extremely slow work pace for the more difficult items, requiring almost 25 minutes to complete all of the problems. Although she worked very slowly on many of the items, Tamara usually did not bother to check the accuracy of her final answers. As a result, many of Tamara's responses demonstrated an understanding of the operations required to produce a correct response, but an inattention or lack of use of important details to obtain the exact correct response. The errors that Tamara made on very easy items were clearly due to a lack of monitoring for accuracy (for example  $16/2 = 4$ ;  $16 + 9 = 105$ ;  $300\%$  of  $75 = 225\%$  instead of  $225$ ;  $2y + 12 = 6$ ,  $y = 3$  instead of  $-3$ ). Tamara's efforts translated to a WIAT-II Numerical Operations subtest standard score of 89. If Tamara had checked her work and caught her errors on easy calculations, her score on this subtest would have been more similar to her Math Reasoning subtest score.

### Summary

In her performance of the tasks of the WISC-IV Integrated Perceptual Reasoning and Working Memory domains and the WIAT-II mathematics subtests, Tamara did not demonstrate relative weaknesses in basic visual perceptual processing, spatial visualization abilities, reasoning with nonverbal visual material, executive direction of visual planning, or relative deficiencies in understanding, reasoning with, and applying mathematics concepts. In fact, Tamara's capacities in these areas are likely as well-developed as her verbal skills despite the large discrepancy between her Verbal Comprehension and Perceptual Reasoning Index scores.

Although Tamara did not display any deficiencies in visuospatial ability or mathematics skills, she did exhibit some specific cognitive process difficulties that significantly affected her ability to perform many of the Perceptual Reasoning Domain tasks she was administered. These included:

1. Difficulties with the analysis of details when a strong overall organizational pattern was not present in visually presented information.
2. Difficulties related to overlooking or not utilizing important visual details to arrive at correct solutions.
3. Difficulties with monitoring work with visual tasks for accuracy of final responses.
4. An extremely slow work pace when complex visual information or complex mathematics problems needed to be processed.

The results of the assessment generally did not suggest the presence of a nonverbal learning disability, as Tamara demonstrated none of the visual



perceptual, reasoning, executive function, or mathematics problem-solving deficits thought to be indicators of the syndrome. In addition, Tamara did not demonstrate any social skills deficits or any of the language deficiencies thought to be characteristic of nonverbal learning disability, such as pointless, excessive talking or "chatter," or difficulties with speech prosody and interpreting humor. In fact, Tamara's Verbal domain task scores displayed a pattern of relationships opposite to that thought to be indicative of nonverbal learning disability, e.g., her scores on verbal tasks requiring relatively fluid reasoning abilities (Similarities 16, Comprehension 13) were better than her scores on tasks requiring retrieval of rote facts (Information 11, Vocabulary 10).

In a team meeting at the school, the results of the assessment were shared with Tamara's parents and school staff, and recommendations for ways to assist Tamara with her difficulties in effectively demonstrating her knowledge of mathematics concepts were considered. The results of Tamara's evaluation indicated that she was eligible for special education services and an Individualized Education Plan (IEP) was developed. Because Tamara's difficulties with math were more related to cognitive processing strategy difficulties than mathematics learning problems, the team decided that rather than having Tamara receive her mathematics instruction through the special education resource room program, Tamara would continue to receive instruction in the regular classroom, and go to the resource room to take her math tests. In the resource room, Tamara would be provided additional time to complete tests if needed, and she would be guided through an error checking routine at the end of the test. If errors were found, Tamara would be provided an opportunity to correct the errors. Tamara's parents also chose to seek the services of a highly recommended tutor who would work with Tamara to help her improve her ability to effectively identify and use details in her problem-solving approach to mathematics and other nonverbal visual tasks, and to practice the use of error-checking routines similar to the one used during test-taking in school.