

## **1. Abstract**

SP was a 7-year and 11-month old girl who initially presented with a chief complaint of difficulty with reading. The following is a case report of the diagnosis and management of a patient with learning-related vision problems.

## **2. History**

### Chief complaint

SP was a 7-year and 11-month old girl who initially presented to our clinic on December 1, 2007 for a visual efficiency and visual information processing evaluations. Her mother reported that SP was having problems with reading and she wished to rule out any learning-related vision problems prior to being assessed for a learning disability. SP's mother indicated that SP was not reading up to her 3<sup>rd</sup> grade reading potential and had been struggling to stay on grade level since the 1<sup>st</sup> grade. SP's mother specifically indicated that her difficulties lied in her ability to sound out words with multiple syllables, reversals errors during reading, fatigue and headaches after approximately 30 minutes of reading, and replaces words (e.g. an for and).

SP had not repeated any grades and had previously received reading remediation in the summer; however, SP's mother indicated that SP appeared to still have not yet caught up to her grade level yet.

Upon administration of the Convergence Insufficiency Symptom Survey (CISS), SP self-reported a score of 17. SP's mother reported a higher symptom score with a score of

31 on the CISS. The parent survey also includes questions related to visual processing and SP mother marked fairly often or always for several questions. See Figure 1 for SP's symptom and Figure 2 for SP's mother reporting.

Figure 1: SP's CISS (total score: 17)

Symptom	Never	Infrequently	Sometimes	Fairly Often	Always
1. Do your eyes feel tired when reading or doing close work?			X		
2. Do your eyes feel uncomfortable when reading or doing close work?	X				
3. Do you have headaches when reading or doing close work?			X		
4. Do you feel sleepy when reading or doing close work?	X				
5. Do you lose concentration when reading or doing close work?			X		
6. Do you have trouble remembering what you have read?	X				
7. Do you have double vision when reading or doing close work?			X		
8. Do you see the words move, jump, swim, or appear to float on the page when reading or doing close work?			X		
9. Do you feel that you read slowly?	X				
10. Do your eyes ever hurt when reading or doing close work?				X	
11. Do your eyes ever feel sore when reading or doing close work?			X		
12. Do you have a "pulling" feeling around your eyes when reading or doing close work?	X				
13. Do words blur or come in and out of focus when reading or doing close work?	X				
14. Do you lose your place while reading or doing close work?			X		
15. Do you have to re-read the same line of words when reading?	X				

Figure 2: SP’s mother parent survey (CISS score: 31, Overall score: 60)

CISS Parent Survey	Symptom	Never	Infre- quently	Some- times	Fairly Often	Always
	1. Does your child report that his/her eyes feel tired when reading or doing close work?				✓	
	2. Does your child report that his/her eyes feel uncomfortable when reading or doing close work?				✓	
	3. Does your child report headaches when reading or doing close work?				✓	
	4. Does your child report that he/she feels sleepy when reading or doing close work?				✓	
	5. Does your child report that he/she loses concentration when reading or doing close work?				✓	
	6. Does your child have trouble remembering what he/she has read?				✓	
	7. Does your child report double vision when reading or doing close work?		✓			
	8. Does your child report that he/she sees the words move, jump, swim, or appear to float on the page when reading or doing close work?		✓			
	9. Does your child read slowly?				✓	
	10. Does your child report that his/her eyes ever hurt when reading or doing close work?			✓		
	11. Does your child report that his/her eyes ever feel sore when reading or doing close work?			✓		
	12. Does your child report a "pulling" feeling around his/her eyes when reading or doing close work?	✓				
	13. Does your child report that words blur or come in and out of focus when reading or doing close work?	✓				
	14. Does your child lose his/her place while reading or doing close work?			✓		
15. Does your child have to re-read the same line of words when reading?			✓			
16. Does your child make reversal errors when reading (was for saw, on for no) or writing (b for d)?				✓		
17. Does your child transpose letters or numbers (21 for 12)?				✓		
18. Does your child have difficulty copying written material?				✓		
19. Does your child have poor printing or handwriting?				✓		
20. Does your child avoid reading?				✓		
21. Does your child have difficulty finishing school assignments in a timely manner?			✓			
22. Does your child misalign digits or columns when doing math assignments?			✓			
23. Does your child seem to be clumsy or knock things over?			✓			
24. Does your child overlook small details (reads beak for break) or misread math symbols ("-" for "+")?					✓	
25. Does your child have a short attention span or is he/she easily distractible when reading or studying?					✓	

Medical/developmental history

SP’s developmental was born full-term and had no delays in any of her developmental milestones. She also indicated no history of chronic ear infections. At the time of evaluation, SP was taking amoxicillin for a sinus infection. Family history was remarkable for a possible learning disability in the father and paternal grandfather. Medical history was also remarkable for hayfever allergies. All other medical and developmental history were unremarkable.

Previous ocular history

SP was previously seen on July 7, 2007 for a comprehensive eye examination where she received an updated spectacle prescription: OD +1.00 -1.00 x 014 and OS +0.50 -1.00 x 178. SP had been wearing spectacles since the 1<sup>st</sup> grade.

**3. Diagnostic Testing**

Visual Efficiency Evaluation

SP was found to have 20/20 visual acuity OD, OS, and OU through her habitual spectacles of OD +1.00 -1.00 x 014 and OS +0.50 -1.00 x 178. Non-cycloplegic retinoscopy and refraction revealed OD +1.25 -0.75 x 014 and OS +0.75 -0.75 x 175 with 20/20 visual acuity. The following tests were performed:

CATEGORY	TEST	FINDINGS	
	<b>Rx</b>	OD +1.00 -1.00 x 014 OS +0.50 -1.00 x 178	
<b>Oculomotor</b>	Fixations (OU)	4+	
	Pursuits (OU)	4+	
	Saccades (OU)	3+	
	DEM	RS	PR
	Test A (sec)	29	
	Test B (sec)	28	
	Vertical Time (sec)	57	10%
	Test C (sec)	127	
	Addition Errors	5	
	Omission Errors	0	
	Transposition Errors	0	
	Substitution Errors	0	
	Horizontal Time (sec)	119.5	<1%
	Ratio	2.10	<1%
Total Errors	5	25%	

<b>Accommodation</b>	Amplitudes (Push up method)	(cm)	(D)	
	OD	6.67	15	
	OS	6.67	15	
	Facility (cpm)	With a ± 2.00 flipper		
	OD	7.5		
	OS	9.0		
	OU	4.0		
	Observation	Noticed more difficulty with (+) lens		
	NRA	+2.25		
	PRA	-4.00		
<b>Vergence</b>	NPC 1st attempt 5th attempt	Break	Recovery	
		4 cm	6 cm	
		6 cm	8 cm	
	Unilateral Cover Test	Distance	Near	
	Alternate Cover Test	No strabismus	No strabismus	
<b>Sensory</b>	IPD (mm)	57		
	Calculated AC/A	4.90		
	NFV	Distance (3 m)	Near (40 cm)	
		Blur	X	X
		Break	14	18
	PFV	Recovery	8	16
		Distance (3 m)	Near (40 cm)	
		Blur	X	X
	Facility 8 <sup>Δ</sup> BO/BI @ Near (40 cm)	Break	30	10
		Recovery	25	8
8.5 cpm Slightly more difficulty with BO		Distance	Near (40 cm)	
Fixation Disparity / Associated Phoria	Not assessed	No fixation disparity		
	W4D	Distance (3 m)	Near (40 cm)	
		2° fusion	2° fusion	
Stereopsis - LD (sec of arc)	Distance (3 m)	Near (40 cm)		
	90"	30"		
Stereopsis - RDS (sec of arc)	Not assessed	Not assessed		

Visual Information Processing Evaluation

The following tests were performed:

<b>CATEGORY</b>	<b>TEST</b>	<b>Raw Score</b>	<b>Percentile</b>
<b>Visual Spatial</b>	Angels in the Snow	8 y.o.	
	Piaget R-L Awareness	6 y.o.	
	Jordan L-R Reversal (Levels I)	3	27%
<b>Visual Analysis</b>	TVPS-R		
	Visual Discrimination	14	66%
	Visual Memory	15	87%
	Visual Spatial Relations	14	68%
	Visual Form Constancy	6	2%
	Visual Sequential Memory	6	1%
	Visual Figure Ground	10	23%
	Visual Closure	6	2%
	Spatial Relations (PMA 1)	14	29%
	Test of Silent Word Reading Fluency (TOWSRF)	70	2%
	Children's Color Trails Test (CCTT)		
	CCTT1 – Time (sec)	42	29%
	CCTT1 – Error (#)	1	6-10%
	CCTT1 – Prompt	0	>16%
	CCTT2 – Time (sec)	53	49%
CCTT2 – Error (#)	1	>16%	
CCTT2 – Error (color)	0	>16%	
CCTT2 - Prompt	0	>16%	

<b>Visual Motor</b>	Beery Visual Motor Integration (5 <sup>th</sup> edition)	17	9%
	Beery Motor Coordination	17	6%
	Wold Sentence Copy (letters/min)	7 <sup>th</sup> grade	

Dyslexia Determination Test, Form A

Grapheme-Nemkinesis: 3<sup>rd</sup> grade (no dysnemkinesis)

Results of decoding: 5<sup>th</sup> grade (highest grade level of sight word recognition)

Results of encoding: 20% correct spelling of Flash Known words (normal)

20% correct spelling of Unknown words (normal)

#### **4. Assessment**

Based off of the testing results and presenting signs and symptoms, SP was determined to have:

- Saccadic Deficiency (379.57): <1 percentile DEM ratio and 25 percentile DEM errors
- Borderline accommodative infacility (367.51): within 1 standard deviation below the mean of Hennessey, Iosue, and Rouse (1984) normative clinical data.
- Binocular disorder (378.8): esophoria at near, reduced positive fusional vergence at near

- Poor Laterality: 6 year old age equivalence on Piaget R-L test
- Borderline Directionality: 27 percentile on Jordan L-R Reversal test
- Poor Visual Form Constancy: TVPS Visual Form Constancy (2 percentile)
- Poor Visual Sequential Memory: TVPS Sequential Memory (1 percentile)
- Weak Visual Figure Ground: TVPS Visual Figure Ground (23 percentile)
- Poor Visual Closure: TVPS Visual Closure (2 percentile)
- Poor Visual Attention: TOWSRF (2 percentile) and CCTT (CCTT1 – Time: 29 percentile and CCTT1 – Errors: 6-10 percentile)
- Poor visual motor skills: Beery VMI (9 percentile),
- and Poor fine motor coordination: Beery MC (6 percentile)

## 5. Management

SP was educated to continue use of her present spectacle. Although SP demonstrates esophoria at near, a cycloplegic evaluation in an effort to push additional plus was not considered because of SP's adequately compensating negative fusional vergence ranges and her minimal acceptance of additional plus on non-cycloplegic manifest refraction.

A vision therapy program was recommended to improve SP's below age-expected oculomotor, accommodative, visual spatial, visual analysis, and visual motor skills that were contributing to her chief complaint of poor reading performance. The vision therapy program consisted of a 45-minute office session per week combined with a prescribed home therapy program consisting of 20-30 minutes per day. The initial estimated treatment time was approximately 25-30 office visits with re-evaluations

occurring after every 5 sessions. In addition, a recommendation was made to SP's teachers to allow for additional time to complete assignments that had a high reading demand. The purpose of dividing SP's therapy into both home and office-based treatment was to focus on instruction of strategies and processes in the office, and to then have these strategies practiced and reinforced at home.

Although the Dyslexia Determination Test (DDT) determined no dyslexic pattern, it was felt that either a mild form of dyslexia may be present due to the mere 2 out of 10 correct responses on the encoding portion of the DDT and the symptoms that SP's mother indicated. It may also be possible that SP's deficient visual sequential memory, ability to remember characters in the correct order, may also have contributed to her poor performance on the encoding portion. Thus a referral for reading therapy was considered but deferred until the conclusion of a vision therapy program. SP enrolled into vision therapy from January 2008 through May 2008, where she completed 17 office sessions and was dismissed ahead of the anticipated 25-30 office visits.

The initial therapy goals were to improve the accuracy of SP's saccadic eye movements, develop an awareness of gross convergence and accommodation, and to develop her ability to accurately make left and right judgments on objects in space. Her first home and office therapy session included the use of the following techniques: hart chart saccades (oculomotor), Brock String (vergence), Monocular Accommodative Rock with +/-0.50 flipper (accommodation), and Kirschner Arrows (visual spatial). Upon return for her second office visit, SP's mother indicated that the accommodative home therapy activity was difficult due to her frequent loss of place on the Hart Chart as well

as the fatigue and strain she experienced while performing the exercise. SP's mother also reported that the assigned directionality tasks were mastered. SP was then prescribed more developmentally challenging exercises where she was asked to make left and right judgment based on someone else's perspective, such as Floor Map II. By the 3<sup>rd</sup> office visit, SP reported improved kinesthetic awareness of the saccadic and accommodative demands, which we then progressed to more finer saccadic tasks such as the Percon Saccades and Michigan Letter Tracking, higher amounts of accommodative and vergence demands, and by the 5<sup>th</sup> office visit directionality judgments of linguistic symbols with the Flashing bdpq's program on the Computer Aided Vision Therapy (CAVT) Visual Thinking 101.

Based on SP's performance in-office and excellent compliance with home therapy, office and home therapy were prescribed to address the following goals: improve accuracy and fluency of fine saccadic eye movements with Michigan Letter Tracking without the need for underlining and Percon Saccades; increase the amplitude of accommodation with higher magnitudes of minus lenses; improve the facility of accommodation with rocking exercises between higher magnitude minus lenses and plus lenses; and loading directionality tasks with a memory demand on the CAVT Flashing bdpq computer program. By the 7<sup>th</sup> office session, SP's mother reported that SP was voluntarily reading on her own. Based on her performance on home and office therapies oculomotility therapy was discontinued and her accommodative therapies were advanced from monocular to binocular demands. Prior to the 7<sup>th</sup> office visit, minimal vergence therapies had been prescribed beyond Brock string. Therefore, SP's vergence therapy was advanced to smooth fusional convergence and divergence with the vectogram.

Additionally, parquetry blocks technique was prescribed to ensure that her visual discrimination skills were age appropriate in identifying similarities and differences among complex forms. SP then progressed to hidden pictures to train figure ground and sequential beads to address sequential memory. Spatial planning therapy with recreating rosner dot patterns on a geoboard was introduced at the 9<sup>th</sup> office visit to reinforce the left to right and up to down search pattern as well as to work on figure ground.

Following 10 sessions of therapy, SP reported on the CISS a score change to 21 (Figure 3). SP’s mother reported a change in symptom score to 22 (Figure 3); however SP’s mother reported that the frequency of letter reversals had remain unchanged.

CATEGORY	TEST	FINDINGS	
	<b>Rx</b>	OD +1.00 -1.00 x 014 OS +0.50 -1.00 x 178	
<b>Oculomotor</b>	DEM	RS	PR
	Test A (sec)	25	
	Test B (sec)	24	
	Vertical Time (sec)	49	20-25%
	Test C (sec)	60	
	Addition Errors	5	
	Omission Errors	0	
	Transposition Errors	0	
	Substitution Errors	2	
	Horizontal Time (sec)	56.47	25-35%
Ratio	1.15	55-60%	
Total Errors	7	5-10%	
<b>Accomm.</b>	Facility (cpm)	With a ± 2.00 flipper	
	OD	15.0	
	OS	15.0	
	OU	12.0	

<b>CATEGORY</b>	<b>TEST</b>	<b>Raw Score</b>	<b>Percentile</b>
<b>Visual</b>	Piaget R-L Awareness	11 y.o.	
<b>Spatial</b>	Jordan L-R Reversal (Levels I & II)	13	8%
<b>Visual Analysis</b>	TVPS-R: Visual Discrimination	5	1%

Based on SP's performance on her progress evaluation, office and home therapy were prescribed to address the following goals: develop speed and accuracy of visually guided fine-motor movements, improve convergence and divergence fusional ranges, load directionality therapies, and work on visual closure. Although SP's test performance on the DEM, Jordan, and TVPS demonstrated below age expected performance, I felt that it was not an accurate reflection of her capabilities as her performance on her weekly therapy demonstrated good mastery of those skills. At the start of visually guided fine-motor movements, SP found this therapy to be the most challenging and taxing because of her poor ergonomics with pencil grip. By the 12<sup>th</sup> office visit, SP was performing better on narrower mazes and Xs and Os patterns with improved ergonomics. Due to previous work with spatial planning with recreating the Rosner patterns on a geoboard, SP transitioned into the Rosner program easily; however she continued to need reinforcement on ergonomics. As her accuracy of recreating the Rosner patterns improved, the dots were slowly removed in an effort to develop her own internal coordinate system. SP had also been doing well with visual closure tasks such as CAVT visual closure and Photo Mysteries and therapy was progressed to visualization therapies such as Flip Forms. Following 15 sessions of therapy, SP reported on the CISS a score

change from 21 to now 11 (Figure 3). SP’s mother was not present for the progress evaluation visit and so no parent survey was conducted.

<b>CATEGORY</b>	<b>TEST</b>	<b>Raw Score</b>	<b>Percentile</b>
<b>Visual Spatial</b>	Jordan L-R Reversal (Levels I & II)	9	22%
<b>Visual Analysis</b>	TVPS-R		
	Visual Form Constancy	12	63%
	Visual Sequential Memory	12	55%
	Visual Figure Ground	15	92%
	Visual Closure	11	34%
	Spatial Relations (PMA 1)	23	92%
	Test of Silent Word Reading Fluency (TOWSRF)	69	45%
	Children’s Color Trails Test (CCTT)		
	CCTT1 – Time (sec)	45	1%
CCTT2 – Time (sec)	56	42%	
<b>Visual Motor</b>	Wold Sentence Copy (letters/min)	>8 <sup>th</sup> grade	

Figure 3: SP’s Convergence Insufficiency Symptom Survey (CISS) and SP’s mother parent survey throughout therapy

	<b>Baseline</b>	<b>5<sup>th</sup> Office Visit</b>	<b>10<sup>th</sup> Office Visit</b>	<b>15<sup>th</sup> Office Visit</b>
<b>SP CISS</b>	17	35	21	11
<b>SP’s mother parent survey</b>	CISS score: 31, Overall score: 60	CISS score: 19, Overall score: 39	CISS score: 8, Overall score: 22	CISS score: 8, Overall score: 25

SP completed 17 sessions of office-based vision therapy with the remaining sessions dedicated to completing the Rosner program and Ideal forms in an effort to refine SP’s awareness of her internal spatial coordinate system and to ensure that the strategies used to reproduce the complex patterns were consistently implemented. At the 17<sup>th</sup> office visit, the remaining visual motor tests were conducted:

<b>CATEGORY</b>	<b>TEST</b>	<b>Raw Score</b>	<b>Percentile</b>
Visual Motor	Beery Visual Motor Integration (5 <sup>th</sup> edition)	24	68%
	Beery Motor Coordination	23	42%

Due to her persistent issues with letter reversals evident throughout her Jordan L-R Reversal test, especially in Part II, a Dyslexia Determination Test Form B was administered to re-evaluate for the possibility of dyslexia. The results were as follows:

Dyslexia Determination Test, Form B

Results of decoding: 5<sup>th</sup> grade (highest grade level of sight word recognition)

Results of encoding: 20% correct spelling of Flash Known words (normal)

50% correct spelling of Unknown words (above normal)

Based on SP's progress during therapy, SP was graduated from vision therapy. She was assigned maintenance therapy with Michigan tracking (oculomotility), Rosner program (visual motor), Haptic writing (visual motor), Narrow Mazes (visual motor), and BDPQ flashcards (visual spatial-directionality). SP was also educated on the purpose of the therapy was to ensure that she continually reinforced the strategies learned during therapy. SP's mother was educated on considering a reading evaluation if continued letter reversals were observed during reading. Typically I would see patients a month after graduating to re-evaluate their visual abilities within the child's natural demands. However, since it was May and the school year was about to end, I indicated to SP's mother to return in October. This would allow me to observe the changes in a new and more challenging academic setting.

SP returned to clinic on October 2008 for a visual information processing re-evaluation. SP and her mother reported that she was doing well in school with some minor reading issues but not to the severity prior to vision therapy. SP's mother also reported that she had not pursued the recommended reading evaluation. Compliance to the maintenance vision therapy was good with no observed regression of skills. Visual

acuity through her habitual spectacles was 20/20 OD, OS, and OU. Non-cycloplegic refraction revealed OD +0.75 -0.75 x 015 and OS +0.50 -0.50 x 174. The following tests were performed through her current spectacles:

CATEGORY	TEST	FINDINGS	
	<b>Rx</b>	OD +1.00 -1.00 x 014 OS +0.50 -1.00 x 178	
<b>Oculomotor</b>	DEM	RS	PR
	Test A (sec)	23	
	Test B (sec)	22	
	Vertical Time (sec)	45	30-35%
	Test C (sec)	62	
	Addition Errors	5	
	Omission Errors	0	
	Transposition Errors	0	
	Substitution Errors	0	20-25%
	Horizontal Time (sec)	58	
Ratio	1.38	15-20%	
Total Errors	5	10-15%	
CATEGORY	TEST	Raw Score	Percentile
<b>Visual Spatial</b>	Jordan L-R Reversal (Levels I & II)	16	1%
<b>Visual Analysis</b>	Spatial Relations (PMA 2)	14	69%
<b>Visual Motor</b>	Beery Visual Motor Integration (5 <sup>th</sup> edition)	26	82%
	Beery Motor Coordination	22	25%

Based on the slight regression in findings, the options of a short course of additional office vision therapy or close monitoring were discussed. Due to SP's good academic performance and no symptom of letter reversal or difficulty with visual motor tasks, SP's mother elected to closely monitor. Patient was given the parent survey questionnaire as a

way to monitor for signs and symptoms of regression of SP's visual skills and was then followed under annual comprehensive eye examinations by her original referring doctor.

## **6. Discussion**

SP and her mother were delightful to work with as a patient. Because both individuals recognized the importance of the therapy, SP was always highly compliant with her therapy. SP's mother was also a very good historian which was extremely helpful for programming SP's therapy. Her mastery of skills was consistently evident in her office and home therapy exercises; however her re-examination scores did not always reflect that same capability. For example, her oculomotor therapy progressed to finer saccadic exercises that required accurate and efficient saccades. She was capable of completing these tasks easily without making any errors; however she consistently demonstrated higher than age expected errors on the DEM. Although SP never verbally expressed this, perhaps test anxiety caused the measurements to be artificially lower than her ability. Upon review of this record, a programming error that I made was the attention I gave her vergence system. Although this was a minor contributing issue to her chief complaint, I could have sequenced her therapy more efficiently and deliberately.

In summary, I believe that SP's therapy was very successful in addressing the visual issues related to her poor reading performance. The proof of this occurred early in the therapy when SP's mother indicated that she began reading books on her own.