Article: Correlation of Magnocellular Function with Measurements of Reading in Children

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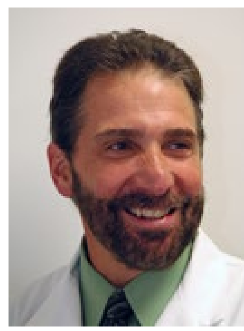
ABSTRACT



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Purpose: Children with reading disability frequently exhibit reduced sensitivity to motion, as assessed by coherent motion thresholds (CMT) and critical flicker frequency (CFF). A retrospective analysis was conducted to evaluate whether there was a correlation between reading fluency as measured by the Test of Silent Word Reading Fluency (TOSWRF), reading rate (as measured with the Visagraph II Eye Movement System), and pseudoword decoding (as measured with the pseudoword decoding subtest of the Wechsler Intelligence Achievement Test, WIAT-II), and these two visual motion sensitivity tests.

Methods: 68 children between the ages of 7-16 years presented to the principal investigator's optometric practice for a vision therapy evaluation between June 1st 2010 and March 31st 2011. As part of the standard protocol for vision therapy evaluations, they were assessed using the CMT, CFF, TOSWRF, WIAT-II (pseudoword decoding subtest), and Visagraph II. The patients were divided into reading ability groups based on the published recommendations from the TOSWRF manual. Individuals at the 25% or below level were labeled as poor fluency, individuals in the 26th to 74th% level were labeled average fluency, and those in the 75% or higher level were labeled as good fluency.

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Keywords: magnocellular function, reading fluency, reading rate

Results: Pearson correlations were computed between the dependent variables revealing several important relationships: Fluency (TOSWRF) correlated significantly with all of the dependent measures selected for study. Of these measures, the WIAT-II subtest score correlated the most strongly at a moderate level (r = +0.569). Reading rate (Visagraph II) was the next strongest correlate of fluency, with changes in rate accounting for 26.5% of the variance in fluency. The variables of CMT and CFF were combined with rate in two follow-up, logistic regressions to determine whether their inclusion added to the classification accuracy of rate. Both variables improved the specificity of rate, which has a high likelihood of false positives. CMT maintained the sensitivity of rate while boosting specificity, whereas CFF caused a decline in the sensitivity of rate while greatly improving specificity. Reading rate with CFF and with CMT both had an overall accurate prediction of fluency of 84%.

Conclusions: Silent word reading fluency correlated with CMT, CFF, reading rate, and WIAT-2. Combining reading rate with a motion sensitivity test (either CMT or CFF) maintained good sensitivity, while greatly improving specificity. Clinicians should consider adding a motion sensitivity test to the Visagraph II reading rate assessment when evaluating school-age children who may be at risk for reading fluency deficits.

INTRODUCTION

When a reading disorder is present, it is the responsibility of an optometrist to have the knowledge and ability to identify if refractive, accommodative, binocular, oculomotor, and/or visual processing/perceptual deficits are contributing factors. Specifically, there are symptoms which may present in either patients with reading disorders, vision deficits, or both. These include frequent loss of place while reading, skipping words, addition and substitution of words ("small word errors"), and a moderately-reduced reading speed.[1] However, clinicians have limited time, and furthermore need to make the most accurate measurements with the highest degree of utility. The purpose of the current study was to examine both the individual and combined abilities of two measures of visual magnocellular (M-cell) functioning to predict problems with fluent reading skills in a clinic sample. The first measure, coherent motion threshold (CMT), has been widely studied in experimental settings,[2–4] while the second measure, critical flicker fusion (CFF), is relatively less utilized. Neither is in wide usage in optometric practice, and the current study sought to assess their usefulness within a selected clinical sample.

CFF refers to the temporal frequency at which an intermittent light stimulus appears not to flicker perceptually. It has been used in numerous clinical and experimental settings for the diagnosis of Alzheimer's disease,[5] hepatic encephalopathy,[6] retinal diseases, post-operative outcome in cataract surgery,[7] and developmental dyslexia.[8] While an early report revealed no relation between CFF and dyslexia,[9] it used CFF as a screener for children deemed likely to develop reading problems later, and not those with an active current diagnosis of dyslexia. More recently, Talcott et al.[8] used CFF in conjunction with CMT in a sample of adults with dyslexia. They found that dyslexics had significantly lower CFF than controls, while exhibiting significantly higher CMT thresholds. Both measures indicated impairment of visual motion sensitivity. When used to predict group membership (dyslexic or control), CFF and CMT combined to correctly classify 77.8% of the patients. These authors did not report how each measure performed on its own, however, and only that they were moderately, negatively correlated, r = -.494, $p < 0.05$. Thus, the individual contributions of these two visual motion sensitivity test measures to reading ability are yet to be determined. Additionally, while Talcott et al.[8] found that non-word decoding, a strong correlate of phonological skill, was correlated with motion sensitivity, they did not quantify reading fluency. Fluency is often the area most impacted by vision-related learning problems.[10]

Recent work has established a link between fluency and measures of M-cell functioning, but the nature of the link remains contested.[11] The M-cell system, or more precisely a deficit in which information from M-cell and parvocellular (P-cell) pathways are integrated, has been widely implicated in vision-related learning problems.[12–17] Both M-cell and P-cell pathways begin with the retinal ganglion cells and terminate in the posterior parietal cortex, a selective spatial attentional area specialized for processing the location of objects in space.[18] The M-cell pathway is dominant in the dorsal visual stream, and thus the term dorsal pathway is often used to describe more accurately functional cortical systems that are dominated by M-cell operation.

For example, Wright, Conlon, and Dyck performed a study in which they divided children with dyslexia into two groups based on the presence or absence of an M-cell deficit.[19] They employed a random-dot kinematogram (RDK) to determine the sensitivity to CMT, which has been shown to correlate with levels of activity in visual area MT in functional neuroimaging studies.[20,21] They found no differences in reading measures between the reading-impaired children with abnormal RDK thresholds compared to those with normal ones. While these authors did document the presence of M-cell-linked psychophysical tasks, and the presence of visual attentional deficits in persons with reading disability, they concluded that these two variables were not linked.

While the above study questioned the link between M-cell deficits and the delayed visual search found in those with reading disability, several more recent studies have provided new evidence for a critical role of the M-cell system in reading disorders. For instance, Solan et al[22] found that the CMT threshold was significantly different between good and poor middle-school students, and furthermore Solan et al[16] found that the CMT threshold correlated significantly with comprehension level and attention, as measured on the Cognitive Assessment System. Numerous other studies have also found that dyslexic readers have a higher CMT threshold than normal controls.[15,23,24]

Despite these recent findings, the evidence remains equivocal regarding the linkage between M-cell dysfunction and reading disability. The goal of the present retrospective analysis was to determine if children with visually-based reading disabilities demonstrate a correlation between reading fluency and reduced visual motion sensitivity. Such a hypothesis is supported by recent research by Kevan & Pammer,[14] who found that pre-reading measures of dorsal stream functioning, as assessed by frequency doubling sensitivity, could predict early literacy skills, more so than age, IQ, and kindergarten letter knowledge.

In the current study, we sought to determine the individual and combined value of CMT and CFF for the clinical assessment of children with reading impairment. In addition to measuring phonological decoding, as did Talcott et al.,[17] we also objectively quantified reading rate using the Visagraph eye movement recording system.[25]

METHODS

Patients

68 children between the ages of 7-16 years who presented to the principal investigator's optometric practice for a vision therapy evaluation between June 1st 2010 and March 31st 2011 were assessed with a battery of temporal visual processing tests, as well as a comprehensive vision examination including refractive, binocular, and ocular health status. Patients were selected if the primary reason for the visit was to determine whether their reading difficulty had any visual basis. Primary complaints included inefficient reading with frequent loss of place, skipping of words or letters, reduced reading speed and/or comprehension, and letter/word reversals. Headaches, diplopia, and eye fatigue were additional symptoms that many individuals also experienced.

Exclusion criteria were as follows. Strabismic and/or amblyopic patients were not included, as well as those with nystagmus. In addition, individuals with developmental delays, hearing loss or auditory processing delays, autism spectrum disorder, seizure disorder, or other ocular, systemic, or neurological diseases were excluded.

Reading Fluency

The Test of Silent Word Reading Fluency (TOSWRF) was administered to determine the reading fluency and reading rate of all patients.[26] They were asked to recognize, both accurately and efficiently, as many printed words within the allotted three minute time period. The words were presented in rows without spaces, and they were ordered by reading difficulty (e.g., dimhowfigblue). The instruction was to draw a line between the boundaries of as many of the words as possible (i.e., dim/how/fig/blue). 63 of the children assessed completed this test.

Patients were then divided into reading ability groups based on the published recommendations from the TOSWRF manual.[26] Individuals who scored 25% or below were labeled as poor fluency readers, those between 26% and 74% were labeled as average fluency readers, and all scores 75% and above were denoted as good fluency readers.[26]

Visual Flicker and Motion Detection

Patients were assessed with CFF and CMT as part of the standard clinical vision therapy evaluation. Both tests were conducted to determine the threshold level of flicker and motion sensitivity detection, respectively, in children experiencing reading problems.

For the coherent motion threshold (CMT) test,[27] patients were seated directly in front of a computer screen with two rectangular stimuli presented under low photopic room illumination conditions (approximately 20 lux) with binocular viewing. The screen dimensions were 41 degrees horizontally and 31 degrees vertically. A fixation target consisting of a thin-lined plus sign (+) subtending 1.5 degrees horizontally and vertically was positioned in the center of the screen. Two rectangular stimulus panels were imaged and positioned on either side subtending 12 degrees horizontally and 24 degrees vertically. The centers of the panels were 17 degrees apart, and 9 degrees from the fixation target. The screen was positioned along the patient's midline. Their habitual refractive correction was worn. One rectangle contained white dots that appeared to move randomly (i.e., non-coherently). The other rectangle contained moving dots that included a specific percentage having coherent lateral movement. There were 300 dots per panel. The patient was instructed to identify the rectangle having horizontal motion (i.e., left or right) by selecting the designated key on the left or right side of the keyboard. The coherent motion threshold percentage was determined by the minimum number of dots that appeared to move laterally divided the total number of moving dots.[27] A 2-alternative, forced-choice paradigm was used, incorporating a double-interleaved staircase method, with the threshold being the geometric mean of the last 8 of 10 reversals. The threshold was assessed twice, and averaged across the 2 trials in each patient. The CMT represented the minimum percentage of coherently-moving dots present to be able to just detect reliably the horizontally-moving direction of the dots. Lower percent scores indicated better motion sensitivity threshold, that is, easier recognition of the motion. Higher scores indicated reduced motion sensitivity, which is suggestive of an M-cell deficit.[15] 64 of the children assessed completed this test.

The critical flicker frequency (CFF) test was also administered to all patients in low photopic illumination conditions (approx. 20 lux).[28] The CFF threshold was assessed binocularly with the habitual near refractive correction in place. The test light consisted of 4 contiguous white light-emitting diodes (LEDs), which were mounted within a handheld rectangular enclosure, 40 cm away along the patient's midline. It provided diffuse illumination via a circular translucent plexiglass cover. The size of the test field was 3.5 degrees with a luminance of 100cd/m^2. The flicker rate was controlled by a calibrated dial, which allowed the experimenter to gradually increase or decrease the flicker frequency over a range of 30 to 60 hertz (Hz). Patients were instructed to fixate the center of the test field, while the flicker rate was either increased ("stops flickering") or decreased ("starts to flicker") at a rate of approximately 1 Hz per second. Three ascending and 3 descending measurements were taken alternately. A single mean CFF threshold was obtained by averaging the 6 measurements. See Chang et al for details.[28] 58 of the children assessed completed this test.

Reading Rate

The Visagraph II Eye Movement Recording System was administered to all patients for the determination of reading rate objectively. This system is designed to measure horizontal, binocular eye movements using the infrared limbal reflection technique. The key parameters included fixations/100 words, regressions/100 words, span of recognition, duration of fixation, reading rate, and grade level efficiency.[25] Once these parameters were assessed, they were automatically computer-analyzed and graphically displayed for comparison to the established grade-level norms.[29]

Each patient was instructed to read two or more paragraphs, with each followed by ten yes/no comprehension questions to answer. The initial paragraph selected was one grade level below the child's current school grade level. The same level was then repeated with a different paragraph taking the initial learning process into consideration. The last paragraph selected was five grades below the level used for the second paragraph, or the lowest grade level available. Seventy percent comprehension was required; if the patient scored below 70%, then an additional paragraph was tested. For a more detailed description of this protocol, see Tannen and Ciuffreda.[25] 58 of the children assessed completed this test.

Table 1: Calculated mean and standard deviations for each independent measurement.
CFF = Critical Flicker Fusion Threshold
CMT=Coherent Motion Test Threshold
V2Fix=Visagraph Fixations/100 Words
V2Rate=Visagraph Average Reading Rate (Words/Minute)
V2Regr = Visagraph Regressions/100 Words
WIAT2PER=Wechsler Individual Achievement Test II Reading Score
TOSWRFPER=Test of Silent Word Reading Fluency Percentile Score
Note: Not all of the 68 children performed reliably in each test.

Measure Type	Measure	Mean	SD	n
Motion sensitivity	CFF	42.92	3.53	58
	CMT	0.11	0.10	64
Oculomotor	V2Fix	217.74	102.29	58
	V2Rate	125.59	74.41	58
	V2Regr	54.81	41.11	58
Reading	WIAT2PER	0.58	0.26	65
	TOSWRFPER	0.46	0.28	63

Phonological Decoding

Decoding ability was evaluated using the Wechsler Individual Achievement Test II (WIAT II) Decoding Subtest.[30] It requires patients to verbally decode nonsense words such as mib, fum, dreep, and ruckid. Proper phonetic pronunciation was indicated on the instructor's score sheet, and it was counted as being correct only if read properly by the patient. The raw score was converted into a percentile based on an age equivalent performance per the company's manual. The higher the percentage, the better the decoding ability. 65 of the children assessed completed this test.

Results

To determine the relationship between the primary reading (fluency and decoding skills), oculomotor (reading rate, regressions, fixations), and motion sensitivity variables (CMT, CFF), preliminary analyses were conducted. Means and standard deviations were calculated for each dependent measure for all patients. These data are presented in Table 1. Based on the two

Table 2: Pearson correlations between the dependent variables.

	TOSWRF	WIAT	CMT	CFF	Vfixation	Vregression	Vrate
TOSWRF	1	.569	.374	.348	-.490	-.482	.515
WIAT	.569	1	-.106	.342	-.463	-.396	.535
CMT	.374	.106	1	.249	.210	.247	.233
CFF	.348	.342	.249	1	-.340	-.370	.327
Vfixation	-.490	-.463	.210	-.340	1	.939	-.803
Vregression	-.482	-.396	.217	-.370	.939	1	-.710
Vrate	.515	.535	-.233	.327	-.803	-.710	1

Table 3: Overall sensitivity and specificity of each test measure.

Logistic Regression Analyses: Individual

Measure	Group	Poor Fluency	Good Fluency	% Correct
Rate	Poor Fluency	11	1	91.7
	Good Fluency	5	9	64.3
			Overall %	**76.9**

Measure	Group	Poor Fluency	Good Fluency	% Correct
CFF	Poor Fluency	12	4	75.0
	Good Fluency	4	10	71.4
			Overall %	**73.3**

Measure	Group	Poor Fluency	Good Fluency	% Correct
WIAT	Poor Fluency	13	5	72.2
	Good Fluency	4	11	73.3
			Overall %	**72.7**

Measure	Group	Poor Fluency	Good Fluency	% Correct
CMT	Poor Fluency	10	7	58.8
	Good Fluency	4	11	73.3
			Overall %	**65.6**

educational measures reported as percentile scores, our sample represented readers who were, on average, performing slightly higher than the median (58th%) on the WIAT-II, with a standard deviation of a full quartile above and below the mean. Therefore, despite the fact that these patients were referred for a vision therapy evaluation with the chief complaint of reading problems, a wide range of reading abilities was present in the sample. The fluency scores (TOSWRF) for these readers were, on average, 14% lower than the WIAT-II scores.

Pearson correlations were computed between the dependent variables yielding the values in Table 2. Several important relationships were found: fluency (TOSWRF) correlated significantly with all dependent measures selected for this study. Of these measures, the WIAT-II score correlated most strongly, at a moderate level ($r = 0.569$), accounting for 32.5% of the variance. This provides validity for TOSWRF fluency being linked to the skills tested by the WIAT-II test. Reading rate was the next strongest correlate with fluency, with changes in rate accounting for 26.5% of the variance. The motion sensitivity tests as a group correlated least with fluency, as compared with the reading and oculomotor tests, with CMT and CFF accounting for only 13.9% and 12.1% of the variance in fluency, respectively.

While both reading measures ($r = 0.569$), and all three Visagraph measures, correlated significantly among themselves (see Table 2), the CMT and CFF did not. Since these two motion sensitivity measures were not correlated, they were analyzed individually. The Visagraph measures as represented by reading rate correlated most highly with fluency.

Patients were divided into reading ability groups based on the published recommendations from the TOSWRF manual.[27] Individuals at the 25% or below level were labeled as poor fluency, individuals in the 26 to 74% were labeled average fluency, and those at 75% or higher were labeled as having good fluency. To determine the ability of the dependent measures to classify the patients into clinically-relevant categories, a logistic regression was performed using the data from the poor and

Table 4: Overall sensitivity and specificity when reading rate is combined with CMT and CFF.

Logistic Regression Analyses: Combined

Measure	Group	Poor Fluency	Good Fluency	% Correct
Rate & CMT	Poor Fluency	10	1	90.9
	Good Fluency	3	11	78.6
			Overall %	**84.0**

Measure	Group	Poor Fluency	Good Fluency	% Correct
Rate & CFF	Poor Fluency	9	2	81.8
	Good Fluency	2	12	85.27
			Overall %	**84.0**

good fluency patients only, with the fluency score as the dependent measure, and the variables of CFF, CMT, rate, and WIAT-II score as covariates. The covariates were entered into a hierarchical, stepwise regression yielding a one-step solution. CFF was found to account for most of the variance in fluency, and on its own accounted for a significantly better than chance level of classification accuracy (Wald's Chi Squared = 4.935, $p = 0.026$, Beta = 3.071). The classifications for each test are listed in Table 3. The far right column represents sensitivity of the measure, with the specificity below, and at the bottom right corner of each table, the overall classification accuracy of the patients. In this analysis, being a poor fluency reader would be the clinical condition of interest, and thus the sensitivity parameter indicates the ability of a given covariate to classify a patient as having poor fluency. From these analyses, reading rate had the best sensitivity, followed by CFF, WIAT-II, and CMT. Of note is the finding that reading rate alone classified approximately 92% of the poor fluency readers accurately, according to the TOSWRF criterion.

Next, the variables of CMT and CFF were combined with reading rate in two follow-up logistic regressions to determine whether the inclusion of motion sensitivity information added to the classification accuracy of rate. These results are presented in Table 4. While both variables improved specificity of reading rate, which has a high likelihood of false positives, CMT maintained the sensitivity while boosting specificity, while CFF caused a decline in sensitivity while greatly improving specificity. Thus, the two measures contributed individually to the classification process.

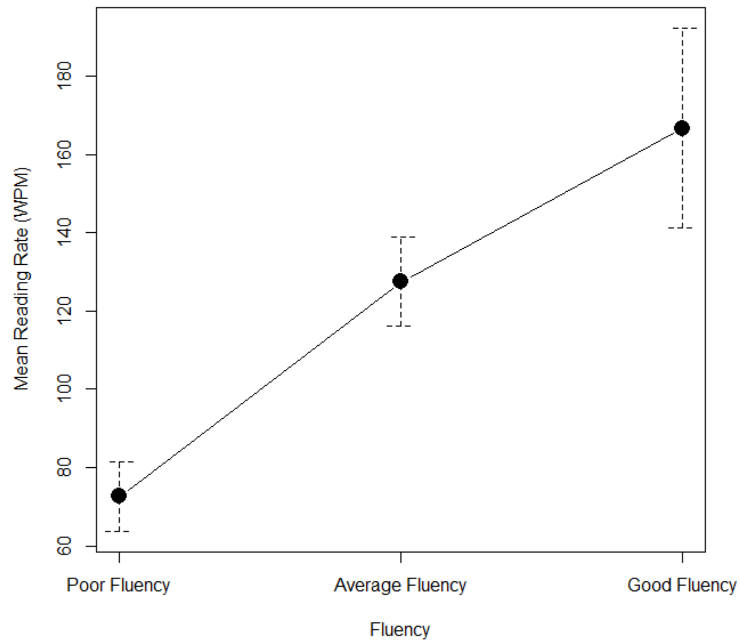

Figure 1: The Effect of Fluency Group on Reading Rate. Reading Rate was measured by the Visagraph in Words per Minute. Plotted is the mean +/- 1SEM.

To determine whether the measured characteristics of the patients differed as a function of their fluency group, several ANOVA's were conducted on the dependent measures of rate, CMT, CFF, and WIAT-II scores. The mean values of these dependent measures as a function of their fluency group are presented in Figures 1 – 4. Results of these ANOVA's are presented in Table 5. CFF was the only parameter that failed to distinguish poor from average fluency readers, but it did distinguish average from good readers. Thus, CFF may therefore have utility in selecting individuals with high levels of fluency from those with average fluency.*

**Separate statistical analysis of the WIAT-II pseudoword decoding and the WIAT-II pseudoword decoding compared to the TOSWRF was deemed non-essential to the analyses here. However it is available upon request to the corresponding author.*

Table 5: ANOVA Summaries

ANOVA			Contrasts (pvalue)		
Measure	F	P	Poor VAverage	Average VGood	Poor VGood
Rate	6.138	0.004	*0.022	0.078	*0.001
CMT	4.191	0.02	*0.016	0.559	*0.011
CFF	3.825	0.028	0.362	*0.038	*0.009
WIAT	4.798	0.012	0.053	0.119	*0.003

*Statistically Significant, p < .05

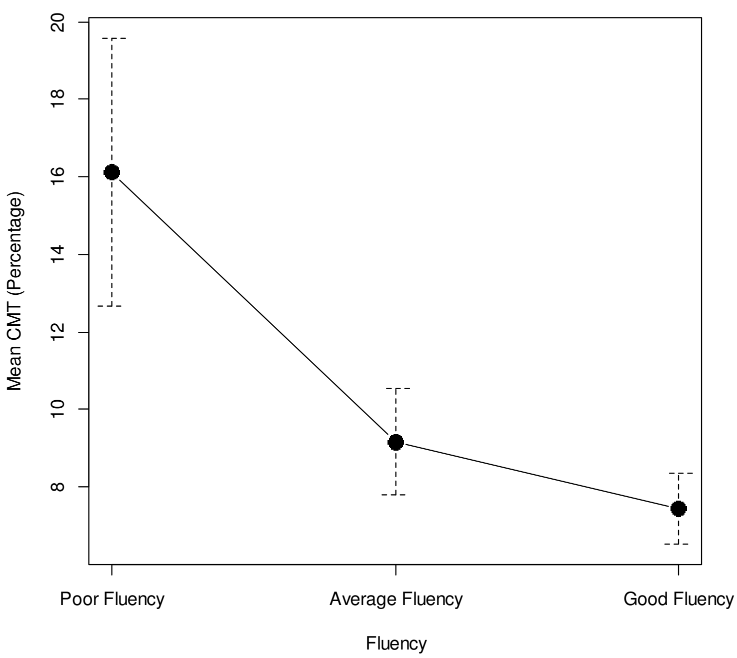

Figure 2: The Effect of Fluency Group on Coherent Motion Threshold (CMT). CMT was measured by the Random Dot Kinematogram task, described in the methods section. Plotted is the mean +/- 1SEM.

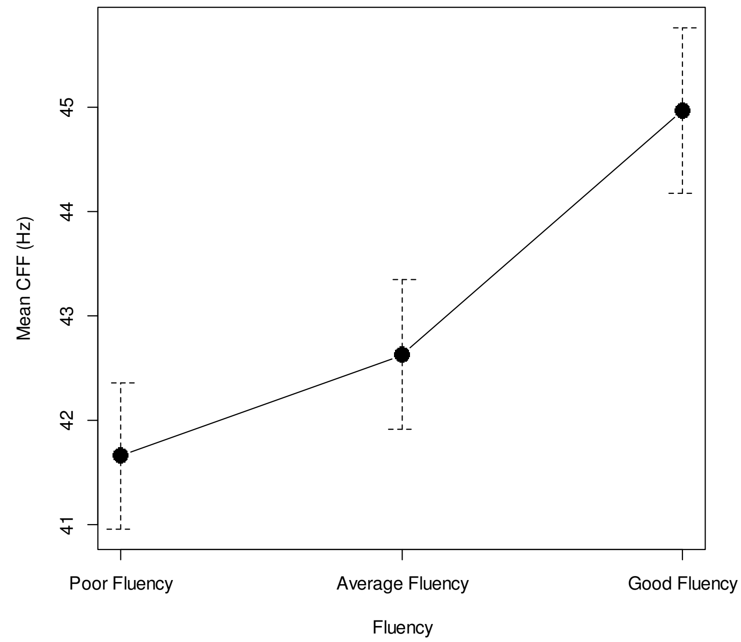

Figure 3: The Effect of Fluency Group on Critical Flicker Fusion Threshold (CFF). CFF was defined as the number of flickers per second at the point at which subjects perceived a single stimulus, as opposed to a flickering stimulus. Plotted is the mean +/- 1SEM.

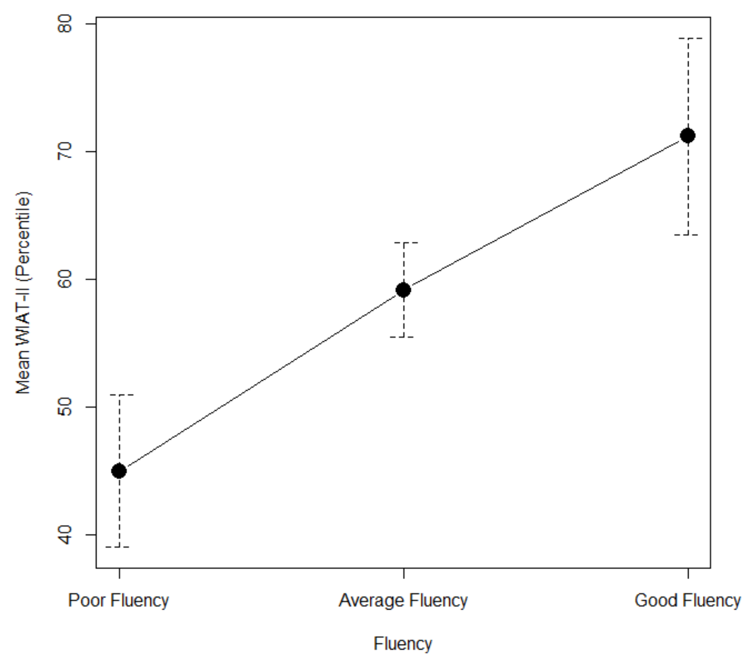

Figure 4: The Effect of Fluency Group on WIAT: II reading test percentile score. Plotted is the mean percentile score +/- 1SEM.

DISCUSSION

There were several important findings in the present study. Reading fluency, as assessed with the TOSWRF, correlated significantly with all of the dependent measures selected for the present study including: CMT, CFF, reading rate, and the WIAT-II. The highest correlation existed between the TOSWRF and WIAT-II, with this likely association determined by the interplay between fluency and decoding. The next strongest correlation existed between the TOSWRF and reading rate on the Visagraph, which is consistent with the above. Additionally, reading rate demonstrated the best sensitivity when comparing poor fluency readers and good fluency readers. When reading rate was combined with a motion sensitivity test, however, such as the CMT and/or CFF, sensitivity was maintained while specificity greatly improved, hence creating an overall balance.

It could be argued that the Visagraph could be used as the primary measure of reading fluency. Quaid and Simpson found that reading speed as measured by the Visagraph III to be significantly correlated with refractive error and vergence facility in a sample of 50 students with an Independent Education Plan and 50 control students.[34] We chose the TOSWRF, as it more widely recognized for reading screening and has a positive correlation with more extensive tests of silent word reading fluency.[22]

M-cell deficits, as assessed by CMT and CFF, provide useful information regarding reading fluency in children. Thus, optometrists should consider adding motion sensitivity tests, along with Visagraph II reading rates, when evaluating children with suspected reading fluency deficits. Previous research by Solan et al. showed that the M-cell channels are malleable, thus allowing for improvement in neuronal integration.[27] In this regard, Shelley-Tremblay, Syklawer, and Ramkissoon[31] used a training program that directly targeted magno-parvocellular integration. They demonstrated objectively both significant increases in reading rate, and most critically, significant increases in amplitude of the visual-evoked potential, in reading disabled elementary students following their training program.

M-cell deficits should be analyzed in the overall context of the patient and their clinical history. For example, Poltavski and Biberdorf found that CMT was greater in concussed players. However, fixation disparity at near was one of the strongest predictors of concussion in a group of hockey players.[35] This points out the importance of combining oculomotor and motion sensitivity tests in selected, special patient populations.

Additionally, other tests of visual processing, auditory-visual integration, and visual-motor integration should be performed as deemed necessary. For example, Solan[36] found that in a group of students completing first grade, 51% of the variance of the vocabulary subtest for the Gates-McGinitie reading test could be explained by variations in the Auditory Visual Integration Test, the Divided Form Board Test, and the Tachistoscopic Exposure Test.[35] The purpose of this present paper was to highlight the value of adding motion sensitivity tests (CFF and CMT), which are not ordinarily performed in the optometric evaluation, in this clinic population.

The following is a proposed, simplified clinical protocol which we recommend based on our analysis of the findings in the present study:

- Assessment of refractive, binocular, and ocular health status
- Visagraph Reading Eye Movement Recordings
- Critical Flicker Frequency*
- Coherent Motion Threshold**
- Wechsler Individual Achievement Test (pseudoword decoding subtest)
- Test of Silent Word Reading Fluency

Other Potential Tests[37] include:

- Test of Visual Perceptual Skills
- Gardner Reversal Frequency Test
- Auditory-Visual Integration Test

** Available soon through Bernell Corporation*
*** Available from the first author*

Vision therapy is designed to improve fixation and saccadic versional eye movements, as well as promote coordination between vergence and accommodation. Coordination of the three oculomotor systems (version, vergence, and accommodation) is important for efficient reading.[32,33] What remains to be investigated in more detail is determination of which therapeutic regimen is most efficacious, and in turn most cost effective. Studies need to compare treatment options systematically to determine whether certain techniques have an additive effect on M-cell functioning, with resultant improvement in reading fluency. This last piece of information will provide clinical vision researchers with the greatest challenge for the future: establishing a causal connection between improved M-cell functioning and enhanced reading ability.

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BETA SIGMA KAPPA – COVD RESEARCH GRANT

Background

The Beta Sigma Kappa (BSK) – COVD Research Grant program administered by the College of Optometrists in Vision Development (COVD) supports optometric and vision science faculty research and optometric resident research. The fund will provide support for optometric faculty research and/or optometric resident research in binocular vision and/or visual performance issues. Annual grant will consist up to $2,000.

Award and Eligibility

All optometric related faculty and optometry residents at an accredited school or college of optometry, irrespective of membership in BSK or COVD, are eligible to apply for a BSK-COVD Research Grant.

One grant will be awarded up to $2,000 annually. Funds support research conducted for a period up to one year.

Both BSK and COVD are 501(c) (3) non-profit organizations; our policy is not to cover any indirect costs associated with research grants for any other of our programs. This policy applies uniformly to all award recipients.

Recipients must submit a final report of their research findings no later than one year post award or the applicant and/or institution become ineligible for funding the subsequent year. The preferred submission is an article in a form suitable for publication.

Recipients are encouraged to present at the annual meeting of COVD and to submit a manuscript to an optometric journal for publication. Any manuscript or publication material produced must acknowledge Beta Sigma Kappa International Optometric Honor Society and the College of Optometrists in Vision Development.

DEADLINE for applications is AUGUST 15. For detailed submission requirements, click here or email info@covd.org.