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Intermittent central suppression and reading efficiency: A correlation study

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Intermittent central suppression and reading efficiency: A correlation study

Abstract
Purpose: It has been suggested that non-strabismic intermittent central suppression (ICS) may interfere with reading efficiency (RE). If during brief moments of suppression vergence posture changes, during the transition from suppression to non-suppression there may be a brief moment of diplopia and/or confusion until the eyes realign with the reading material. If this were true, it is likely that ICS would have a deleterious effect on oculomotor performance during reading. The purpose of the current study was to explore a possible correlation between ICS and eye movements during reading.

Method: 70 professional students ranging in age from 21 to 37 were tested for suppression tendencies with a modified diamond target on the Borish Vectographic Nearpoint Card 11. The number of intermittent suppression episodes as well as the total time of suppression was measured. The subjects' eye movements were then measured using the Taylor Visagraph 11, a system that quantifies a number of specific eye movement characteristics during a reading task. Subjects who exhibited no suppression were assigned to the control group and those who exhibited any suppression were assigned to the experimental group.

Results: No statistically significant (PC. 05) difference was found between the experimental group (N) and the control group (NB) on any of the eye movement characteristics. Additionally, no statistically significant correlation was found between time of suppression or number of suppression episodes, and any individual eye movement characteristics.

Conclusions: The current study found no correlation between ICS and RE. It should be noted that the sample size was small and the subjects were normal, high achieving adults. Also, many of the subjects in the experimental group exhibited minimal suppression tendencies. Future studies should attempt to include more subjects with greater suppression tendencies.

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Darin L. Paulson

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intermittent central suppression, reading efficiency, taylor visagraph ii, eye movements

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INTERMITTENT CENTRAL SUPPRESSION
AND READING EFFICIENCY:
A CORRELATION STUDY

By

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JEFFREY S. PELSON

A thesis submitted to the faculty of the
College of Optometry
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for the degree of
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Advisor:

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Biography

Vicki S. Borowicz (Luehmann) grew up in Canton, Minnesota where she attended Mabel-Canton High School class of 1993. Following high school, she attended Moorhead State University in Moorhead Minnesota. Vicki earned her Bachelor of Arts in Biology with a minor in chemistry and graduated in 1998. She entered optometry school at Pacific University College of Optometry in 1998 and will graduate with a Doctor of Optometry Degree in May 2002. Following graduation she plans to work in a group practice somewhere in Minnesota.

Jeffrey S. Pelson grew up in Tigard, Oregon where he attended Tigard High school, class of 1991. Following high school, he enlisted in the US Navy and served four years in both Florida and Idaho in the nuclear field. After receiving an honorable discharge in 1995, he began his college education at Portland Community College in Tigard. Studies included basic arts and sciences and after two years at PCC he earned an Associate Degree and transferred to Pacific University. Jeff entered optometry school in 1998 at Pacific University and earned a Bachelor of Science in Vision Science in 1999 from Pacific's college of optometry. Jeff will graduate with a Doctor of Optometry Degree in May 2002 from Pacific University College of Optometry. Following graduation he plans to work in private practice and one day hopes to own a practice of his own.
Abstract

**Purpose:** It has been suggested that non-strabismic intermittent central suppression (ICS) may interfere with reading efficiency (RE). If during brief moments of suppression vergence posture changes, during the transition from suppression to non-suppression there may be a brief moment of diplopia and/or confusion until the eyes realign with the reading material. If this were true, it is likely that ICS would have a deleterious effect on oculomotor performance during reading. The purpose of the current study was to explore a possible correlation between ICS and eye movements during reading.

**Method:** 70 professional students ranging in age from 21 to 37 were tested for suppression tendencies with a modified diamond target on the Borish Vectographic Nearpoint Card II. The number of intermittent suppression episodes as well as the total time of suppression was measured. The subjects' eye movements were then measured using the Taylor Visagraph II, a system that quantifies a number of specific eye movement characteristics during a reading task. Subjects who exhibited no suppression were assigned to the control group and those who exhibited any suppression were assigned to the experimental group.

**Results:** No statistically significant ($p<.05$) difference was found between the experimental group (N) and the control group (NB) on any of the eye movement characteristics. Additionally, no statistically significant correlation was found between time of suppression or number of suppression episodes, and any individual eye movement characteristics.

**Conclusions:** The current study found no correlation between ICS and RE. It should be noted that the sample size was small and the subjects were normal, high achieving adults. Also, many of the subjects in the experimental group exhibited minimal suppression tendencies. Future studies should attempt to include more subjects with greater suppression tendencies.

**Key Words:** Intermittent central suppression, reading efficiency, Taylor Visagraph II, eye movements
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Introduction

Based on the growing reading demands of today's society, both in the work place and in education, being able to effectively and efficiently read is crucial. More than ever before, individuals are spending more time reading, both in books and on the computer, to further the education and better their lives. Reading ability differs from reading efficiency in several key ways. Ability has both functional and cognitive attributes. Cognitively it involves having the knowledge and understanding to retrieve and process written information, while functionally the control of the extra ocular muscles to read. Efficiency expands beyond just having the ability to include areas such as: ability free of asthenopic complaints, speed, comprehension and the like. Reading inefficiency can be detrimental to the success of the individual. There are many conditions which have been reported to be associated with decreased reading efficiency, from poor or inaccurate oculomotor control\(^1\) to the presence of developmental dyslexia\(^2\). It is essential that we identify the cause of the reading inefficiency and eliminate it for the individual.

One visual system attribute that could potentially lead to reading inefficiency is suppression. Optometrists have defined suppression as the fighting of neural impulses between the dominant and non-dominant eye. This fight typically ends with the dominant eyes impulses reaching higher cortical neurons while inhibiting impulses from the other eye.\(^3\) Furthermore, intermittent central suppression (ICS) is the random interruption of the central one to three degrees of the visual angle.\(^4\) Hussey has been studying ICS and reading efficiency and has reported that ICS patients tend to show a greater prevalence of eye movement and accommodative problems which may effect reading efficiency.\(^5,6,7\) Likewise, poor readers tend to show many, if not all, these same
characteristics. Simply finding the correct refraction for an individual may not provide all the essential information to identify and correct a reading efficiency problem.

Finding and treating Intermittent Central Suppression (ICS) may be a key to improving reading efficiency, thereby improving the quality of life for many individuals. Reports have been published regarding presence of ICS and decreased reading efficiency. Following ICS treatment the reading efficiency is reported to have increased. However, no one has conducted a masked correlation study between ICS and reading efficiency.

**Materials & Methods**

The current study was designed to compare the presence of ICS and reading efficiency. All subjects were ages 18-35, had 20/20 best corrected monocular visual acuity as measured with a distance and near Snellen chart. Subjects were excluded if they exhibited strabismus on a unilateral cover test at near or far, if they had history of ocular trauma or surgery, or if they had been previously diagnosed with dyslexia. The study was double masked with two phases. The first phase consisted of one researcher conducting the intermittent central suppression testing (Figure 1). In the second phase a different researcher, who did not know the results of the suppression testing, performed reading efficiency measurements using the Taylor Visagraph 11.

*Figure 1. ICS Testing in progress,*
Prior to any measurements in phase one, each subject was required to spend ten minutes reading Chapter 16 Adler’s Physiology of the Eye. Following the reading, subjects were instructed to view The Modified Borish Near Point Card II mounted at 40 cm while wearing polarized filters. The card was modified with polarized filters overlaying the diamond target such that the right eye saw only the right side of the diamond and the left eye saw only the left side of the diamond (Figure 2). They were asked to raise their right hand if the right side of the card ever disappeared and to raise their left hand if the left side of the card ever disappeared (Figure 3). They were asked to lower their hand if the missing section of the card reappeared. Each subject was timed and video taped for one-minute and the frequency and duration of any suppression was recorded by the researcher. Subjects showing any ICS were assigned to the experimental group and subjects not showing ICS were assigned to the control group.
Following the suppression testing, a second researcher measured the reading efficiency using the Taylor Visagraph II (Figure 4). The Visagraph is a device which uses goggles with infrared optics and a computer to measure eye movements made during reading. Software in the computer determines various characteristics of eye movements. It measures several specific areas including: regressions per 100 words read, fixations per 100 words read, average span of recognition (words), average duration of fixation (seconds), directional attack percentage, grade level equivalent and comprehension question percentage correct.

All data is assessed as a way to measure reading efficiency. Subjects were again comfortably seated in a chair, wearing their habitual refractive compensation, while the researcher placed and adjusted the infrared goggles. The subjects were then given the proper instruction set per the Taylor Visagraph II and each subject was given the same two sample paragraphs to read. The subjects were each tested twice to control for a learning effect. Following the reading, comprehension was assessed with ten yes or no questions. Using the Visagraph parameters of age and level of education the subjects were scored in the following areas: fixations per 100 words read, regressions per 100 words read, directional attack percentage, average span of recognition, average duration of fixation, and grade level equivalent. A correlational analysis was conducted using the results of each phase. Every attempt was made to conduct the two phases on the same day.
Results

No statistically significant (p<.05) difference was found between the experimental group (n = 25) and the control group (n=43) on any of the eye movement characteristics. Additionally, no statistically significant correlation was found between time of suppression or number of suppression episodes, and any individual eye movement characteristics. The total number of subjects tested was seventy-two, however, only sixty-eight were used in the statistical analysis. Four subjects were discarded due to failing inclusion criteria, specifically, being strabismic on cover testing.

Figure 5 shows the average duration of suppression for 68 subjects ranging from zero to greater than 11 seconds of central suppression. The greatest duration of suppression was 38 seconds in a sixty second period and a mean of 6.6 seconds. Figure 6 shows the average frequency of suppression in cycles per minute, with the greatest frequency of central suppression being 6 cycles/minute. One cycle consisted of the subject raising their hand every time central suppression was noted and lowering their hand when the suppression
cycle ended. Figure 7 shows the percentage of correct answers from the Visagraph II comprehension quiz. The non-suppressing subjects \((n = 43)\) scored an average of 81.6 percent correct and the suppressing subjects \((n = 25)\) scored an average of 78.8 percent correct \((p=.2306)\).

Figure 8 shows the regressions per 100 words read during the Visagraph II testing. Non-suppressing subjects showed an average of 18.36 regressions per 100 words read while the suppressing subjects averaged 15.32 regressions under the same conditions \((p=.5923)\).

Figure 9 shows the non-suppressing subjects average 117.08 fixations per 100 words read whereas the suppressing subjects averaged 111.24 fixations under the same conditions \((p=.8013)\).
T-tests were also run on span of recognition \((p=.9536)\), directional attack \((p=.5741)\), grade level equivalent \((p=.7303)\), and duration of fixations \((p=.8623)\). Correlational analyses were also run between the control group and experimental group for all eye movement characteristics with no statistically significant correlations found, see table 1.

### Table 1. Correlational Coefficients and P-values Between Suppressors and Non Suppressors

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regressions/100 words</td>
<td>-0.168</td>
<td>0.5923</td>
</tr>
<tr>
<td>Fixations/100 words</td>
<td>-0.278</td>
<td>0.8013</td>
</tr>
<tr>
<td>Average Span of Recognition (words)</td>
<td>-0.227</td>
<td>0.9536</td>
</tr>
<tr>
<td>Average Durations of Fixations (sec)</td>
<td>0.292</td>
<td>0.8623</td>
</tr>
<tr>
<td>Directional Attack %</td>
<td>-0.186</td>
<td>0.5741</td>
</tr>
<tr>
<td>Grade Level Equivalent</td>
<td>-0.238</td>
<td>0.7303</td>
</tr>
<tr>
<td>Comprehension Question Correct %</td>
<td>0.279</td>
<td>0.2306</td>
</tr>
</tbody>
</table>

### Discussion/Conclusions

The current study found no correlation between intermittent central suppression and reading efficiency. It should be noted that this sample size was small and the subjects were normal, high achieving graduate students. The likelihood of finding reading efficiency problems in adults who have attained such a high level of education is probably reduced. The subjects who showed suppression tendencies have in some way adapted to their suppression tendencies in order to progress to the graduate level of education.

Many of the subjects in the experimental group exhibited minimal suppression tendencies. The greatest number of suppression cycles found under these conditions was 6 cycles in one minute. The relatively low number of suppression cycles combined with a small sample size, may have reduced the likelihood of finding a significant correlation.
Future studies should attempt to include young readers who have been identified as poor achievers in reading, individuals with known eye movement problems or individuals with greater than 6 cycles per minute of central suppression. These people would likely struggle with the information they are trying to process in addition to the conflicting information received from the suppressed eye as it turns back on. This would cause the patient to make a refixation movement, which essentially loads the cognitive system, causing reduced reading comprehension/reading efficiency. Additionally, a larger sample size would allow for more accurate statistical analysis to be run.

Despite the indications from this study, we hold out hope that finding and treating Intermittent Central Suppression (ICS) in some populations, might be one of the keys to improving reading efficiency, thereby improving the quality of life. We hope that future studies find that key, and to unlock the door to opportunity.
References


