INTERMITTENT CENTRAL SUPPRESSION

AN EVALUATION OF ITS PRESENCE USING THREE INSTRUMENTS

- **Zeri F, Optom It**[a]
- **De Luca M, Ph.D.**[a]
- **Spinelli D, Dr.**[a,b]
- **Zoccolotti P, Dr.**[a,c]

a. Servizio di Neuropsicologia - IRCCS Fondazione Santa Lucia di Roma
b. Istituto Universitario di Scienze Motorie di Roma
c. Dipartimento di Psicologia Università La Sapienza di Roma

Abstract

A brief suppression of the central portion of stimuli, called Intermittent Central Suppression (ICS), has been reported during binocular fusion. Hussey linked the presence of ICS to reading deficiency. The present study reports an investigation of ICS in a group of proficient readers to evaluate the sensitivity of different tests in measuring this effect.

Twenty-nine college students were examined with three different tests: Poltest, Steroscope Test and Modified Borish Test. The tests revealed different sensitivities to detect suppression. The Poltest was least sensitive; the Stereoscope Test was slightly more sensitive and the Modified Borish Test produced the largest number of suppression reports. About half of the sample reported some degree of ICS. However, our results differed from those reported by Hussey; our participants reported that suppressions were of a shorter duration and were limited to one eye. This could be caused by the different samples; Hussey participants were not proficient readers, while ours were. Recommendations for future research are made.

Key words

binocular rivalry, intermittent central suppression, Modified Borish Test, Poltest, Stereoscopic Test, suppression

INTRODUCTION

Suppression is an inhibitory mechanism producing total or partial cancellation of one of the two monocular images.[1-2] The adaptive value of this mechanism is to avoid confusion or diplopia.

There are several types of suppression.[1-5] These include: *clinical* suppression induced by organic or functional pathologies, *experimental* suppression induced by a variety of artificial conditions (such as binocular rivalry), and the *functional* suppression responsible for the failure to perceive physiological diplopia.

Other types of suppression involve selective central portions of stimulus information. For example, McKee and Harrad[6] observed *fusional* suppression, where participants with normal stereopsis suppressed portions of the monocular stimulus presented as part of a stereogram. Other authors[7-11] described a phenomenon of brief, alternating, monocular suppression limited to the central portion of the visual field, while peripheral fusion was maintained. Anapolle[7] defined this "involuntary, temporary suspension of vision in one or both eyes" as Intermittent Central Suppression (ICS).

Hussey[10] described ICS as monocular suppressions during binocular fusion. It was characterized by brief cycles of suppression limited to the central 2-3 deg. His participants reported an initial monocular suppression lasting about 2-3 seconds (s) followed by binocular fusion for 2-3 s, and finally the previously dominant eye was suppressed for 2-3 s. Hussey's sample was participants with reading problems.

The debate on the role of visual deficits in participants with non-specific reading problems or with dyslexia is ongoing.[12] Several visual defects, including deficits in binocular integration, have been hypothesized to be the cause, or a contributing cause, of reading disabilities.[13,14] While ICS has not been cited as a potential cause of reading problems (with the exception of Hussey) it seems reasonable to think that this phenomenon may impair a complex visual task such as reading. Thus, ICS may disturb accurate fixation by inducing fluctuation in vergence and producing super-imposition of different monocular images. However, a prerequisite to the evaluation of the hypothesis that ICS may be linked to reading deficiency, is the further investigation of its presence and characteristics. Thus, the purpose of the present study was to evaluate the sensitivity of each of three tests in determining the presence and characteristics of ICS in a group of proficient readers.

PARTICIPANTS

Participants were 29 students (11 males) of the Psychology Department of the University of Rome. Participants were screened by an optometrist (first author) in order to exclude anyone with strabis-
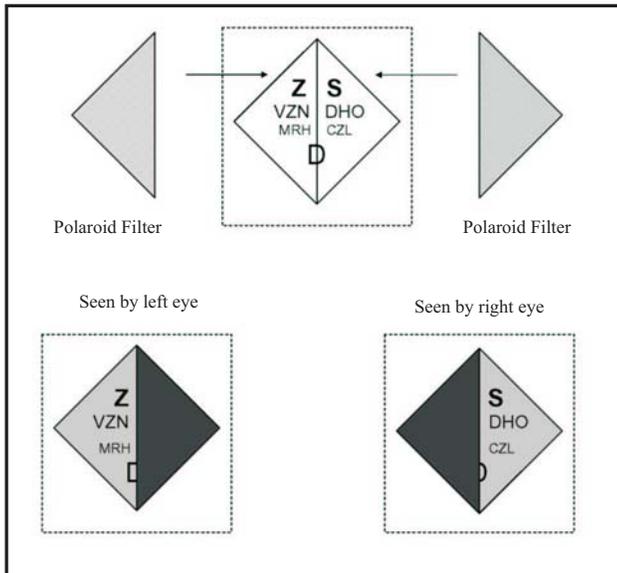
Figure 1. Modified Borish Test. Two polarized filters orthogonally oriented (left and right triangles) were superimposed on the diamond target of the Borish nearpoint vectographic test. The bottom part of the figure shows the expected view for the left eye and the right eye, respectively.

mus and/or amblyopia. The mean age was 23.5 (SD 1.96) years. All participants provided informed consent to the research.

Best corrected monocular and binocular visual acuities for all participants, as determined by the Snellen chart, were at least 20/25. Fifteen participants did not wear ophthalmic corrective lenses; nine participants were myopic, four were compound myopic astigmats, and one participant was hyperopic. No participant had more than a 0.75 Diopter difference in lens power between the eyes. Eye Dominance was tested using the hole-in-the-card method.[15]

METHODS
The Tests
1. *Poltest* is a binocular polarized test sensitive to small clinical, i.e, suppression scotomas.[16] Three circular lights (diameter 1 cm) separated by 1.1 cm are displayed at 3 m distance; overall the display subtends 1deg. The central light is polarized, while the lateral lights are not. A polaroid is located in front of each eye; the two polaroids are orthogonally oriented.
2. *Modified Borish Test (MBT)*[10-11, a] is a nearpoint vectographic test card modified by the addition of two polaroid filters superimposed on a portion of the stimulus (see Figure 1). Appropriately oriented Polaroid filters are worn by the participant so that the right and left
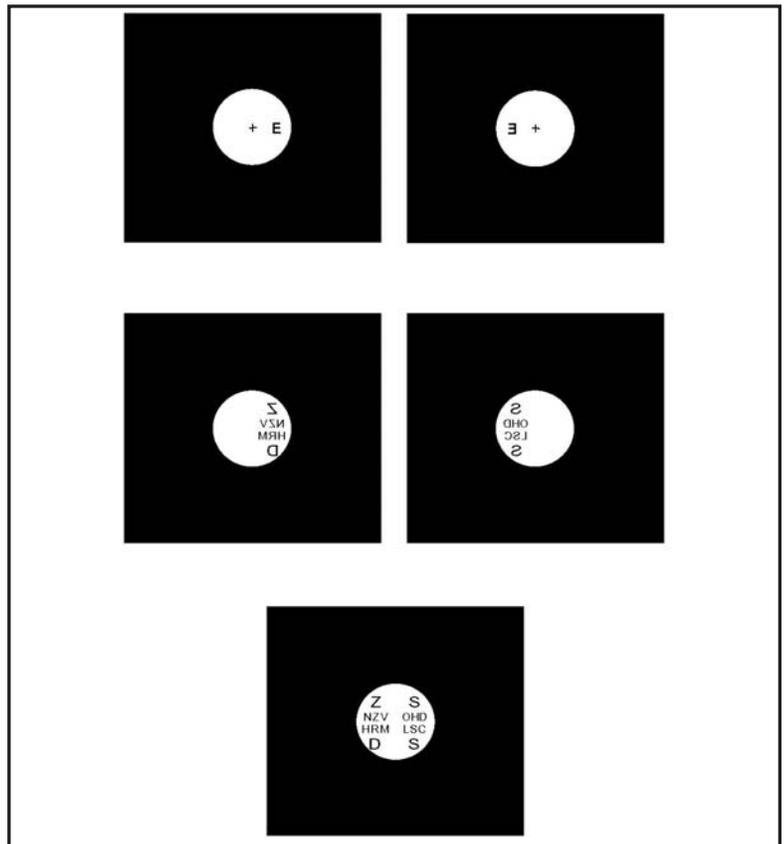

Figure 2. Monocular stimuli used in the Stereoscope test (non-polarized). Top: Single-letter condition. Middle: Crowded-letters condition. Letters were specularly inverted, in order not to be seen inverted as the result of mirror reflection. Bottom: binocular display of the crowded-letters condition.

halves of the diamond are viewed by right and left eye, respectively. The diagonal of the diamond subtends 2 deg of visual angle at 40 cm viewing distance.

3. *Stereoscope Test* is a non-polarized dichoptic test we developed for this study. The instrument is a Wheatstone type stereoscope. The target consists of two white circular patches surrounded by a black background. Each patch subtends 2 deg of visual angle at the distance of 83 cm and the patches are presented in a dichoptic manner (Figure 2). Each patch contains black letters arranged in the right or left half of the patch. Two stimulus conditions were used: condition one was a single-letter condition (Figure 2, top), and condition two was a crowded-letters condition (Figure 2, middle; eight letters in each right or left hemicircle). This latter condition was used to evaluate the effect of crowding on central suppression. Figure 2 (bottom) represents the final binocular effect as seen by the observer in the crowding condition.

Testing protocols
A pre-test was given on each of the three instruments before testing on that instrument. All participants were tested on each of the three instruments. The tests were randomly assigned to the participants. The time interval between each test ranged from 5 to 10 minutes.

Poltest: Overall the test lasted 60 s and the orientation of the polaroids were inverted after 30 s. The participant was instructed to observe any intermittency of the central light during the testing period: this phenomenon would indicate suppression. Reporting the constant presence of three lights indicated that no suppression occurred; reporting two lights indicated that the fovea of one of the two eyes was suppressed; reporting intermittent suppression of the central light was the perceptual experience indicative of ICS. The participant was instructed to attend to any observed changes and report the number and duration of suppressions. The latter were scaled as: less than one second; between 1 and 2 s; between 2 and 3 s; more than 3 s.

Table 1: Classification of types of suppressions

S0= no reported suppressions (binocular fusion)

S1= no more than 2 very short disappearances of one or more than one letter.

S2= frequent intermittent suppression (3 times) of one letter, more than one letter or the entire monocular stimulus. Suppressions did not occur in regular cycles, and could be alternating or monocular.

S3= frequent intermittent suppression (3 times) of one letter, more than one letter or entire monocular stimulus. Suppressions occurred in regular cycles and could be alternating or monocular.

S4 =regular cycles of intermittent suppression of entire monocular stimulus. Monocular suppression lasted about 2-3 seconds followed by binocular fusion for 2-3 s, and then, the previously dominant eye was suppressed for 2-3 s, as in Hussey's description of ICS.[10]

S5 =constant monocular suppression of one eye (clinical suppression)
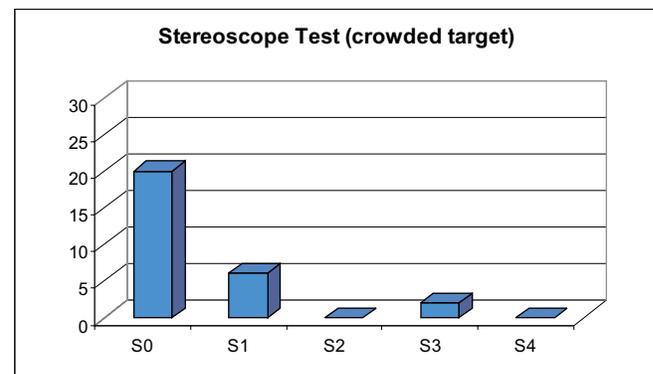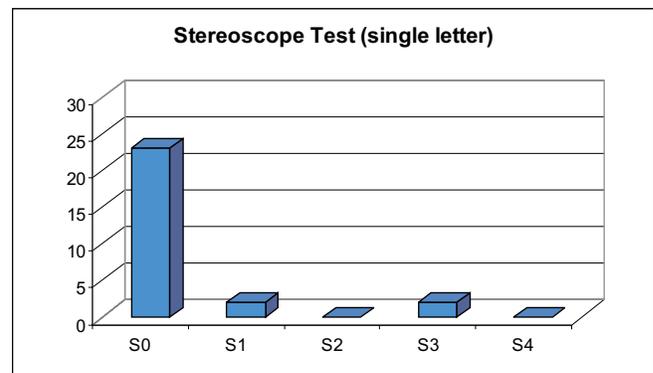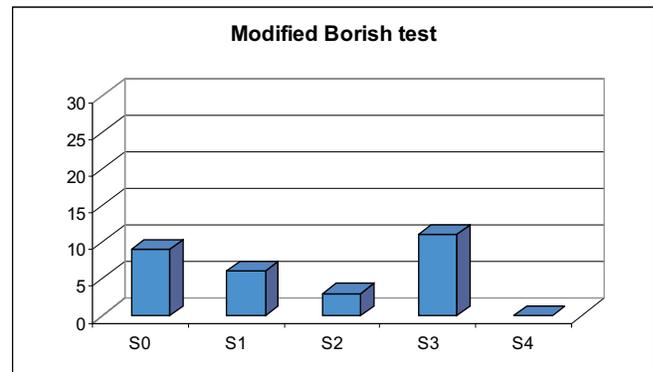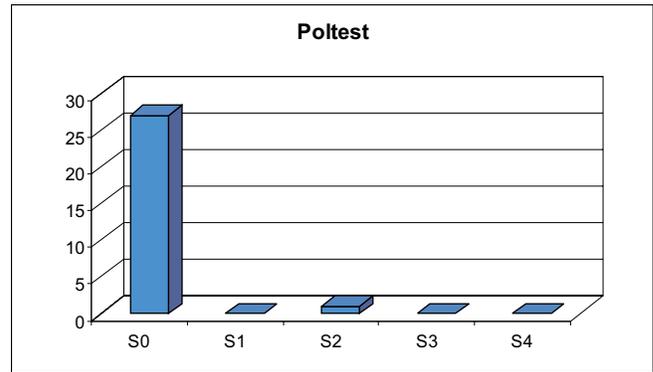
D= Diplopia

Figure 3 Relative frequencies of the various categories of suppression measured by the three Tests considered. Diplopia and constant monocular suppression responses were omitted. For label on the abscissa see Table 1.

MBT and Stereoscope Test: the subject was instructed to view the display for one minute, to determine if any of the following events took place:

a) disappearance or darkening of letters or portions of letters and/or disappearance or darkening of one side of the diamond in the MBT

b) disappearance of letters or portions of letters in the Stereoscope Test and/or disappearance of one hemicircle in the Stereoscope Test.

At the end of testing on these instruments, the participant reported the number of suppressions and approximate durations. The latter were scaled as: less than one second; between 1 and 2 s; between 2 and 3 s; more than 3 s.

Classifications of ICS

Based on our preliminary observations and on Hussey's[10] description, seven categories of responses were defined (see Table 1). They ranged from no reported suppressions (SO), to diplopia (D). Between these extremes were five categories, ranging from low to higher frequencies and durations of suppressions. These were termed S1 to S5 respectively. Table 1 specifies each classification. Suppressions were classified as monocular when they were reported for the same eye at least 80% of the time; otherwise they were classified as alternating.

RESULTS

Figure 3 depicts the reported suppressions with Poltest, MBT and two conditions of the Stereoscope Test. Categories were ordered in a five-level scale, from S0 (no suppression) to S4. We did not include diplopia or constant monocular suppression (S5) since they were rarely reported by our participants. Inspection of the figure shows some interesting elements.

None of our subjects experienced the type of suppression reported by Hussey.[10] Further, the tests had different sensitivities to detect ICS.

The Poltest generated virtually no reports of ICS. The Stereoscope Test was slightly more sensitive, with two participants reporting suppressions. However, the crowded target condition was somewhat more sensitive. The MBT produced

the highest number of suppression reports. In fact 14 participants, about half of the group, fell in categories S2 and S3 where suppression is robust. The data of participants reporting ICS in these categories with the MBT were analyzed in terms of duration and monocular vs. alternating suppressions.

Suppression duration was brief: less than one second for nine participants and 1-2 s for four participants. Only one participant reported suppressions longer than 2 s. Nine participants reported alternating suppression and five participants (one in S2 and four in S3) reported monocular suppressions (four participants with left eye suppression and one participant with right eye suppression). All participants were right eye dominant.

DISCUSSION

The main result of the present study is that ICS was experienced in a large proportion of participants; about half of the sample of participants without reading difficulties reported some form of ICS.

The reports of ICS varied greatly with the type of test used. The use of polarized patterned stimuli, as in the MBT, was critical. As shown by Poltest results, polarized unpatterned stimuli were not effective; a similar finding was present with unpolarized patterned stimuli presented in a dichoptic manner with the Stereoscope Test.

The difference in sensitivity of the tests used might be a phenomenon similar to binocular rivalry (as previously discussed), where "…the binocularly viewed and dissimilar and nonfusionable contours produce a temporal alteration between the eyes…"[18] Consequently, the Poltest, which showed the fewest suppressions has the least dissimilar and nonfusionable contours. In increasing order of reported suppressions were: the Stereoscope Test single letter condition, the Stereoscope Test crowed letter condition, and finally the MBT. It is noteworthy that this progression mimicked an increasing array of dissimilar and nonfusionable contours in each test's stimuli. Further, the fewer suppressions reported on the Stereoscope Test as opposed to the MBT suggests the different backgrounds (gray in the MBT vs. white in the Stereoscope Test) might have played a part in the relative sensitivities of these tests.

The ICS described by Hussey[10] is similar, though not identical with the suppressions reported in the present study. In both cases suppression occurred in the central portion of the visual field, was intermittent, and was detected with polarized patterned stimuli. However, the timing of the phenomenon was different. In Hussey's study, suppression alternated between the two eyes producing a cyclic phenomenon, (suppression of the left eye, fusion, suppression of the right eye) with an average duration of suppression of about 2-3 s. In the present study, suppression time was shorter (less than one second in 9 participants), and often involved only one eye (5 participants).

The difference between the results may be due to the characteristics of the samples studied. While the present study investigated good readers, Hussey[10] studied participants with reading deficits. His suggestion that a cyclic intermittent suppression may generate problems in reading is interesting, and it is conceivable that dyslexics and other challenged readers represent a special population, in terms of their visual characteristics. The presence of abnormal visual and/or visual-motor processing in dyslexics has been proposed in the literature.[17] In this vein, the present data on ICS provide information on ICS in proficient readers, enabling a reliable test of the association of this effect with non-proficient readers.

We plan future research using our protocol with the MBT along two dimensions: first to investigate relationships between ICS and steroacuity, distant and near phorias, refractive status in proficient readers, and second to use our protocol to investigate these relationships in participants who have reading difficulties.

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Source

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Corresponding author
Dott. Fabrizio Zeri
Via G.B.Bodoni, 6
00153 Roma
f.zeri@flashnet.it
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