A STUDY OF
BINOCULAR
ACCOMMODATIVE
AND
VERGENCE
FACILITY
AND
PREDICTIVE ANALYSIS OF GLOBAL STEREOPSIS

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ABSTRACT
Accommodative facility, vergence facility and random dot stereopsis were evaluated in a sample of 43 university baseball and softball players. All had previously passed a modified clinical vision screening. Seventeen subjects were categorized with low accommodative or vergence facility, but only three were low in both. Three of the subjects, including one with low accommodative facility failed the Random Dot E test.

KEYWORDS
accommodative facility, vergence facility, global stereopsis, sports vision

Accommodative and vergence facility tests have become important elements in the clinical investigation of binocular vision. Their unique method of producing step changes in the stimulus differentiates them from more traditional methods of introducing gradual or ramp-like changes usually associated with phoropter testing. Accommodative and vergence facility tests are thought to simulate real-life situations in which rapid changes in fixation distances are required. These situations extend from the classroom to the playing field. Further, many clinicians feel these step changes stress the visual system, with a resultant performance indicative of the ability to sustain effort.

For this investigation, binocular accommodative and vergence facility were evaluated in a sample of college athletes who were participating in a vision screening.

Binocular facility testing was utilized because of renewed interest in the mutual interactions between accommodation and vergence through the AC/A and CA/C ratios. Anomalous interactions have can be hypothesized as important in the generation of ocular and visual symptoms and reduction of binocular efficiency.

There have been several published studies providing normative data for binocular accommodative and vergence facility but none using the same subjects. Garzia and Richman presented experimental norms for binocular accommodative facility in a sample of young adults. Zellers, Alpert and Rouse presented normative binocular accommodative facility in a group of 18- to 30-year-old subjects. The sample included optometry students and clinic patients. Hennesssey, Iosue and Rouse demonstrated differential binocular accommodative facility between symptomatic and asymptomatic subjects in a sample of 8- to 14-year-olds. Scheiman, Herzberg, Frantz et al. developed normative binocular facility in a large sample of 6- to 12-year-olds. All of these studies utilized accommodative stimulus levels created by +2.00/-1.00 diopter lenses. Targets were 20/30 reduced Snellen equivalent letters. Each of these experiments selected subjects who had passed a modified clinical screening procedure.

Buzzelli evaluated the developmental changes in vergence facility in a large sample of school-aged children. There have also been several unpublished studies of vergence facility cited by Griffin.

The primary purpose of this study was to evaluate accommodative and ver-
gence facility in the same individuals to
determine the degree of interrelationship
between these skills. An important clinical
question is to ascertain the relationship
between performances in the two facility
tests. Are they predictive of one another or
is there a degree of independence between
them? Clinicians can use this information
for predictive and taxonomic purposes.

The secondary goal of this study was
to assess the relationship of global
eroscopy to these facility results. In addition
to accommodative and vergence
certainty, each subject was tested for stereo
sensitivity with the Random Dot E test. This test has been found to be an important
element in the assessment of amblyopia
and strabismus in children. It is a very
effective tool for this purpose when utilized
at a test distance of 1.5 meters. Small angle
esotropes and mild amblyopes are often capable of achieving
global stereopsis but rarely at this test
distance, dot density, dot size and disparity
level (168 seconds of arc).

There have been attempts to incorporate random dot stereopsis testing in
preschool and school vision screening programs, particularly those involving
lay screeners. Rosner investigated the
ability of random dot testing to identify
children who failed a modified clinical
screening. All 10 children who failed a
modified clinical screening also failed the
Random Dot E test. These children had
visual acuity deficits and/or binocular
vision disorders (strabismus).

**METHODS**

**Subjects**

The sample consisted of 47 members
of university varsity baseball and softball
teams. There were 24 males and 23
females, with mean ages of 19.8 and 19.7
respectively. A modified clinical screening
was performed on all subjects prior to
the experimental session. The tests included
distance and nearpoint visual acuity, cover test at distance and nearpoint,
ocular motility, static retinoscopy, dynamic (MEM) retinoscopy with
habital correction and direct ophthalmoscopy. If any subject failed one test
based on established criteria, they were excluded from the study. Four people were
excluded for this reason. This reduced the sample to 43 (22 males and 21 females).
All subjects used in the study had 20/20
monocular and binocular near acuity with
their habitual refractive correction.

**Procedure**

All facility and stereopsis testing was
performed by the authors. The screening
procedures were performed by third and
fourth year optometry students
experienced with vision screening protocol.
A nearpoint card with reduced 20/30 let-
ters arranged in a 6 by 6 matrix served as the
target for the facility tests. The card
was held by the subjects throughout the
testing at a distance of 40 cms. Full room
illumination was utilized with an additional
source of light from the overhead lamp
of a phoropter stand.

Accommodative and vergence
stimuli selected were +2.00/-2.00 dioptr
spheres and 8 BI/8 BO dioptr prisms. In
other investigations of accommodative
facility, +2.00/-2.00 lenses have been used
and are commonly applied for clinical
assessments. There is less consensus on the
magnitude and range of prism values to be
used for vergence facility. The 8 BI/8
BO powers chosen for this study are rep-
resentative. Identical BI and BO powers were
consistent with the identical values
typically used in accommodative facility
testing. All testing was performed under
binocular conditions.

Suppression was monitored for both
facility tests by a physiological diplopia

**RESULTS**

For the purposes of this study, the
subjects were dichotomized for accom-
modative facility and vergence facility performance. One standard deviation below the mean of the sample was chosen as the cut-off value. Subjects whose scores were one standard deviation or more below the mean for the sample were placed in the low facility category. Hennessey, Isobe and Roue identified this level as separating symptomatic from asymptomatic subjects. Those with scores above this criterion level were designated as high. There were eight accommodative facility and nine vergence facility scores in the low category.\(^c\)

A 2 x 2 contingency table summarizes the data (see Table 1). The accommodative facility results are placed in the two columns, with the vergence results in the rows. The marginal frequencies give the number of subjects in the four possible categories (high and low accommodative facility and high and low vergence facility). For example, 35 subjects had high accommodative facility and 8 low. The numbers within the table represent the combined occurrences of accommodative and vergence facility performance. For example, there were 29 subjects in the high accommodative facility category that also had high vergence facility.

One-third of the sample (33\%, 17/43) were in the low category for either accommodative or vergence facility. Of the 17 in the low category of either test, only three (17.6\%) were low in both facility tests.

Of those in the high vergence facility category, 85.3\% (29/34) also had high accommodative facility. Of those with high accommodative facility, 82.9\% (29/35) also were in the high vergence facility category. Of subjects in the low vergence facility category, only 33\% (3/9) also had low accommodative facility. Of subjects with low accommodative facility, 37.5\% (3/8) also had low vergence facility.

A chi square analysis was unable to reject the null hypothesis of no significant differences between the expected and observed frequencies \((X^2=.63, df=1, p=.20)\). The coefficient of contingency was C=.19, and was not significant \((p=.10)\).\(^a\)

Only three subjects failed the Random Dot E test. All three of them were in the high vergence facility category, with two in the high accommodative facility category. Thus, only one subject with a low facility test (accommodative) failed the stereopsis test.

### CONTINGENCY TABLE DATA SUMMARY

The left vertical column indicates high accommodative facility, and the right vertical column low accommodative facility. The top horizontal column indicates high vergence facility while the bottom horizontal column indicates low vergence facility.

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Low</th>
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<tbody>
<tr>
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<tr>
<td>Facility</td>
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<tr>
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<td>5</td>
</tr>
<tr>
<td><strong>Total Low</strong></td>
<td>6</td>
<td>3</td>
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<tr>
<td><strong>Total</strong></td>
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<td>9</td>
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<td><strong>Total Low</strong></td>
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**Table 1.**

### DISCUSSION

The results suggest that there is generally good concordance between accommodative facility and vergence facility, at least for those in the high facility categories. If a subject was in the high category for one facility test, there was over an 80\% probability of being in the high category for the other test. If a subject had high accommodative facility, there was an 83\% probability that vergence facility was also high. Conversely, of subjects with high vergence facility, there was an 85\% probability that accommodative facility would also be high.

However, low performance in one test was a poor predictor of performance in the other. This is because most subjects were in the low category of only one facility test (14/17). Only three had low accommodative and vergence facility. If one facility test was low, there was approximately only a one in three probability that the other test would also be low (3/8 accommodative facility, 3/9 vergence facility). As a result, the chi square analysis indicated there was a degree of independence between accommodative and vergence variables, which are poorly correlated. This is reflected in the low contingency coefficient that was not significant.

The results of the stereopsis testing were consistent with clinical intuition and other reports relating stereopsis to typical vision screening.\(^12,14\) All the subjects passed a modified clinical vision screening, and 93\% (40/43) passed the Random Dot stereo test. Two of the three subjects failing the stereo test were in the high facility category for both accommodative and vergence facility. Only one individual in a low facility category (accommodative) also failed the stereo test. This suggests two conclusions.

First, the Random Dot E stereo test is correlated to performance on our modified clinical screening. All of the subjects in the present study were preselected by having passed a vision screening. Therefore, most of these subjects were expected to pass the stereo test. This one-way analysis should not be interpreted to mean that these results support the power of Random Dot stereopsis to detect those individuals who would have failed a vision screening. Random Dot stereopsis has been very useful in the detection of amblyopia and strabismus in children, if used under the proper stimulus conditions.

Second, the results showed that Random Dot stereopsis testing did not detect those individuals with low accommodative or vergence facility. Of the 17 subjects with a low facility test, only one (6\%) also failed the Random Dot stereopsis test. Stereopsis testing would not be an effective substitute for facility testing. This is
not an entirely unanticipated result. Although stereo sensitivity is dependent on sensory-motor integrity of the binocular system, it is determined under steady state conditions. Accommodation and vergence remain at constant levels. In contrast, binocular facility testing forces the accommodative and vergence systems to detect and respond to rapid and frequent changes in the stimulus. These results support the clinical impression that stereopsis as a metric of sensory-motor status does not always reflect binocular function under more dynamic conditions, such as facility.2

FOOTNOTES

a. Random Dot E Test, Stereo Optical Co., Chicago, IL.

b. Orinda criteria for distance visual acuity, refractive status, binocularity and ocular health. Greater than or equal to +.75 for dynamic (MEM) retinoscopy.2

c. Facility test data is not thought to be normally distributed, but rather, skewed and kurtotic. Using the published raw data from two large studies, the distribution of binocular accommodative facility was skewed slightly positively in one2 and negatively in the other but severely platykurtotic in both.

d. The upper limit of C for a 2 x 2 contingency table is .707.

REFERENCES


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