# EVALUATION OF VISUOMOTOR SKILLS IN AMBLYOPIC CHILDREN WITH BENDER GESTALT TEST

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## ABSTRACT

***Objective:*** *To evaluate the visual motor skills in amblyopic children with Bender Gestalt test and determine whether there is an association between amblyopia and test results.*

***Material and Method:*** *Bender Gestalt test was administered to 23 amblyopic children and 13 control subjects. The error scores and error types were noted and converted to visual maturation age. The developmental percentile was determined to compare the groups.*

***Results:*** *The mean percentile level of the amblyopic patients was 38.26%. Bilateral amblyopes performed significantly poorer than unilateral amblyopes and controls. (24.44% vs. 47.14% and 60%).*

*There was a significant correlation between the logMAR visual acuity of the better seeing eye and the test performance.*

***Conclusion:*** *This study shows that visuomotor functions were negatively affected in bilateral amblyopia. Unilateral amblyopes seem to respond to the test as normal as healthy subjects. The vision of the better seeing eye is an important topic in the interpretation of test results.*

***Key Words:*** *Amblyopia, Bender Gestalt test, visual motor coordination* ***Nobel Med 2013; 9(1): 76-80***

## GÖZ TEMBELLİĞİ OLAN ÇOCUKLARDA BENDER GESTALT TESTİ İLE VİZÜEL MOTOR BECERİLERİN DEĞERLENDİRİLMESİ


## ÖZET

**Amaç:** Göz tembelliği olan çocuklarda Bender Gestalt testi ile vizüel motor becerilerin değerlendirilmesi ve göz tembelliği ile test sonuçları arasında herhangi bir ilişki olup olmadığının saptanması.

**Materyal ve Metod:** Bender Gestal testi 23 göz tembelliği olan çocuğa uygulandı, kontrol grubu olarak 13 çocuk çalışmaya dahil edildi. Hata skoru ve hata tipleri kaydedildi ve görsel olgunlaşma yaşına dönüştürüldü. Çocukların gelişimsel eğrileri gruplar arasında karşılaştırıldı.

**Bulgular:** Göz tembelliği olan çocukların ortalama yüzdelik değeri %38,26 olarak saptandı. Çift taraflı göz tembelliği olan çocuklar tek taraflı göz tembelliği olanlar ve kontrollere göre testte istatistiksel olarak anlamlı düzeyde daha başarısız oldular. (%24,4, %47,14 ve %60). Daha iyi gören gözün logMAR görme keskinliği ve test performansı arasında anlamlı bir korelasyon saptandı.

**Sonuç:** Bu çalışmanın sonuçlarına göre bilateral göz tembelliğinde vizuomotor fonksiyonlarının olumsuz etkilendiği görülmüştür. Tek taraflı göz tembelliği olanlar ile sağlıklı kontroller arasında test sonuçları arasında farklılık saptanmadı. Daha iyi gören gözün vizyonu test sonuçlarının yorumlanmasında oldukça önemlidir.



**Anahtar Kelimeler:** Göz tembelliği, Bender Gestalt test, görsel motor koordinasyon **Nobel Med 2013; 9(1): 76-80**


## INTRODUCTION

Amblyopia is the leading cause of visual impairment in children and a relatively prevalent developmental problem affecting approximately 5% of the general population. It has been shown to be the number one cause of monocular vision loss in adults aged 20-70.[1] Furthermore, persons with amblyopia have a higher risk of becoming blind because of potential loss to the sound eye from other causes. With this regard ambliyopia is also an important socioeconomic problem. Most cases of amblyopia are reversible with early detection and treatment.[2] There are many studies in the literature regarding the pathophysiology, early detection and management of amblyopia.[3-6] Visual defects associated with amblyopia have also been extensively studied.[7,8] However there are a few studies regarding the functional impact of amblyopia on visual motor skills and maturation in children.[9,10]

In our study we evaluated the visual motor maturation of 23 children with amblyopia and 13 children in the control group with Bender Gestalt test and we aimed to investigate whether there was a difference between amblyopes and normal subjects. This test is one of the most frequently used tests by clinical psychologists.[11] The test was developed by Bender in 1938 using Wertheimer's 9 Gestalt figures and was proposed as a test of neurological integrity.[12]

## MATERIAL and METHOD

Forty children aged 6 years 3 months to 11 years 11 months were enrolled into the study. Four children were excluded from the study due to IQ level below normal. Thirty-six children with normal mental-motor development were included in the study. Twenty-three had amblyopia of different causes and 13 children were normal subjects in the control group. The amblyopia and control groups were age matched. Informed consent was obtained from each child's parent or legal guardian before admitting to the study. All patients underwent a complete ophthalmological examination. Best corrected visual acuity (BCVA) was measured using the Snellen chart. Amblyopia was defined as an uncorrectable difference of 2 or more Snellen lines between eyes. Children with ocular pathology other than amblyopia and children with any mental or motor deficiencies were not admitted to the study.

Visual motor maturation was assessed with the Bender Gestalt test. The original Bender Gestalt cards were used. There are nine cards and there is a figure on each card. The test was administrated by the same psychologist to all participant children. The test was administered binocularly and the children were asked "to draw the figures as they see them". The children were allowed to manipulate the cards and their drawing papers, the orientation of the cards and the paper while each design was copied was noted. The psychologist who administered and interpreted the results was masked to ocular status of the children in order not to lead to bias. The tests were then scored for the presence/absence of the 30 error definitions (distortion, rotation, integration and perseveration). A total error score was obtained for each child. Visual motor maturation age was determined for each child according to the test →

**Table 1:** Data of the amblyopic patients included in the study

| Patient ID | Sex | Age (months) | Right BCVA | Left BCVA | Amblyopia type | Unilateral/ Bilateral | Total Error Score | Percentile % |
|---|---|---|---|---|---|---|---|---|
| 1 | Female | 91 | 0.70 | 0.90 | Anisometropic | Unilateral | 5 | 50.00 |
| 2 | Male | 79 | 1.00 | 0.80 | Anisometropic | Unilateral | 11 | 20.00 |
| 3 | Male | 75 | 0.40 | 1.00 | Anisometropic +strabismic | Unilateral | 9 | 40.00 |
| 4 | Female | 108 | 1.00 | 0.60 | Anisometropic | Unilateral | 3 | 40.00 |
| 5 | Male | 116 | 1.00 | 0.70 | Anisometropic | Unilateral | 4 | 50.00 |
| 6 | Female | 115 | 1.00 | 0.05 | Anisometropic | Unilateral | 0 | 80.00 |
| 7 | Female | 120 | 0.40 | 1.00 | Anisometropic | Unilateral | 0 | 75.00 |
| 8 | Female | 96 | 0.70 | 1.00 | Anisometropic | Unilateral | 7 | 20.00 |
| 9 | Female | 120 | 1.00 | 0.50 | Anisometropic | Unilateral | 0 | 75.00 |
| 10 | Male | 95 | 0.50 | 1.00 | Anisometropic | Unilateral | 5 | 50.00 |
| 11 | Female | 107 | 0.60 | 1.00 | Anisometropic | Unilateral | 0 | 90.00 |
| 12 | Male | 94 | 1.00 | 0.50 | Strabismic | Unilateral | 9 | 10.00 |
| 13 | Female | 143 | 1.00 | 0.30 | Anisometropic | Unilateral | 2 | 40.00 |
| 14 | Female | 123 | 0.10 | 1.00 | Strabismic | Unilateral | 4 | 20.00 |
| 15 | Male | 78 | 0.40 | 0.70 | HRE | Bilateral | 11 | 20.00 |
| 16 | Male | 108 | 0.80 | 0.50 | HRE | Bilateral | 9 | 5.00 |
| 17 | Female | 79 | 0.60 | 0.40 | HRE | Bilateral | 9 | 30.00 |
| 18 | Male | 78 | 0.60 | 0.40 | HRE | Bilateral | 11 | 20.00 |
| 19 | Male | 82 | 0.40 | 0.40 | HRE | Bilateral | 8 | 40.00 |
| 20 | Female | 82 | 0.30 | 0.70 | HRE | Bilateral | 12 | 20.00 |
| 21 | Male | 97 | 0.60 | 0.60 | HRE | Bilateral | 6 | 30.00 |
| 22 | Female | 108 | 0.40 | 0.60 | HRE | Bilateral | 9 | 5.00 |
| 23 | Female | 76 | 0.70 | 0.50 | HRE | Bilateral | 4 | 50.00 |

BCVA: Best corrected visual acuity, HRE: High refractive error

**Table 2:** The mean and median of the total error scores and the distribution.

| | Distortion | | Rotation | | Integration | |
|---|---|---|---|---|---|---|
| | Mean±SD | Median | Mean±SD | Median | Mean±SD | Median |
| **Unilateral amblyopes (n=14)** | 2.78±2.80 | 2.5 | 0.86±0.86 | 1,0 | 0.57±0.85 | 0 |
| **Bilateral amblyopes (n=9)** | 5.00±2.17 | 5.0 | 2.22±1.48 | 2,0 | 1.55±1.23 | 1,0 |
| **Control subjects (n=13)** | 1.07±1.25 | 1.0 | 0.69±1.11 | 0 | 0.92±0.95 | 1,0 |
| **+p** | 0.002** | | 0.020* | | 0.046* | |
| | ++p | | ++p | | ++p | |
| **Unilateral-Bilateral** | 0.046* | | 0.026* | | 0.043* | |
| **Unilateral-Control** | 0.093 | | 0.427 | | 0.266 | |
| **Bilateral-Control** | 0.001** | | 0.011* | | 0.221 | |

+: Kruskal Wallis test, ++: Mann Whitney U test, SD: Standart deviation, **: p<0.01, *: p<0.05

result. The developmental percentile to which the child belongs was determined from the chart using the birth age and visual motor maturation age of the patient.

Statistical analysis was carried out using SPSS 15.0 (Statistical Package for Social Sciences) for Windows. Snellen visual acuities were converted into logMAR for statistical analyses. Kruskal-Wallis test was used for comparison of all groups and Mann-Whitney U test was used for comparison of subgroups with each other. Pearson correlation test was used for correlation analysis. A level of p<0.05 was considered statistically significant and the results were evaluated at 95% confidence interval.

## RESULTS

Thirty-six children were included in the study between March 2008 and December 2008. The mean age was 100.75±17.36 months (range:75-143 months ). Of the 36 children, 16 (44.4%) were female and 20 (55.6%) were male. Amblyopic patients (n=23) were divided into 2 subgroups as unilateral and bilateral amblyopia. 14 patients (38.8%) had unilateral amblyopia while 9 patients (25%) had bilateral amblyopia defined as bilateral low vision which could not reach 0.80 Snellen acuity with spectacle correction and could not be explained with organic causes except for refractive errors of 14 patients with unilateral amblyopia, 11 patients had anisometropic amblyopia, 2 patients had strabismic amblyopia and one patient had amblyopia due to both strabismus and anisometropia. 13 children included in the control group were normal healthy subjects with visual acuities in both eyes equal to 1.0 Snellen. The data of the amblyopic patients included in the study is presented in Table1.

The most frequently committed error was distortion, followed by rotation and integration. No error related to perseveration was committed. The mean of the total error scores and the distribution are presented in Table 2. There were significant differences among groups for distortion, rotation and integration error scores. When the groups were compared with each other with Mann-Whitney U test, bilateral amblyopes made significantly higher number of errors than unilateral amblyopes and the control subjects (p=0.046 and p=0.001). However, although the unilateral amblyopes made more errors than the controls, the difference between them was not significant (p>0.05).

The mean percentile level of the children was 46.11±23.84% and range was between 5% and 95%. The mean percentile level of amblyopes was significantly lower than controls (38.26±26% vs 60.00±16.20%, p=0.007). However when we further evaluated the subgroups of amblyopia, we found that the difference was mostly due to the bilateral amblyopes included in study group. The mean percentile level was significantly lower in bilateral amblyopes when compared with unilateral amblyopes and the control group (p<0.01). There was not a significant difference between unilateral amblyopes and controls in case of →

percentile level (p>0.05). The mean total error score was significantly higher in bilateral amblyopes than in unilateral amblyopes and the control group. (p<0.01) (Table 3).

The groups were compared for the mean logMAR visual acuity of the better seeing eye (logMAR $VA_{be}$) and a significant difference was found among groups. When the subgroups were compared with each other, the mean logMAR $VA_{be}$ of bilateral amblyopes was significantly higher than unilateral amblyopes and controls (p=0.001 and p=0.001). There was not a significant difference between unilateral amblyopes and controls (p>0.05). A significant negative correlation exists between logMAR $VA_{be}$ and percentile level and a significant positive correlation exists between logMAR $VA_{be}$ and total error scores (p<0.01). These might be interpreted as higher the visual acuity of the better seeing eye, better the percentile level and fewer error scores (Table 4 and 5).

**Table 3:** Comparison among groups according to mean percentile and total error score.

| | Percentile | | Total error score | |
|---|---|---|---|---|
| | Mean±SD | Median | Mean±SD | Median |
| **Unilateral amblyopes (n=14)** | 47.14±25.16 | 45.0 | 4.21±3.70 | 4.0 |
| **Bilateral amblyopes (n=9)** | 24.44±14.88 | 20.0 | 8.78±2.53 | 9.0 |
| **Control subjects (n=13)** | 60.00±16.20 | 50.0 | 2.69±1.84 | 3.0 |
| **+p** | 0.001** | | 0.001** | |
| | ++p | | ++p | |
| **Unilateral-bilateral** | 0.032* | | 0.008** | |
| **Unilateral-control** | 0.068 | | 0.377 | |
| **Bilateral-control** | 0.001** | | 0.001** | |

+: Kruskal Wallis test, ++: Mann Whitney U test, SD: Standart deviation, **: p<0.01, *: p<0.05

**Table 4:** The mean and median of logMAR visual acuities and comparison between groups

| | LogMAR $VA_{be}$ | |
|---|---|---|
| | Mean±SD | Median |
| **Unilateral amblyopes (n=14)** | 0.003±0.01 | 0 |
| **Bilateral amblyopes (n=9)** | 0.198±0.09 | 0.22 |
| **Control subjects (n=13)** | 0 | 0 |
| **+p** | 0.001** | |
| | ++p | |
| **Unilateral-bilateral** | 0.001** | |
| **Unilateral-Control** | 0.335 | |
| **Bilateral-Control** | 0.001** | |

+: Kruskal Wallis test, ++: Mann Whitney U test, SD: Standart deviation, **: p<0.01, *: p<0.05

**Table 5:** The correlation of logMAR VAbe with percentile level and total error score (n=36)

| | LogMAR $VA_{be}$ | |
|---|---|---|
| | r | p |
| **Percentile** | -0.524 | 0.001** |
| **Total error score** | 0.597 | 0.001** |

r: Spearman's correlation coefficient, **: p<0.001

## DISCUSSION

This study shows that visuomotor functions were negatively affected in bilateral amblyopic patients. To our knowledge, this is the first study in the literature regarding amblyopia and Bender Gestalt testing. The Bender Gestalt test is one of the most frequently used tests of visual motor maturation. The test was developed by Bender in 1938 using Wertheimer's 9 Gestalt figures and was proposed as a test of neurological integrity.[12] The subject is asked to copy each of the 9 figures and his/her reproductions are judged for the presence of errors and later modified as an assessment of developmental maturational level of children's visual motor integration.[13] The Koppitz system was selected for the present study because the system is applicable to ages 5 through 11 and is being used in Turkey.[14]

Visual defects associated with amblyopia have been extensively studied, but a few studies have about its functional effect on visuomotor skills in the literature. In a recent study Webber et al. reported that fine motor skills were reduced in children with amblyopia, particularly with strabismus.[10] They found that the deficits in motor performance were prominent on manual dexterity tasks requiring speed and accuracy. Grant et al. reported that prehension (eye-hand coordination) deficits were associated with amblyopia in adults.[9] They concluded that visuomotor adaptations in amblyopes were relatively minor and limited to aspects of movement planning. In our study we evaluated the visuomotor functions with Bender Gestalt test and converted the results to percentiles to display the deviation from normal population. We have found that 15 of 23 amblyopic children were in a lower percentile than 50%. Four of the patients were in the 50% percentile and only the remaining 4 patients (17.4%) were in a percentile higher than 50%. The mean percentile was 38.26%. At first sight, this finding may be interpreted as amblyopes generally display poorer visuomotor functions than the normal population. However, in this study we have found that the mean total error score and percentile level were different between bilateral and unilateral amblyopes. Bilateral amblyopes performed much worse in Bender Gestalt test than unilateral amblyopes and the control subjects. Despite the fact that the mean percentile level was slightly lower than the general population level for unilateral cases, the mean of bilateral cases was 24.44% and was significantly low when compared with unilateral amblyopes (47.14%) and →

controls (60%). This finding shows the significance of binocularity for a good visuomotor function. However, when we made a correlation analysis between logMAR $VA_{be}$ and test results regarding the whole participants, we have found a significant correalation between them shown in Table 5. This result might be interpreted as the visual acuity of the better seeing eye increases, the test performance also increases and the number of errors decreases. These findings show that not only the binocularity of the subjects but also the visual acuity of the better seeing eye might effect the test performance.

Bender Gestalt test is a commonly taught and utilized test in Turkey. It has been recommended as a guide for school counselors by the ministry of education. According to the results of our study, we advise that children performing poorly in Bender Gestalt test and with no previously known eye disease should be referred for ophthalmic examination as amblyopia and low vision of the better seeing eye might be a reason for a poor result. Further studies are necessary to display the percentage of poor results related to visual deficits and motor deficits or both.

This is the first study evaluating visuomotor functions in amblyopia with Bender Gestalt test, despite the relatively low number of children included. Further studies including greater number of patients will enlighten us more about the visuomotor functions of amblyopes. We plan to study on this subject in amblyopic patients with different types and levels of amblyopia.

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