BINOCULAR VISION AMONG CHILDREN IN SECOND GRADE
OF KINDERGARTEN SCHOOL IN SURABAYA

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ABSTRACT

Objective: to study binocular vision and stereo acuity among children in second grade of kindergarten school in Surabaya. Design: the study design was descriptive and cross sectional. Methods: 520 children in Surabaya were included in the study with the following criteria i.e. good condition, cooperative and no anterior or posterior segment anomalies. The binocular vision was examined using Worth Four Dot Test for their fusion and the stereo acuity was carried out using Titmus Test. Results: Total of 520 pre-school children between 4 – 6 years old was included in this study with 258 boys and 262 girls. Most of the children (413) were 5 years old. In addition, 513 children had fusion and 478 children were able to examine their stereo acuity. The average stereo acuity was 75.17 seconds of arc. Furthermore, 389 children (74.88%) had normal stereo acuity (60 seconds of arc or better). Conclusion: Most of in second grade of kindergarten school in Surabaya (74.88%) had normal or better stereo acuity which indicating binocular vision.

Keywords: binocular vision, stereo acuity, children, second grade kindergarten school

INTRODUCTION

In normal people, image on both eyes makes perception of single stereoscopic vision or single binocular vision (Burian 1974, Cashel 1980). A normal binocular vision requires: First, normal physiology of the eye i.e. the image of the object should be directed to the fovea of both eyes corresponding to the acuity, size and shape. Second, good coordination of extra ocular muscle on both eyes where the image of the object from various eye positions can be directed to both fovea. Third, the ability of central nervous system to synthesis both images on both eyes to one single image or fusion (Cashel 1980, Sanyoto 1980, Hamidah 1991).

Worth (1981) classified three well-correlated levels of binocular vision to perception; simultan, fusion and stereoscopic vision. Moreover, the quality of binocular vision, i.e. whether bad or good, can be determined by measuring or assessing the stereo acuity. Likewise, good visual acuity of both eyes is required for stereos vision. In normal adults, fixation of fovea of both eyes produce stereo acuity of 60 seconds of arc or better, whereas monofixator, i.e. fixation of fovea on only one eye, or micro strabismus (Park 1968, Sanyoto 1980) resulted in stereo acuity of more than 60 seconds of arc. In addition, better stereo acuity is determined from people having the least seconds of arc. The binocular vision evolves along with visual acuity. The optimum visual acuity development in child is achieved in the age of 4 – 5 years old and is assumed similar to adult. Is there any similarity in stereo acuity between pre-school children and adult i.e. 60 seconds of arc or better?

Tatsumi and Akira (1972) using stereo Fly Test reported stereoscopic vision of 100 seconds of arc in children between 4 – 5 years old. Another study by Amigo (1973) showed the stereoscopic vision in children aged 4 and 5 years old were 173 and 167 seconds of arc, respectively. Furthermore, Cooper et al., reported the average stereoscopic vision in children aged 4, 5 and 6 years were 95, 102, and 94 seconds of arc, respectively. In contrast, Heron et al., reported of 61.5, 30.5 and 29.5 seconds of arc in children aged 4, 5 and 6 years, respectively.

Today there has been lack of understanding regarding binocular vision in Indonesian people in which their commonly misleading term is visual acuity. This binocular vision is as important as visual acuity where this will apply to some jobs application requiring good binocular or stereoscopic vision such as pilot, engineer, public transport driver, or laboratory personnel frequently use binocular microscope.

Unfortunately, there are fewer studies and data of binocular vision carried out in pre-school children in Indonesia until now. Therefore, this has inspired the author to carry out a study of binocular vision among pre-school children in Surabaya. The aim of this study was to measure the average stereoscopic vision among those pre-school children in second grade of kindergarten schools (TK B). The author expected that the current study would have any benefits to support government program in promoting Indonesian intellectuality by giving the best education in pre-school

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children to achieve the best human resources in the future.

METHODS

The study design was descriptive and cross sectional. The study was carried out in the selected second grade of kindergarten school (TK B) in Surabaya and it was done in the backyard of the school. An appointment was made prior to scheduled visit to those schools to avoid interfering school programs. All pre-school children in second grade of kindergarten schools (TK B) in Surabaya were included in this study. A random multi stage cluster was applied for sampling method in which it assured that each districts, kindergarten schools and pre-school children selected were included in the study. The inclusion criteria in this study were pre-school children in second grade of kindergarten school (TK B), good condition, normal eyes i.e. no anterior or posterior segment anomalies, informed consent from parents, and they attended at the time of study. The observed variables were visual acuity (visual acuity), fusion (Worth Four Dots Test), stereoscopic vision, and age.

All pre-school children attended at the time of study were examined for:
1. Hetero anamnesis via questionnaire to their parents regarding any visual disturbance, the use of spectacles, and birth history.
2. Natural visual acuity examination using Snellen or pictures
3. Anterior and posterior segment examination using binoculars, torch, and ophthalmoscope
4. Fusion examination using Worth Four Dot Test
5. The Titmus Test used for stereo acuity examination following positive result of fusion.

RESULT

The study was carried out from December 2001 to March 2002 in pre-school children in selected second grade of kindergarten schools (TK B) in Surabaya. From 543 pre-school children registered, 520 children (95.76%) can be examined whereas 23 children (4.24%) were not attended in school at the time of study.

1. Sample Characteristics

   Table 1. Age and gender distribution of pre-school children in second grade of kindergarten schools (TK B).

<table>
<thead>
<tr>
<th>Age</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of children</td>
<td>Percentage (%)</td>
<td>Number of children</td>
</tr>
<tr>
<td>4 years</td>
<td>12</td>
<td>2.31</td>
<td>27</td>
</tr>
<tr>
<td>5 years</td>
<td>211</td>
<td>40.58</td>
<td>202</td>
</tr>
<tr>
<td>6 years</td>
<td>35</td>
<td>6.73</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>258</td>
<td>49.62</td>
<td>262</td>
</tr>
</tbody>
</table>

Table-1 shows that most of the pre-school children (413 children; 79.42%) included in this study were 5 years old; 68 (13.08%) children were 6 years old; and 39 (7.50%) children were 4 years old. According to gender distribution, 258 (49.62%) were male and 262 (50.38%) were female.

2. Visual acuity, fusion, and stereoscopic

   Table 2.1. Visual acuity and Worth Four Dot Test of pre-school children in second grade of kindergarten schools (TK B) according to age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Visual acuity</th>
<th>WFDT*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OD</td>
<td>OS</td>
</tr>
<tr>
<td>4 years</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>5 years</td>
<td>88</td>
<td>306</td>
</tr>
<tr>
<td>6 years</td>
<td>25</td>
<td>42</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>374</td>
</tr>
</tbody>
</table>

*Worth Four Dot Test
The visual acuity examination of the right and left eye indicated that 119 (22.89%) children had optimum visual acuity (6/6). Yet, 374 (71.92%) children have not had optimum visual acuity (6/6). Furthermore, 27 (5.19%) children were uncooperative. In addition, fusion examination of Worth Four Dot Test showed 517 (99.42%) children had fusion whereas 3 (0.58%) children cannot be examined for uncooperative behavior.

### Table 2.2. Stereo acuity (Titmus Test) distribution of pre-school children in second grade of kindergarten schools (TK B) according to age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Stereo Acuity (Titmus Test) in second of arc</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>4 years</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>5 years</td>
<td>218</td>
<td>57</td>
</tr>
<tr>
<td>6 years</td>
<td>38</td>
<td>14</td>
</tr>
<tr>
<td>Total</td>
<td>272</td>
<td>77</td>
</tr>
</tbody>
</table>

Following Worth Four Dot Test examination of the fusion of 517 children, Titmus Test was carried out resulting in 47 (92.46%) children can be examined their stereoscopic acuity whereas 39 (7.54%) were uncooperative. In addition, the children having 40 seconds of arc were 272 (52.61%) and those having 60 seconds of arc or better were 389 (74.88%) children. Furthermore, the average stereoscopic acuity of pre-school children in second grade of kindergarten school (TK B) in Surabaya was 75.14 seconds of arc.

### 3. Additional Results

Table 3.1. Stereo acuity distribution of pre-school children with visual acuity 6/6 in both eyes according age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Stereo Acuity (Titmus Test)</th>
<th>uncooperative</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
<td>50</td>
<td>60</td>
</tr>
<tr>
<td>4 years</td>
<td>2</td>
<td>2.25</td>
<td>-</td>
</tr>
<tr>
<td>5 years</td>
<td>50</td>
<td>56.18</td>
<td>10</td>
</tr>
<tr>
<td>6 years</td>
<td>12</td>
<td>13.48</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>64</td>
<td>71.91</td>
<td>16</td>
</tr>
</tbody>
</table>

Table-3.1 shows that 64 (71.91%) of 89 children with 6/6 visual acuity had stereoscopic acuity of 40 seconds of arc whereas 83 (98.26%) children had stereoscopic acuity of normal; or 60 seconds of arc or less.

### DISCUSSION

This descriptive and cross sectional study was carried out to identify the binocular vision and the average stereoscopic acuity in pre-school children selected in second grade of kindergarten schools (TK B) in Surabaya. They were examined their natural visual acuity of the left and right eye, fusion using Worth Four Dot Test, and stereoscopic vision using Titmus Test. Total of 520 children were included and consisted of 258 (49.62%) male and 262 (50.38%) female. The children included in this study were between 4 to 6 years old in which most of the children were 5 years old (413 or 79.42%); 39 (7.5%) children were 4 years old; and 68 (13.08%) children were 6 years old (Table-1).

Table-2.1 shows that 119 (22.89%) children had optimum visual acuity 6/6 on one or both eyes. However, 374 (71.92%) children have not had optimum visual acuity 6/6.
visual acuity 6/6 and 27 (5.19%) children were uncooperative at the time of study. Moreover, 66.66% of 4 years old children and 61.76% of 5 years old children had visual acuity less than 6/6. This current study reported 71.92% children who have not had visual acuity 6/6 yet as is normal in children of 4 – 5 years old (Friendly, 1985). In addition, this value might indicate the visual acuity is still develop or an anomaly in refraction (Abrams D, 1993; Nalson LB, 1991; Rosner J, 1990).

Furthermore, Worth Four Dot Test of 520 children revealed that 517 (99.42%) children had fusion whereas 3 children cannot be examined as 2 children were uncooperative and 1 child was mentally retarded (1 child). Of these 517 children, 478 children can be examined their stereoscopic vision whereas 39 children were uncooperative.

In Table-2.2 illustrates that 272 (52.61%) children had stereo acuity of 40 seconds of arc and 389 (74.88%) children had 60 seconds of arc or less. Based on age distribution of stereo acuity, 307 (74.33%) of 5 years old children and 54 (79.41%) of 6 years old had stereo acuity of 60 seconds of arc. Additionally, the average stereo acuity of pre-school children of 4 – 6 years old in second grade of kindergarten schools (TK B) was 75.17 seconds of arc.

A study by Tatsumi and Akira (1972) using Fly Test, found that the average stereo acuity of 4 years old children was 100 seconds of arc. Furthermore, Amigo et al., reported average stereo acuity of 167, 102 and 30.5 seconds of arc, respectively. In this study the average stereo acuity of 58.18 in 4 years old children was similar to the study by Heron et al. Among 5 years old children, Tatsumi and Akira (1972) by using stereo Fly Test and Romano (1975), reported similar stereo acuity of 100 seconds of arc. In addition, Amigo et al., Cooper et al, and Heron et al., reported stereo acuity of those children of 167, 102 and 30.5 seconds of arc, respectively. When comparing the study by Tatsumi and Romano, and this study, there was similar average stereo acuity of 79.86 in 5 years old children. Using stereo Fly Test, Cooper et al. and Heron et al. reported average stereo acuity of 94 and 29.5 seconds of arc in 6 years old children, respectively, this study reported 55.55 seconds of arc.

Furthermore, this study also reported binocular vision among children having visual acuity 6/6. Table-3 describes 89 of 520 children had visual acuity 6/6 on the left and right eye. Also, 64 (71.91) children had stereo acuity of 40 seconds of arc and 83 (93.26%) children had 60 seconds of arc or less. Only 2 children reported uncooperative. These results indicated that most of the children having optimum visual acuity of 6/6 (93.26%) had normal binocular vision i.e. the stereoscopic acuity of 60 seconds of arc or less. Only 6.74% of pre-school children in second grade of kindergarden schools (TK B) had stereoscopic acuity of more than 60 seconds of arc (have not had normal stereoscopic acuity) even though they had visual acuity 6/6 which indicating normal and fusion. The reason for this was their stereoscopic acuity remain in the stage of evolving as supported by Reading RW that the stereoscopic acuity of 5 – 8 years old children are still in the stage of evolving or the possibility of subnormal binocular vision (Monofixation syndrome).

CONCLUSION

To sum up, the current study reported:
1. The average stereo acuity of 4 – 6 years old pre-school children in second grade of kindergarden school (TK B) was 75.17 seconds of arc.
2. Those children having stereo acuity of 60 seconds of arc or better was 74.88%. This result indicated that most of them had normal or better binocular vision.
3. 93.26% of those children having optimal visual acuity 6/6 had normal stereo acuity of 60 seconds of arc or better.

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