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Short Communication

Preschool children medium-long distance stereoscopic vision testing

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SUMMARY

To test preschool children's medium- long distance stereoscopic vision normal average value, and intermittent strabismus children,s medium-long distance stereoscopic vision acuteness is the goal of this study. The software of random stereoscopic vision and graph, which is developed by Hu-Chong etc has been used, to test 414 cases normal preschool children and 19 cases intermittent exotropia childrens medium-long distance (1-5 m) stereoscopic vision (before operation and after operation). The normal average value of preschool children's medium-long distance stereoscopic vision was achieved. Intermittent exotropia children's stereoscopic vision acuteness was declined with the increase of distance. This method can provide reference as screening abnormal stereoscopic vision during scientific research and clinical work.

Key words: Preschool children; Distance; Stereoscopic vision

Stereoscopic vision is the highest form of visual sense, an advanced testing method of vision function (岩田美雪 and 粟屋忍, 1987), and the important direction to screen strabismus or amblyopia. To choose the best operation time, the treatment has been evaluated (Huang and Hu, 2001). At present, vision research is still in the developing period of visual method (Meng, 1988). We used the graph and random stereoscopic vision software to test 433 cases of children's medium-long distance stereoscopic vision including normal group and exotropia group.

Normal group (normal preschool children): From December 2000 to December 2001, we used random sample to choose 414 cases of preschool children whose eyesight is normal, not squint, not illness in six shenzhen kindergartens (eyesight: 3-year old ≥ 0.5, 4-year old ≥ 0.6, 5-6 years old 1.0). Boys were 206 cases (49.76 %), and girls were 208 cases (50.24%) among them. Squint group (Intermittent exotropia): From December 2001 to March 2002, we treated 19cases of intermittent exotropias children ranging from 4-year old to 12-year old. Among them, boys were 12cases (63.84%), girls were 7 cases (36.84%).

Testing methods were as follows. International standard sight form to test long sight was utilized to test eyesight. Corneal reflection method with triple prism was utilized to test squint degree of near and far. Covering testing, eyeball movement and synoptophore were combined to test squint angle, AC/A ratio and retinal correspondence. According to 1987 national amblyopia, strabismus prevent group laid down the standard to diagnose and classify. Routine examination with slit-lamp and funduscope etc were used to eliminate ophthalmopathy. Titmus and TNO stereoscopic graph were used to test the sharpness for short-distance stereoscopic vision testing. "Association" computer equipped with resolution nation of 640×480 and 15 inches color indicator was used for medium-long distance stereoscopic vision testing. Graph and random stereoscopic vision software were used. Stereoscopic sharpness was in between 15-625 arc ("). Parallax will be adjusted with 1-8 scope. Divisions of the oculi axes with red and green spectacle were tested respectively between 1-5 m. The person who is tested should distinguish the minor parallax of graph and random stereoscopic concavo-convex. Then with the testing distance and parallax range, we can calculate stereoscopic vision arc (").

As a result, in short-distance stereoscopic vision testing of normal group, there was marked difference

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Table 1. Age and TNO (case)

Age	15"	30"	60"	120"	240"	480"	Total
cp	2	8	60	21	3	2	96
3 ncp	2	4	50	34	3	3	96
cp	5	3	68	20	3	1	100
4 ncp	5	4	51	38	2	-	100
cp	2	9	67	19	3	-	100
5 ncp	5	1	6	73	18	2	100
cp	2	12	89	15	-	-	118
6 ncp	1	5	92	19	1	-	118

Table 2. Age and stereoscopic vision (case)

Age	40"	50"	60"	70"	80"	100"	200"	400"	Total
3	63	19	13	-	-	-	-	-	96
4	74	11	11	1	1	1	1	-	96
5	81	4	9	-	5	1	-	-	100
6	92	18	4	-	4	-	-	-	118
Total	310	52	37	1	10	2	1	1	414

($P \leq 0.001$) between different age. In stereoscopic vision, 72.9% of 3-year old and 87.3% of 6-year old belong to normal scope (Table 1). In stereoscopic sharpness 98.90% of 3-year old was the normal scope in Titmus testing (Table 2). In graph stereoscopic vision testing (GST), the percentage of passing (1-5 m) parallax was shown in Table 3. In random stereoscopic vision testing (RST), the percentage of passing (1-5 m) parallax was shown in Table 4. Using GST and RST, normal children standing between 1 m to 5 m could pass 78", so that they could reflect the minor vision sharpness of different distance (for example, the stereoscopic average value).

In squint group, short-distance stereoscopic vision before and after operation was shown in Table 5. There was no marked difference between the before operation and the after operation ($P \geq 0.05$). In long-distance stereoscopic vision, the passing percentage of 78" people before and after operation was shown in Table 6. After operation, in between one to two weeks, within 1-5 m, most of the sick have apparent improvement than before.

In addition, comparison between normal group and squint group (before operation) was performed. There was no marked difference in short-distance stereoscopic vision sharpness ($P \geq 0.05$). But there is marked difference in long-distance stereoscopic vision sharpness ($P \leq 0.05$). As a clinical feature, stereoscopic vision sharpness was reduced by

Table 3. GST distance and parallax (case/%)

Distance (m)	1	2	3	4	5	6	7	8	Failure
1 cp	409(98.8)	5(1.20)	-	-	-	-	-	-	-
ncp	403(97.34)	8(1.93)	1(0.24)	-	-	-	-	-	-
2 cp	376(90.82)	31(7.49)	5(1.20)	2(0.48)	-	-	-	-	-
ncp	355(85.07)	49(11.84)	8(1.93)	2(0.48)	-	-	-	-	-
3 cp	318(76.81)	68(16.42)	19(4.11)	5(1.20)	3(0.27)	1(0.24)	-	-	-
ncp	267(64.49)	103(24.88)	26(6.28)	13(3.14)	3(0.72)	1(0.24)	1(0.24)	-	-
4 cp	243(58.70)	112(27.05)	27(6.25)	10(2.42)	8(1.93)	5(1.20)	1(0.24)	1(0.24)	1(0.24)
ncp	166(40.09)	153(36.96)	53(12.8)	20(4.83)	12(2.90)	5(1.20)	2(0.48)	-	3(0.72)
5 cp	161(38.89)	150(32.23)	50(12.08)	25(6.03)	18(4.34)	6(1.45)	3(0.72)	1(0.24)	-
ncp	87(21.01)	163(39.37)	78(18.84)	39(9.42)	19(4.59)	7(1.69)	5(1.20)	5(1.20)	11(2.66)

Table 4. RST distance and parallax (case/%)

Distance (m)	1	2	3	4	5	6	7	8
1 cp	414(100.0)	-	-	-	-	-	-	-
ncp	414(100.0)	-	-	-	-	-	-	-
2 cp	412(99.52)	1(0.24)	1(0.24)	-	-	-	-	-
ncp	412(99.52)	1(0.24)	1(0.24)	-	-	-	-	-
3 cp	396(95.62)	17(4.10)	2(0.48)	-	-	-	-	-
ncp	386(93.24)	26(6.28)	1(0.12)	-	-	-	-	-
4 cp	355(85.75)	54(13.04)	3(0.72)	2(0.48)	-	-	-	-
ncp	340(82.12)	67(16.18)	6(1.45)	20(4.83)	1(0.24)	-	-	-
5 cp	308(74.40)	91(21.98)	13(3.14)	2(0.48)	1(0.24)	-	-	-
ncp	271(65.46)	124(29.95)	16(3.86)	2(0.48)	-	-	-	-

Table 5. Titmus and TON stereoscopic vision (case)

Arc(")	Titmus		TON	
	Before operation	After operation	Before operation	After operation
30	5	5	3	4
60	11	11	13	13
120	2	-	1	1
240	1	3	2	1

Table 6. Every distance of before and after operation passing 78"(case/%)

Distance(m)	Before operation		After operation	
	cp	ncp	cp	ncp
1	17(9.47)	17(89.47)	19(100.00)	18(94.47)
2	17(89.47)	17(89.47)	19(100.00)	16(84.21)
3	16(84.21)	15(78.95)	18(94.74)	18(94.74)
4	15(78.95)	14(73.68)	18(94.74)	18(94.74)
5	14(73.68)	12(63.16)	18(94.74)	18(94.74)

distance increasing.

There is an argument in stereoscopic vision's mature age. It is believed that with age's growing, stereoscopic vision will grow and become mature. In different period, the growing speed of stereoscopic vision is different. And the results which are tested in different measures are not the same (Ciner, 1989 and 1991). 水上·彦 used TV-Random Dot Stereo Test to measure infant's stereoscopic sharpness, and it showed stereoscopic vision growing start from 3-to-4-month-old baby, it grows rapidly after one-year-old. Nearly 6-month-old baby, the stereoscopic vision sharpness is 1715". From 2.5-to-3-year-old infant, is 567" (水上·彦 *et al.*, 1990). Walsh and Hoyt thought stereoscopic vision has completely set up at the age of 5. Partes thought it becomes at the age of 7. Romano uses Titmus to show that from 2-to-9-year-old, stereoscopic grows slowly but steadily, and it becomes normal at the age of 9 (Romano and Romano, 1975). Simons believes 5-year-old children's eyesight functions don't grow mature (Simons, 1982). Guo-jingqiu etc believe stereoscopic vision grow mature before 3-year-old (Guo, 1993). Williams proved between 7-year-old and 9-year-old, there is improvement in stereoscopic vision; between 9-year-old and 11-year-old, there is no clear change and there is no marked difference with adults (Williams *et al.*, 1988). With Titmus, we discovered that stereoscopic vision has grown mature at age of 3; With TNO, we discovered that it is growing but not matured completely from 3-to 6-years old.

According to the testing distance, we divided stereoscopic vision into short-distance and long-distance. Short-distance refers to 30-50 cm, long-distance refers to 5-6 m, medium-distance refers to 1-4 m. Short-distance stereoscopic vision testing is

very similar with the eyesight testing, but has different mechanism. Short-distance stereoscopic vision is an active one which participate in adjusting and converging pupil reaction. Long-distance stereoscopic vision is an inactive one which doesn't use accommodation and convergence. With the change of testing distance, medium-distance stereoscopic visions accommodation and convergence will reflect the quantity difference more precisely (Liu and Yan, 1995; Liu and Feng, 1996). As normal persons accommodation and convergence are healthy, when he or she looks far away, his or her eyes are still in the right position, so his or her short, medium, long distance stereoscopic vision are almost the same. Moreover, stereoscopic vision testing is important to those whose eyesight function is abnormal. In recent years, people in nation or abroad notice most intermittent strabismus short-distance stereoscopic vision is normal, but long-distance stereoscopic vision is not good. Away point out, as we known, though intermittent strabismus's short-distance stereoscopic vision is good, long-sight stereoscopic vision will turn dominant squint and it will not stereoscopic vision. Long-distance stereoscopic will be a study subject in the future (丸尾敏夫 1995). At present, most of the time, we used synoptophore to test long distance stereoscopic vision in clinical. It divides the eyes under unnatural condition, so it can't measure phoria and exotropia person's stereoscopic function (矢崎悌司, 1993). Therefore, we designed and used GST and RST to seek a suitable medium-long distance testing way of intermittent squint.

It is designed and controlled by computer. Parallax can be adjusted within 1-8 scope. GST is sensitive and RST overcomes single eye clue. It can distinguish stereoscopic cross-parallax and not-cross-parallax. It is easy to use, not fade, wear and tear. It has got interesting character. It suits for 3-year-old children or above. Many clinical cases can be tested by it.

We study GST and RST medium-long distance stereoscopic testing, there is no clear difference of passing 78" percentage (it is the same as the former study). It can illustrate normal childrens stereoscopic vision sharpness doesn't change with the increase of testing distance. From the experiment, we got the normal average value of children's stereoscopic sharpness at each distance. It can provide the reference as the screen of abnormal stereoscopic vision during scientific research and clinical working. In our point of view, medium-long distance stereoscopic vision plays an important role in studying children's accommodative esotropia, intermittent exotropia and other unfixed strabismus.

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