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The impact of attention training on children with low vision: a randomized trial

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Aim: The purpose of this study was to show the effectiveness of a 6-week attention training program on the cognition, quality of life (QOL), and activities of daily living in children with low vision.

Materials and methods: Included in this study were 20 children with low vision, aged 7–12 years. The children were divided into 2 groups. While the first group (n = 10) participated in a 6-week Pay Attention© training program 3 times a week for 30 min, the second group (n = 10) was the control. Before and after the program, all of the participants were evaluated using a modified child Mini Mental State Examination (MMSE), the Northwick Park Index of Independence (NPI), and the low vision QOL (LVQOL) questionnaire.

Results: After 6 weeks, while significant differences in the outcome measurements were observed in the trained children ($P < 0.05$), the children in the control group had no significant differences ($P > 0.05$). Some differences between the groups were significant in favor of the trained children ($P < 0.05$). In the trained children, significant differences were found in terms of the MMSE, NPI, and LVQOL ($P < 0.05$).

Conclusion: The results obtained from this study show that the attention training program improves cognitive function, independence in activities of daily living, and the QOL of children with low vision.

Key words: Low vision, cognition, attention, activities of daily living, quality of life

Introduction

In children, poor vision means impaired visual performance as a result of impaired visual acuity and contrast sensitivity, visual field defects, and other related dysfunctions (1,2). Visual performance is severely impaired in a child with poor vision and cannot be corrected with medical, surgical, or accessory tools such as loupes (2). Visual acuity should also be examined using valid charts (3).

Cognition refers to mental processes (4). These processes involve attention, memory, language, problem solving, decision making, planning and organization, abstract thinking, conception, and mathematical abilities (5).

The development of cognition in a visually impaired person differs from that of an individual with normal visual ability. That difference is affected by both individual factors (functional eye sight, prematurity, and additional handicaps) and environmental factors (6). Severely impaired vision is one of the principal factors that delay the neural development in early stages. It was reported that this delay affected several important areas of neural development, such as cognitive skills, linguistic skills, and social relationships (7). Additional problems such as developmental stagnation, regression, and autistic disorders are also reported in many visually handicapped children (8).

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Young children with normal vision touch the objects around them as they are seen. However, in many cases, the environment of a child with severely impaired vision is cleared of such objects to avoid self-injury. Therefore, these children gain less experience than their peers with normal visual function. This situation causes a decline in their intellectual growth rates (9). Dekaban noted MRI abnormalities in 10 of 13 children with retinal dystrophy and various neurologic complications in 8 of them (10).

The ability to see has a fundamental role in the progression of the cognitive process. The cognitive process is affected by sensorial and visual information. This influence occurs predominantly in the advanced stages of development (11). Tadic et al. demonstrated the association of the ability to see with cognitive skills and with specific functions of attention such as realization, sustaining, and dividing among children with congenital blindness (12). Sohlberg and Mateer noted that attention was a hierarchical model. The essential step of this hierarchical model is to focus on a stimulus and be able to sustain attention on that thing over a long period of time. The frontal area of the brain possesses a special ability to realize this hierarchic function of attention (13).

There are several screening tests used for neurophysiologic examination to search for developmental restrictions among children. These tests usually cover a narrow field in terms of age range and cognitive functions. There are numerous test batteries assessing cognitive disorders; however, they generally take a long time to be performed. Hence, simple screening tests are needed that are able to comprehensively assess the cognitive functions in children within a short period of time and to recognize superior cognitive disorders in early stages. The Mini Mental State Examination (MMSE) has been modified by several researchers to evaluate the cognitive functions of children 4 years of age and older (14). Currently, there is no valid, reliable, standard test specifically developed to assess the cognitive functions of children having different levels of visual loss.

Visually impaired children must gain sufficient information to function independently at home, at school, and in the outside world. Educational programs should focus on introducing and promoting independent life knowledge. A visually impaired child should be educated by a special rehabilitation team about daily life activities, e.g., personal hygiene, nutrition, care, preparing food, and shopping (15).

Impaired vision is a process that affects the quality of life (QOL) of both the child and his or her family throughout their life-spans. This process also intensely affects the growth and education of the child, caregiving family members, and professionals. An assessment of QOL provides important information for clinical interventions. It is well known in adults that impaired vision affects QOL in a negative way; however, little information is available about the effects of impaired vision in children (16). There are numerous questionnaires for the evaluation of the QOL of visually impaired individuals; however, there is no QOL questionnaire with verified validity and reliability for elementary school children (17–19). In this study, the low vision QOL (LVQOL) questionnaire, which is a tool widely used in order to assess the QOL of children with low vision worldwide as well as in Turkey, has been used to assess QOL of the participants.

Our study was planned to evaluate how the special education for attention affects cognitive functions, daily life activities, and QOL among children with low vision.

Materials and methods

To determine the cause of their visual impairment and presenting visual acuity, 80 children with visual impairment were examined by an ophthalmologist. After the examination, 39 children were diagnosed with low vision. Only 20 children accepted the offer to participate in this study and they were included in this study. Accordingly, the visual acuity as found by Snellen chart were as follows: 4 children with low vision had visual acuity of 40/200, 5 children with low vision had visual acuity of 20/200, 7 children with low vision had visual acuity of 10/200, and 4 children with low vision had visual acuity of 2/200. The children with low vision were recruited from a school for visually impaired children in Denizli, Turkey. The inclusion criteria for this study were:

1. Aged 7–12 years,
2. Having no neurological or orthopedic disorders,
3. Being diagnosed with low vision.

The study was approved by the ethical board committee of the Pamukkale University Medical Faculty (Ref no: 06.2; date, 03.06.2009) and was supported by the Pamukkale University Scientific Research Projects Foundation (Grant no: 2008SBE008).

Baseline measures, including the demographics of the children and visual diagnosis, were assessed and recorded before the assessment. The children included in the study were divided into 2 groups, the training group and the control group. The training group was trained with Pay Attention© training, which was applied 3 times per week at 30 min per session for 6 weeks. First, both groups were administered a modified child MMSE for cognitive functions, the Northwick Park Index of Independence (NPI) for activities of daily living (ADL), and the low vision QOL (LVQOL) for life quality. Next, a 6-week attention training program was introduced to the children in the training group. No intervention was implemented in the control group. At the end of the educational period, the same assessments were repeated in both groups.

Prior to the study period, the school administrators, teachers, and children were informed about the study and their verbal and written consents were received.

To eliminate the factors that might affect the results, such as reduced concentration or fatigue, the evaluation was done at different times, in a silent and quiet environment.

The cognitive functions of the children were evaluated with a modified child MMSE, adapted by Jain and Passi for children. This scale includes orientation, attention and concentration, sensorial perception, memory, and language subtests. It is introduced for children aged between 3 and 14 years. The orientation subtest consists of 3 main items, including place, time, and individual, and has a total of 12 questions. Its score is between 0 and 12. The attention subtest consists of 2 items, including counting forward and backward. Its score is between 0 and 7. The sensorial perception consists of 1 item for short-term memory. Its score is between 0 and 3. The memory subtest consists of 1 item, including recalling the objects asked. Its score is between 0 and 3. The language test has 6 items, such as expressing, realizing the act, and copying patterns. Its score is between 0 and 12. The time span to complete the test is 5 to 7 min (20).

To assess the ADL of children with low vision, the NPI was used. This index consists of 17 subtests: 1) transferring from the bed to the chair, 2) dressing, 3) bathing: in and out, 4) bathing: washing, 5) lavatory, 6) continence, 7) grooming: teeth, 8) grooming: other, 9) transfer off floor, 10) preparation of tea, 11) use of taps, 12) cooking, 13) feeding, 14) mobility (indoors), 15) stairs: up, 16) stairs: down, and 17) mobility (outdoors). Scoring of the NPI is as follows: 0 points mean total dependency, 1 point means partial dependency, and 2 points mean full independence. The highest score achievable from the whole test is 34 points (21).

The patients were administered the LVQOL. This questionnaire consists of 4 sections and 25 items. It involves questions relating to different phases of vision. The time span to complete the test is 5 to 10 min. It is a valid and reliable test (r = 0.72). It is performed with the answers of individuals to the questions of the survey (18).

1. Distance vision, mobility, and lighting: It includes 12 items assessing distance vision, mobility, and lighting in terms of QOL. The lowest score that can be achieved in this section is 0 and the highest point is 60.

2. Adjustment: It consists of 4 items assessing individuals' compliance with the visual problem in terms of QOL. The lowest score that can be achieved in this section is 0 and the highest point is 20.

3. Reading and fine work: This section consists of 5 items assessing reading skills and the capability of doing fine work. The lowest score that can be achieved in this section is 0 and the highest point is 25.

4. Activities of daily living: It includes 4 items relating to vision and daily living activities in terms of QOL. The lowest score that can be achieved in this section is 0 and the highest point is 20.

Training: A 6-week educational program was implemented 3 days a week for training attention function, a cognitive function parameter. The duration of each training session was planned to be approximately 30 min, according to the needs of the children. The Pay Attention program developed by Kerns et al. and Thomson et al. was used for training.

This is an attention training program developed for children aged 4–10 years (22,23).

The activities are designed systematically and sequentially depending on the age and cognitive level of the child. The Pay Attention program mainly aims to improve 4 attention parameters: sustained attention, selective attention, divided attention, and alternated attention.

To exercise each attention parameter, 4 tasks are used. Tasks are chosen from 1 or a maximum of 2 attention parameters. Three or 4 tasks in each attention component were used at the same time, but the number of these tasks could be reduced as part of 1 or 2 attention areas (sustained and selective attention). In the first task, family cards are presented and asked to be classified according to the orders. In the second task, children are asked to mark the commands found on the home warning cards. In the third task, family cards are demonstrated one by one to the child and he or she is asked to press the button in his or her hand as soon as he or she sees the answer to the command given. In the fourth task, the child is asked to press the button in his or her hand when he or she hears the command given while listening to a CD on the computer. The goal is to intensely motivate an attention component. Generally, it was used as an attention training program in the order of sustained attention to divided attention. When the child achieves 90%–100% accuracy after 3 sequential sessions, he or she has advanced to the next parameter of attention. The time concept becomes important, particularly for children decelerating to achieve accuracy. Finishing in a time span 20% shorter than the initial time in the 3 sequential sessions is a criterion for jumping to the next step.

Statistical analysis

Statistical analyses were performed using SPSS 13.0. Descriptive statistics were given as the mean ± standard deviation (SD) or percentage (%). The Wilcoxon test was used to detect differences between before and after the training program. The comparison of the groups was calculated using the Mann–Whitney U test statistical analyzing method. $P < 0.05$ was considered statistically significant.

Results

The physical characteristics of the children, including age, height, and weight, are shown in Table 1. Among the children with low vision who participated in the study, 5 had nystagmus (25%), 5 had retinitis pigmentosa (25%), 3 had myopia (15%), 3 had coloboma (15%), 2 had glaucoma (10%), 1 (5%) had optic atrophy, and 1 had the diagnosis of cataract (5%).

Given the results of the evaluation of cognitive functions, in the trained group, there was a statistical difference between the pre- and posteducation results achieved from the orientation points, language points, and total points for cognition and daily living activities tests ($P < 0.05$), while no difference was found in the control group ($P > 0.05$) (Table 2). When we compared the groups with each other, there was no difference between the groups before training and the groups were similar; however, after training, statistically significant differences were found in favor of the trained group in the orientation score, language score, and total score for cognition and daily living activities tests ($P < 0.05$) (Table 3).

When comparing the pre- and posttraining results of the evaluation of QOL, statistically significant differences were found in the trained group in the 1st subtest, the 4th subtest, and the total points ($P < 0.05$), while there was no difference in the control group ($P > 0.05$) (Table 2). When we compared the groups with each other, statistically significant differences were found in the 3rd subtest before training and in the 3rd subtest, 4th subtest, and total scores after training in favor of the trained group ($P < 0.05$) (Table 3).

Table 1. The physical characteristics of the children with low vision.

Physical characteristics	Group 1 (n = 10) X ± SD	Group 2 (n = 10) X ± SD
Age (years)	9.3 ± 1.05	10.4 ± 1.34
Height (cm)	133.2 ± 9.25	137.5 ± 6.96
Weight (kg)	30.0 ± 8.11	31.1 ± 6.99

Table 2. Comparison of cognitive functions, activities of daily living, and LVQOL results before and after training of children with low vision.

Cognitive functions	Group 1 (n = 10) (training group)		P	Group 2 (n = 10) (control group)		P
	Before training	After training		Before training	After training	
	mean ± SD	mean ± SD		mean ± SD	mean ± SD	
Orientation	9.2 ± 1.8	11.2 ± 1.4	**0.004**	8.2 ± 3.1	10.4 ± 1.8	0.414
Attention and concentration	6.7 ± 0.6	7.0 ± 0.0	0.180	6.1 ± 1.4	6.9 ± 0.2	0.593
Registration and sensory perception	3.0 ± 0.0	3.0 ± 0.0	1.000	3.00 ± 0.00	3.0 ± 0.0	1.000
Recall	3.0 ± 0.0	3.0 ± 0.0	1.000	2.9 ± 0.3	3.0 ± 0.0	0.655
Language	11.0 ± 1.1	11.7 ± 0.9	**0.038**	9.7 ± 2.7	10.2 ± 2.2	0.317
Total score	33.0 ± 2.9	35.7 ± 2.0	**0.012**	29.8 ± 6.9	30.6 ± 6.6	0.854
Activities of daily living total score	28.7 ± 3.2	32.0 ± 2.9	**0.005**	29.5 ± 3.0	29.8 ± 3.0	0.180
LVQOL						
Distance vision, mobility, and lighting	45.9 ± 5.9	48.3 ± 6.8	**0.007**	43.5 ± 7.7	44.0 ± 10.0	0.715
Adjustment	17.1 ± 3.6	17.6 ± 3.4	0.102	16.1 ± 3.8	16.2 ± 3.7	0.317
Reading and fine work	18.5 ± 4.5	19.1 ± 4.2	0.083	12.5 ± 4.9	12.9 ± 5.0	0.414
Activities of daily living	15.1 ± 2.5	15.8 ± 2.6	**0.038**	13.4 ± 4.6	12.3 ± 4.5	0.180
Total score	96.5 ± 11.5	101.2 ± 12.9	**0.005**	84.5 ± 12.7	84.4 ± 16.0	0.893

Discussion

The sense of vision has important roles in many areas of development and one of these areas is cognitive development (24). Although neurodevelopmental problems occurring after birth have been reported in visually impaired children, cognitive potential may initially be normal, but it may be suppressed because of developmental stagnation, regression, and autistic disorders (25). It has been noted that attention functions are of importance, particularly to realize school activities, in individuals with low vision, and the capacity of attention is at lower degrees among individuals with low vision and blind people in comparison with healthy children (25,26).

Quintana highlighted the importance of attention for cognitive functions and noted that auditory impulses contributed to focus attention, activating memory (27). Neimann et al. (28), Sohlberg and Mateer (29), and Sohlberg et al. (30) reported that stimulation of the attention system eased changes in cognitive capacity and that repetitive activities and stimulation of the attention system might lead to changes in cognitive capacity. We preferred using the Pay Attention training set, since it consists of auditory stimuli and the stimuli used for training include repetitive activities.

In the literature, there are studies highlighting the fact that superior cognitive functions such as attention and memory are affected in children with low vision and blind children. However, the lack of any research about training these functions led us to ascertain the effects of attention training using the Pay Attention training set on cognitive functions, daily living activities, and QOL among children with low vision.

In a review, Penkman noted that the Pay Attention training set was used in children who had traumatic brain injuries, attention deficit disorder, hyperactivity disorder, and central nervous system tumors (31).

Kerns et al. divided a group of 14 children, aged between 7 and 14 years who were diagnosed with attention deficit and hyperactivity syndrome, into 2

Table 3. Comparison of cognitive functions, activities of daily living, and LVQOL of the groups.

Cognitive functions	Before training comparison of the groups		After training comparison of the groups	
	z	P	z	P
Orientation	−0.499	0.617	−2.146	**0.032**
Attention and concentration	−0.797	0.426	−1.826	0.068
Registration and sensory perception	−1.000	0.317	−1.000	0.317
Recall	−1.000	0.317	−1.000	0.317
Language	−0.957	0.338	−1.996	**0.046**
Total score	−0.569	0.569	−1.985	**0.047**
Activities of daily living total score	−0.801	0.423	−2.014	**0.044**
LVQOL				
Distance vision, mobility, and lighting	−0.644	0.520	−0.797	0.425
Adjustment	−0.619	0.536	−0.815	0.415
Reading and fine work	−2.427	0.015	−2.390	**0.017**
Activities of daily living	−0.886	0.376	2.031	**0.042**
Total score	−1.740	0.082	−2.195	**0.028**

subgroups using the random sampling method, and the authors trained 1 of these subgroups using the Pay Attention program. The authors implemented the training program as 2 sessions of 30 min per week for 8 weeks; thus, the children attended a total of 16 sessions of treatment. The authors reported that the attention measurements of the treated children were increased and there was a significant increase according to the trainers' attention ratings (22).

In the present study, the Pay Attention training set developed by Kerns et al. was implemented for children with low vision as 30-min sessions 3 days a week for 6 weeks, for a total of 18 sessions. Orientation, language, and total scores significantly differed after training in the trained children with low vision and between the groups. These results demonstrated that the Pay Attention training set might improve cognitive functions in children with low vision. We think that the lack of changes in the other parameters, particularly in the attention subtest, results from the fact that the evaluation test is a universal test and is developed specifically for children with attention deficit and hyperactivity syndrome. However, the improvement seen in the total points of cognition and other subtests with the use of the Pay Attention training suggests that it is a good and important training set to ameliorate the cognitive functions of children with low vision. Our advice is that the visual stimulus cards of the Pay Attention training set might be modified with adaptations such as contrast and magnifying that are specific to children with low vision. Furthermore, the auditory stimulus included in the Pay Attention training set to improve attention is another important factor in choosing this set.

The fact that visually impaired persons and fully or almost fully blind people have insufficient visual stimuli creates difficulties in their daily living activities (32). It has been observed that children with low vision are more independent in daily routines than blind children (33). With occupational treatments and home treatment approaches, the daily living independence of children with low vision can be enhanced (34). The results of our study suggested that attention training ameliorated the level of independence, enhancing participation in the daily living activities of children with low vision. The outcomes related to daily living activities contributed to self-confidence and independence in daily routines, increasing the children's awareness of their environments and their capacity of focusing attention on their school work after the attention training.

In studies conducted, it was demonstrated that the level of QOL of individuals with low vision is lower than that of visually normal people, and with rehabilitation approaches for persons with low vision, the level of QOL can be improved (17,18). Comparing children with low vision with fully or almost fully blind children, Atasavun noted that the level of QOL of children with low vision was better than that of fully or almost fully blind children, because of their remaining capacity to see (32). Atasavun also argued that cognitive training should be integrated into other training and treatment approaches to improve the QOL of children with low vision (35).

In our study, after attention training with Pay Attention, significant improvements in QOL were seen in the subtests, except in the second subtest involving the compliance of the individual with vision. Moreover, the total score and ADL subtest showed significant differences when we compared the groups with each other. This result demonstrated that attention training contributed to QOL in a positive way. An individual with a high level of attention becomes more alert to the events occurring in his or her environment and his or her awareness is increased. Implementation of specific training to improve the attention function of children with low vision in the treatment program supports the QOL of the children.

As a result of our study, it was observed that improvement of the attention function of children with low vision using the Pay Attention training set resulted in advances in cognitive functions, independence in daily living activities, and an increased level of QOL. It is convenient for improving the attention function of children with low vision that the Pay Attention training set includes auditory stimulus as well as visual stimulus cards. However, rearranging the visual stimulus cards, particularly for individuals with low vision, in terms of contrast and magnifying makes this training set more useful for these children. We think that the physiotherapist, family, teachers, and other specialists should collaborate for education to improve the cognitive functions of visually impaired children and that there is a need for technological auxiliary tools specifically developed for children with low vision.

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