EFFECTS OF A REMEDIAL PROGRAM ON VISUAL-MOTOR PERCEPTION IN SPINA BIFIDA CHILDREN*1

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SUMMARY

Most studies dealing with spina bifida children concentrate on medical or physical factors, largely ignoring any psychosocial and educational consequences. The present study assessed the effect of a remedial program on visual-motor perception in spina bifida children. Thirty-six spina bifida boys and girls (mean age 82.87 months) with a myelomeningocele and an associated hydrocephalus were assigned randomly to either a control, attention-placebo, or experimental group. Following the administration of the Frostig Program for the Development of Visual Perception, the experimental group significantly improved on a global index of visual perception and the five subtests of Frostig’s Development Test of Visual Perception; at a maintenance test two months later, all treatment gains (except on the visual spatial perception subtest) were still evident. These results are discussed in terms of the provision of remedial education for spina bifida children, and a possible cognitive mechanism mediating the behavioral change in the experimental group.

A. INTRODUCTION

Spina bifida children have typically been shown to be of below-average intelligence (12, 16, 23). Nonetheless, the utility of such information may be severely limited. Reynell (20) points out that predictions regarding such

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1 Based on the senior author’s Master’s dissertation submitted to the Faculty of Arts, University of the Witwatersrand; and conducted under the supervision of the second author. The authors express thanks to Mike Saling for statistical advice. Reprint may be obtained from the second author at the address shown at the end of this article.
children's school progress made on the basis of a single IQ score may mask a variety of subtle learning difficulties. Indeed, it has been demonstrated that while some spina bifida children may be of normal intelligence, there is a general tendency for these children to have a specific perceptual impairment.

Miller and Sethi (18, 19) and Dodds (5) both found that visual perception was retarded in hydrocephalics. More specifically, Dodds (5) demonstrated that figure-ground perception caused the most difficulty. These studies are suspect, however, since they did not distinguish between children with or without spina bifida; any generalizations to such populations would therefore be hazardous. Spain (23) and Tew (24) investigated perceptual functioning specifically in spina bifida children. They found that although there was a general perceptual deficit, visual-motor coordination manifested the most consistent and particular perceptual impairment in all instances.

A deficit in visual-motor perception has a number of concomitant incapacitating effects. First, children with such perceptual deficits have difficulty in recognizing objects and their relationships to each other in space. Since the world is then perceived in a distorted manner, it appears unstable and unpredictable to the child (9). Second, it also causes difficulties in carrying out many everyday activities, such as getting on a shirt (or blouse), fastening buttons, or catching a ball. Third, this perceptual deficit will affect academic learning, particularly arithmetic and writing, irrespective of the child's IQ. Fourth, spina bifida children with a visual-motor perceptual disability are subject to emotional disturbance (9); they may reveal character and behavior disorders which are at least partly the result of their perceptual problems. Finally, and possibly most importantly, these children begin to associate experiences of failure with school attendance and the process of learning. This in turn may lead to problems in relationships with teachers, parents, and peers.

Notwithstanding the fact that spina bifida children have been shown to evidence a specific visual-motor perceptual impairment (1, 21) and the behavioral and emotional consequences arising from this deficit, its psychological and educational implications have been largely ignored (8). This neglect is all the more serious, since both Field (7) and Tizard (25) maintain that there should be no doubt regarding the educability of these children. The present study therefore attempted to assess the effects of a remedial program on the perceptual functioning of spina bifida children. Such an empirical assessment is important, since any provision of educational services not based on empirically validated programs is necessarily inadequate (22, 25).
B. Method

1. Subjects and Setting

The sample consisted of 17 boys and 19 girls whose mean $IQ = 85.83$ ($SD = 16.42$) and mean age = 82.87 months ($SD = 22.58$) and who were diagnosed as spina bifida with a myelomeningocele by a multidisciplinary team at the Transvaal Memorial Home for Children. Only children who could respond to a verbal and a paper-and-pencil task were included. The children constituted three basic levels of education: viz., preschool ($n = 15$), grades 1 and 2 ($n = 9$), and grades 3 through 5 ($n = 12$). Of the 36 children, 18 were mobile (albeit with the use of crutches and/or calipers), the rest ($n = 18$) wheelchairbound. Ten suffered from ocular defects, and 24 had undergone shunt surgery.

Testing for the Frostig Developmental Test of Visual Perception (DTVP) and the administration of the Frostig Program for the Development of Visual Perception took place in familiar school surroundings with a minimum of distraction.

2. Instruments

Two sets of instruments were used. The DTVP (9) was used to assess the effects of the remedial program as it provides a global visual perception score, as well as information regarding five specific areas of visual perception. In subtest I, Visual Coordination, the task is to draw straight and curved lines between increasingly narrower boundaries or a straight line to a target. The second task, subtest II Figure-Ground perception, requires the child to discriminate between intersecting shapes and find hidden figures. In Form Constancy, subtest III, the child must discriminate circles and squares in different shadings, sizes, and positions among other shapes on the page. The task in subtest IV, Perception of Position in Space, is to differentiate between figures in an identical fashion and those in a reversed or rotated position. Finally, subtest V, Spatial Relationships, involves the copying of patterns by linking dots. The DTVP has proved valuable, since it facilitates identification of children requiring special perceptual training (17), and is a valuable clinical instrument whenever there is evidence of severe learning difficulties (10).

The Frostig Program for the Development of Visual Perception was administered as it has been favorably accepted for the education of learning disabled children (1). The program consists of five sets of work sheets (one for each of the subtests in the DTVP) divided into a series of three books.
graded according to difficulty. Learning sequences are broken down into small successive steps arranged so that the child can experience success. Whenever the child experiences difficulty, the teacher modifies the step to render it easier for the child. Inherent in this program is the assumption that the child whose perceptual skills have been developed is free to benefit from instructions and learn independently.

3. Procedure

Ss were randomly assigned to one of three groups (with an equal number of Ss per group): viz., a control, attention-placebo, and experimental group. All Ss initially completed the DTVP which constituted the pretest measure. The Frostig Program for the Development of Visual Perception was then administered to the experimental group, and extended over a period of six months. Administration took place individually, twice weekly with each session lasting 30 minutes. A program was constructed to provide the attention-placebo group with a stimulating environment, allowing them the same exposure to the E (the first author) that the experimental group had received. This semistructured program involved jig-saw puzzles, drawing, coloring, reading, and looking at magazines, and cutting out pictures from magazines. The control group received no experimental manipulation at all and were not seen by the E; they merely attended their regular classes.

The DTVP was then administered to all three groups following the completion of the program (the posttest). No S was then seen for a period of eight weeks, after which the DTVP was again administered, constituting the maintenance test. This was conducted to assess whether any treatment gains were maintained after withdrawal of Frostig's developmental program.

C. Results

One-way analysis of variance yielded no significant pretest differences between the three groups on any of the DTVP's subtests of the global perceptual index ($\rho > .05$).

Whenever an intervention takes place in a pretest-posttest experimental design, Huck and McClean (13) and Humphreys (14) have shown that a repeated measures analysis of variance is not the appropriate statistical technique. Rather, an analysis of covariance with the pretest score as the covariate is the correct analytic method. This covariance analysis revealed that the three groups differed on all five subtests and the global perceptual score at posttesting. Significant differences were also found between the three groups on subtests I, II, III, and V and the global score at maintenance testing (see Table 1). One-tailed $t$ tests for adjusted means (6) revealed that

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the experimental group differed significantly from both the attention-placebo and control groups on all subtests at the posttest and maintenance (see Table 1). For subtest IV, however, the experimental group only differed significantly from the control group; all other differences were not significant. The mean perceptual scores for the five subtests for the three groups at pretest, posttest and maintenance are depicted in Table 1.

D. DISCUSSION

During pretesting, the mean perceptual quotients (PQ) for the control, attention-placebo, and experimental groups were 78, 83, and 85, respectively, indicating general perceptual impairment. The experimental group received a mean posttest PQ of 94 which reflects normal perceptual functioning, since it has been suggested that a score below 90 reflects perceptual impairment below which children are unlikely to learn to read if taught mainly by visual methods (17). The mean PQ’s of the attention-placebo (PQ = 84) and control (PQ = 77) groups were still well below the norm for the DTVP. The significant between-group differences suggest that the improvements in perceptual functioning in the experimental group may be attributed to the administration of the program.

The adjusted mean scale score for the three groups on subtests I, II, III, and V also revealed that there were significant group differences at posttesting and maintenance testing when the experimental group was compared to the attention-placebo control groups, with the experimental group evidencing a significant improvement (see Table 1). That there was no significant improvement in visual spatial perception (subtest IV) might be a function of this sample’s physical handicap; 18 of the children had minimal physical handicaps (e.g., necessitating the use of crutches or calipers), while the remaining 18 were wheelchair-bound. As awareness of one’s body is fundamental for this particular area of perceptual functioning, any paraplegia must necessarily result in a limited degree of sensation and also body awareness; thus it may be that physical handicap had a greater prior effect on performance for this perceptual task (26).

Visual-motor perceptual dysfunction, held to be a principal and consistent area of difficulty in spina bifida children (1) was observed within the present sample (2). This dysfunction was reduced as a result of the administration of Frostig’s remedial program for visual-motor perception. Two implications follow. First, children with spina bifida may profit from early visual perceptual assessment, especially before they begin school (4). This is important, since it has repeatedly been shown that if long-range improvements in the child’s cognitive functioning are to be effected, the earlier remediation starts,
### TABLE 1
**Data from Analysis of Covariance, t tests for Adjusted Means, and Changes in Perceptual Score**

<table>
<thead>
<tr>
<th>Test</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<tr>
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<tr>
<td>Posttest</td>
<td>20.24***</td>
<td>30.05***</td>
<td>8.02***</td>
<td>3.24*</td>
<td>3.28*</td>
<td>63.30***</td>
</tr>
<tr>
<td>Maintenance</td>
<td>7.71**</td>
<td>10.79***</td>
<td>6.94**</td>
<td>1.40</td>
<td>6.08**</td>
<td>19.74***</td>
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<tr>
<td><strong>t statistics</strong></td>
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<tr>
<td>Posttest</td>
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<tr>
<td>Experimental vs. Control</td>
<td>4.83*</td>
<td>5.72*</td>
<td>3.67*</td>
<td>2.32*</td>
<td>2.18*</td>
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<tr>
<td>Experimental vs. Attention-Placebo</td>
<td>3.66*</td>
<td>4.19*</td>
<td>2.47*</td>
<td>.26</td>
<td>2.16*</td>
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<tr>
<td>Experimental vs. Control</td>
<td>3.52*</td>
<td>12.28*</td>
<td>3.30*</td>
<td>.42</td>
<td>2.41*</td>
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<tr>
<td>Experimental vs. Attention-Placebo</td>
<td>2.39*</td>
<td>5.88*</td>
<td>2.74*</td>
<td>1.62</td>
<td>2.39*</td>
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**Changes in perceptual score**

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
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<th>Maintenance</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Maintenance</th>
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<tr>
<td>Posttest</td>
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<td>75</td>
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<td>68</td>
<td></td>
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<tr>
<td>Pretest</td>
<td>68</td>
<td>57</td>
<td>82</td>
<td>64</td>
<td>73</td>
<td></td>
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<tr>
<td>Maintenance</td>
<td>70</td>
<td>58</td>
<td>82</td>
<td>70</td>
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<td><strong>Attention-Placebo group</strong></td>
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<tr>
<td>Pretest</td>
<td>68</td>
<td>61</td>
<td>77</td>
<td>62</td>
<td>67</td>
<td></td>
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<tr>
<td>Posttest</td>
<td>76</td>
<td>64</td>
<td>86</td>
<td>69</td>
<td>72</td>
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<tr>
<td>Maintenance</td>
<td>79</td>
<td>69</td>
<td>86</td>
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<tr>
<td><strong>Experimental group</strong></td>
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<tr>
<td>Pretest</td>
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<td>55</td>
<td>76</td>
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<td>63</td>
<td></td>
</tr>
<tr>
<td>Posttest</td>
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<td>74</td>
<td>92</td>
<td>75</td>
<td>76</td>
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<td>67</td>
<td>92</td>
<td>71</td>
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</tbody>
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* *p < 0.05.*
** **p < 0.01.*
*** ***p < 0.001.*
the better (10, 11). Second, special training techniques which assist the child to correct this specific perceptual impairment may also be of benefit in enhancing the child's intellectual potential, thereby increasing his chances of coping (7).

Improvement in performance in the experimental group may thus generally be attributed to the implementation of the remedial program. More specifically, however, Bandura (2) and Bandura, Adams, and Beyer (3) postulate that an individual's self-efficacy expectation may mediate behavior change. In the present study, children's self-efficacy may have increased as a result of repeated performance accomplishments during the administration of the program. A cognitive mechanism might therefore mediate the behavior change. Since children generally work at their own speed while completing the program, some Ss complete more material than others. Future research might therefore specifically investigate this issue; a positive relationship between the amount of work correctly completed and degree of perceptual improvement would provide some support for the role of perceived self-efficacy.

Kent and O'Leary (15) point out that programming specifically for maintenance and generalization of any treatment gains is an essential goal of any treatment program. Since perceptual functioning is held to be a central disorder in spina bifida children, it is important for future research to investigate whether improvements in this area generalize to others (e.g., intelligence). In addition, the results of the present study demonstrate that perceptual gains diminished marginally after a two-month period. Programs aimed at enhancing maintenance of any treatment gains are thus required. Administering such programs for a longer period may facilitate maintenance of treatment gains.

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