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Balance treatment ameliorates anxiety and increases self-esteem in children with comorbid anxiety and balance disorder

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ABSTRACT

Comorbidity between balance and anxiety disorders in adult population is a well-studied clinical entity. Children might be particularly prone to develop balance-anxiety comorbidity, but surprisingly they are practically neglected in this field of research. The consequence is that children are treated for what seems to be the primary disorder without noticing possible effects on the other disorder. In Study 1, children with balance dysfunction were compared to normally balanced controls on anxiety and self-esteem. In study 2, children with balance dysfunction were assigned to either balance training or a waiting-list control. Training consisted of 12 weekly sessions of balance treatment. Anxiety and self-esteem were tested before and after treatment/waiting. Study 1 confirmed significantly higher anxiety and lower self-esteem in the balance dysfunction group compared to the control group. Study 2 showed that treatment improved balance performance, reduced anxiety, and increased self-esteem relative to the control waiting list group. Taken together, the present findings are in accord with the observations of comorbidity between balance and anxiety disorders in adults and confirm their validity in children younger than 7 years of age. This profile of comorbidity between balance dysfunction and anxiety also include lower self-esteem.

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1. Introduction

Anxiety disorders represent the most common mental syndromes, occurring in about 5–20% of children (Bernstein, Borchardt, & Perwein, 1996; Pine, Cohen, Gurley, Brook, & Ma, 1998). One condition observed by parents, teachers, and professionals of these children is that of comorbidity between anxiety and balance dysfunction. However, this comorbidity is rarely conceptualized within an integrative diagnostic and therapeutic framework.

The vast majority of studies describing the comorbidity of balance dysfunction and anxiety have been conducted in adult populations. These studies revealed reduced balance control in persons with primary anxiety disorders (Jacob, Furman, Durrant, & Turner, 1996; Jacob et al., 1993; Sklare, Stein, Pikus, & Uhde, 1990; Yardley, Britton, Lear, Bird, & Luxon, 1995), or anxiety symptoms in individuals with primary balance disorders (Levinson, 1989a, 1989b; Yardley, 1994; Yardley et al., 1995). To our knowledge, only two studies documented these associations in children. We have demonstrated that 7 to 14-year-old children treated in psychiatric clinic for a primary diagnosis of generalized or separation anxiety disorder scored significantly lower than healthy control children on static and dynamic balance tests (Erez, Gordon, Sever, Sadeh, & Mintz, 2004). Also, higher incidence of fears was reported in a large sample of 7 to 18-year-old children with cerebellar-vestibular dysfunction relative to the expected rates in the general population (Levinson, 1989a). Given the qualitative nature of the later report, the first goal of the present study was to assess whether the co-occurrence of anxiety and balance dysfunction may also be observed in children with a primary diagnosis of balance disorder (Study 1).

Typically, the first line of treatment for anxious children referred to psychological or psychiatric treatment is cognitive behavioral therapy (CBT), administered alone or in combination with pharmacotherapy (Lyneham & Rapee, 2005; McClure et al., 2007). Such treatments are highly effective in ameliorating anxiety symptoms. Children who are referred to therapy because of balance dysfunction are effectively treated with sensory-motor oriented interventions typically administered by occupational or physical therapists (Humphries, Wright, Snider, & McDougall, 1992; Pless & Carlsson, 2000). Unfortunately, because the comorbidity between anxiety and balance difficulties is rarely the focus of diagnostic attention, these two treatment strategies are rarely coordinated. Specifically, psychological interventions hardly ever address children's balance difficulties, whereas occupational/physical therapies rarely apply systematic assessment and treatment of anxiety symptoms. Such a myopic vision of patient's symptoms and signs prevails in spite of a published neurological model that predicts that either of the two disorders may benefit from the treatment of the other (Balaban, 2002). The model takes into account the mutually excitatory relations between the balance-related systems gated by the brainstem parabrachial nucleus and the anxiety-related systems gated by the amygdala nucleus. Such closed-loop network has some interesting implications concerning the etiology and treatment of the balance-anxiety comorbidity. In terms of the etiology, the model implies that pathology at one of the nuclei can derange the activity of the entire network. Specifically, comorbidity may arise due to chronic anxiety that impairs the balance function or due to chronic imbalance that triggers anxiety. In terms of the treatment, the model implies that normalization of the entire network will follow a treatment directed at the primary disorder. Based on this prediction, the second goal of the present study was to test the effect of a structured balance treatment on anxiety symptoms in children with a primary diagnosis of balance disorder (Study 2). In addition, low self-esteem in DCD children has been associated with both balance dysfunction (Cantell, Smyth, & Ahonen, 1994; Piek, Dworcan, Barrett, & Coleman, 2000; Schoemaker & Kalverboer, 1994) and anxiety (Weems, Costa, Watts, Taylor, & Cannon, 2007). We therefore predicted that low self-esteem may be associated also with the comorbidity between balance and anxiety and alleviated by successful treatment of the comorbidity.

2. Study 1

2.1. Methods

2.1.1. Participants

The balance dysfunction group consisted of 35 children (9 girls), mean age 5.8 years (range = 5.0–7.3), who were referred to public child-development clinics because of sensory-motor difficulties.

Inclusion criteria were successive referrals with a score below the clinical cutoff (less than 13.3) on the balance subtest of the Bruininks–Oseretsky test of motor proficiency (BOTMP; Bruininks, 1978), and no prior treatment. The control group consisted of 25 non-referred children (10 girls), mean age 5.8 (range = 5.0–7.0), who were free of balance dysfunction according to the BOTMP.

2.1.2. Balance measures

2.1.2.1. The balance subtest of the Bruininks–Oseretsky test of motor proficiency (BOTMP; Bruininks, 1978). This test assess directly children's performance and served also as inclusion criteria. It consists of eight items: standing on one foot on the floor with eyes open, standing on a balance beam with eyes open, and with eyes closed, walking on a line on the floor, and on a balance beam, heel-to-toe walking on a line, and on a balance beam, and stepping over a stick while walking on a balance beam. The BOTMP has age-related norms, demonstrates good internal consistency (α = .81), and moderate test–retest reliability (α = .56). Higher scores indicate better balance control.

2.1.2.2. Vestibular processing scale of the Sensory Profile Questionnaire (Dunn, 1999). This 11-item parent-report questionnaire provides measure of children's vestibular processing abilities. It was applied to confirm that the dysfunction has socially notable presence. Items are scored on a 0–5 scale, with higher scores representing better performance.

2.1.2.3. Southern California Post Rotary Nystagmus Test (SCPNT; Ayres, 1972). Following Levinson (1989a), we monitored nystagmus as a direct measure of vestibular dysfunction. In this test, the child sits on a rotating board, with their head tilted forward at 30°. The experimenter spins the child 10 rotations over a 20-s period, and then abruptly stops the motion. The child is instructed to lift his/her head and gaze forward. Duration of nystagmus (rapid involuntary rhythmic eye movements) is recorded as an index of vestibular function. Children were first rotated counter clockwise, and after 10 min break, were rotated clockwise. The two nystagmus durations were summed, and abnormal nystagmus was noted as a score either below or above one standard deviation from the age and gender standardized mean. The test–retest coefficient of the SCPNT is .85.

2.1.3. Anxiety and self-esteem measures

2.1.3.1. Fear Survey Schedule for Children (FSSC). Self-reported survey of fears. The Israeli version is based on the original (Scherer & Nakamura, 1968) and on an updated version (Ollendick, 1983) that has been validated for use in Israel with children of various age groups. An anxiety score was computed as the sum of the questionnaire's 70 items, with high scores reflecting high anxiety levels.

2.1.3.2. Anxiety/Depression subscale of the Child Behavior Checklist (CBCL; Achenbach, 1991). The scale measures parental perceptions concerning how often their child exhibits anxiety/depression behavior. The Israeli version was validated (Zilber, Auerbach, & Lerner, 1994) and its 14 items are scored on a three-point scale ranging between 0 (never) and 2 (always or very often). An anxiety/depression score is derived by summing the items, with high scores reflecting high anxiety/depression levels.

2.1.3.3. The pictorial scale of perceived competence and social acceptance for young children (Harter & Pike, 1984). This scale consists of 24 items grouped into four subscales assessing children's perception of their physical and cognitive competence, and their perception of acceptance by peers and mothers. The physical and cognitive competence subscales were aggregated to provide a self-perceived competence score. The peer and maternal acceptance subscales were aggregated to provide a self-perceived acceptance score. High scores represent high self-esteem. For reliability and validity of the scales in an Israeli sample see Orr, Assor, and Priel (1989).

2.1.4. Statistical analysis

Each of the dependent variables was analyzed by a separate ANOVA with group (balance dysfunction vs. control) and gender (male vs. female) as independent between-subjects variables. Non-significant effects and interactions are not reported.

Table 1
Means and SDs of balance function, anxiety, and self-esteem measures by group and gender in study 1

	Balance dysfunction group		Control group	
	Girls (n = 9)	Boys (n = 26)	Girls (n = 10)	Boys (n = 15)
Balance function				
Balance (BOTMP)	5.6 (2.3)	11.0 (4.2)	25.3 (3.8)	22.9 (3.1)
Nystagmus	1.4 (0.6)	1.0 (0.8)	0.6 (0.5)	0.7 (0.3)
Vestibular processing	30.7 (9.2)	35.1 (11.2)	50.0 (3.6)	49.1 (4.1)
Anxiety				
FSSC—total	147.3 (32.1)	179.7 (14.4)	141.8 (21.6)	144.7 (22.8)
CBCL—anxious/depressed	6.4 (5.4)	15.6 (6.0)	1.6 (2.4)	3.4 (4.0)
Self-esteem				
Self-perceived competence	38.8 (8.4)	30.7 (6.4)	44.1 (3.9)	43.6 (5.2)
Self-perceived acceptance	39.9 (7.0)	31.3 (6.2)	40.2 (6.0)	40.4 (4.8)

2.2. Results

2.2.1. Balance measures

Table 1 presents means and SDs of balance, nystagmus and vestibular processing scores by group and gender. Children with balance dysfunction performed worse on the BOTMP, $F(1, 58) = 307.6$, $p < .001$ (confirming the selection procedure), and the nystagmus test, $F(1, 58) = 11.4$, $p < .001$. Inferior vestibular processing was reported by parents of children in the balance dysfunction group compared to parents of children in the control group, $F(1, 58) = 56.8$, $p < .001$. A significant group by gender interaction was found for the BOTMP test, $F(1, 58) = 18.7$, $p < .001$, with boys in the balance dysfunction group displaying poorer balance than girls, while boys in the control group displaying better balance than girls.

2.2.2. Anxiety measures

Table 1 presents means and SDs of the FSSC and CBCL scales by group and gender. Compared with control children, children with balance dysfunction reported higher level of anxiety on the FSSC, $F(1, 58) = 11.7$, $p < .001$. Relative to parents of control children, parents of children with balance dysfunction reported higher anxiety/depression in their children on the CBCL, $F(1, 58) = 36.6$, $p < .001$. Significant gender effects were also revealed for the FSSC, $F(1, 58) = 8.9$, $p < .01$ and the CBCL anxiety/depression scale, $F(1, 58) = 15.1$, $p < .001$, with boys presenting higher anxiety than girls. The main effect of gender for the FSSC was subsumed under a group by gender interaction, $F(1, 58) = 6.2$, $p < .05$, demonstrating that higher anxiety in boys was characteristic of the balance dysfunction group but not of the control group.

2.2.3. Self-perceived competence and acceptance

Table 1 presents means and SDs of the self-perceived competence and acceptance scores by group and gender. Compared with children in the control group, children with balance dysfunction had lower competence and acceptance scores, $Fs(1, 60) = 27.4$ and 7.9, $ps < .001$ and .01, respectively. These effects were qualified by group by gender interaction for the competence and the acceptance scores, $Fs(1, 60) = 4.7$ and 6.9, $ps < .05$ and .01, respectively, revealing lower self-perceived competence and acceptance in boys relative to girls in the balance dysfunction group but not in the control group.

3. Discussion

This study is the first to demonstrate comorbidity of balance dysfunction and anxiety symptoms in children as young as 5 years of age, and thus may have implications for early diagnosis and intervention for children with this comorbid condition. Typically, anxiety disorders are first diagnosed only around the age of 8 years. Because balance dysfunction can be diagnosed as early as 3 or 4 years of

age, it may be useful to evaluate anxiety markers more thoroughly in young children suspected for balance dysfunction. Such early detection and potential early intervention may buffer the development of balance-related anxieties when these children grow older.

The present findings also indicate an association between balance dysfunction and reduced self-esteem. These findings are in line with previous studies reporting that children with motor difficulties are prone to reduced self-esteem (Losse et al., 1991). This is obvious in terms of reduced self-perceived physical competence (Cantell et al., 1994; Piek et al., 2000), but also in terms of reduced self-perceived acceptance (Schoemaker & Kalverboer, 1994).

4. Study 2

Study 1 confirmed the association between balance dysfunction, anxiety and low self-esteem in children with a primary diagnosis of balance dysfunction. Study 2 tests the effect of a balance intervention on the above association of disorders. We expected that measurable balance improvements will be associated with reduction in anxiety levels and an increase in self-esteem.

4.1. Methods

4.1.1. Participants

Forty-nine new children with balance dysfunction, mean age 5.6 years (range = 5.0–7.0), were recruited from public child-development clinics in the greater Tel-Aviv area. Children were either self-referred, physician-referred, or teachers-referred to therapy for balance difficulties. To assure that all participants presented with both balance dysfunction and high anxiety level, inclusion criteria were: below the clinical cutoff score (less than 13.3) on the balance subtest of the BOTMP and a total score higher than 150 on the anxiety FSSC scale. Exclusion criteria considered the observation that children with motor disabilities also may demonstrate excessive tactile sensitivity which by itself may be associated with elevated anxiety (Goldsmith, Van Hulle, Arneson, Schreiber, & Gernsbacher, 2006). To avoid the intervention of 'tactile sensitivity' in the association between balance and anxiety we excluded children who scored above the clinical cutoff (score 40 that indicates the 50th percentile) on the Touch Inventory for Elementary School Aged Children (TIE; Royeen & Fortune, 1990). Also excluded were children who had received psychological or occupational therapy during the 3 years preceding onset of the study.

All children were recruited within a 3 months period, and were assigned to either a balance treatment group or a waiting-list control group, based on treatment resources availability at the time of intake. Because there were no urgent cases, severity of presenting symptoms did not play any role in assignment to groups. The treatment group (n = 25, 3 girls) and the control group (n = 24, 3 girls) did not differ in age, balance function, anxiety, and self-esteem at the time of group assignment (see Table 2).

4.1.2. Procedure

After obtaining a written parental informed consent, all children were assessed on the balance subtest of the BOTMP, the SCPNT, the Vestibular Processing Scale of the Sensory Profile Questionnaire, and the TIE. Anxiety was assessed using the FSSC, and the CBCL anxious/depressed scale, and self-esteem was assessed using the Pictorial Scale of Perceived Competence and Social Acceptance for Young Children. These baseline data were collected during two intake sessions. The order of measures was counterbalanced across children within each group.

Children assigned to the treatment group were given 12 weekly sessions of balance treatment. Each session lasted 45 min and consisted of ~15 min of flexor and extensor muscle-tone training, ~15 min of maneuvers requiring balance maintenance in different body postures, and ~15 min of activity involving vestibular stimulation in different head and body positions. This treatment approach is based on the Sensory Integration treatment method and it is commonly used in OT clinics. Treatment was administered by four certified and experienced occupational therapists. To ensure adherence to treatment protocol, 10% of the sessions were randomly monitored by another

Table 2
Means and SDs of balance function, anxiety, and self-esteem pre- and post-treatment/waiting list by group in study 2

	Treatment group		Control group	
	Pre-treatment	Post-control	Pre-waiting	Post-waiting
Balance function				
Balance (BOTMP)	3.3 (1.9)	14.0 (3.7)	3.9 (2.2)	2.9 (2.0)
Vestibular processing	25.2 (3.9)	46.4 (2.9)	26.1 (4.8)	24.8 (3.7)
Anxiety				
FSSC—total	184.0 (11.3)	128.1 (9.3)	187.5 (7.3)	185.3 (8.9)
CBCL—anxious/depressed	16.6 (5.5)	5.0 (2.4)	14.2 (4.8)	15.6 (4.7)
Self-esteem				
Self-esteem—performance	30.0 (6.2)	40.1 (4.1)	28.5 (4.8)	28.5 (4.6)
Self-esteem—acceptance	30.7 (6.4)	36.2 (6.2)	26.3 (6.5)	25.3 (5.9)

occupational therapist. No deviations from protocol were detected. Compliance with treatment was very good and all children in the balance dysfunction group completed the 12 intervention sessions.

Following the 12 therapy sessions (treatment group) or 12 weeks of waiting (control group), children's balance, anxiety, and self-esteem were assessed again, using the same battery of measures employed during the intake sessions. At the end of their waiting period, all children in the control group also received treatment.

4.1.3. Statistical analysis

To assess the effect of treatment, separate repeated-measures ANOVAs were computed for each of the dependent variables with group (treatment vs. control) as a between-subjects factor, and time (pre-treatment vs. post-treatment/waiting) as a within-subject factor.

4.2. Results

4.2.1. Treatment effect on balance measures

Table 2 presents means and SDs of balance and vestibular processing by group. Analysis of BOTMP confirmed a group by time interaction, $F(1, 47) = 260.7$, $p < .001$. Post hoc t-tests showed that the groups did not differ on balance during the pre-treatment but did differ at post-treatment session, $t(47) = 12.9$, $p < .001$. Paired t-tests demonstrated an improvement in balance in the post vs. pre-treatment session, for the balance treatment group, $t(24) = 16.1$, $p < .001$, and a decrease in balance for the control group, $t(23) = 3.9$, $p < .001$. Furthermore, 18 of the 25 treated children were no longer below the clinical cutoff for balance (13.3), whereas all the children in the waiting control group remained within clinical range, $\chi^2 = 27.3$, $p < .001$.

Analysis of parental *Vestibular processing report* revealed a group by time interaction, $F(1, 47) = 481.2$, $p < .001$. Follow-up t-tests showed that the two groups demonstrated similarly deficient vestibular processing in the pre-treatment test ($p > .40$). Post-treatment, parents of treated children reported better vestibular processing than parents of control children, $t(47) = 22.6$, $p < .001$. Paired t-tests comparing post vs. pre-treatment sessions showed an improvement in vestibular processing after treatment, $t(24) = 23.0$, $p < .001$, and a deterioration after a waiting period, $t(23) = 3.1$, $p < .01$. Children in both groups showed a 'definite deficit level' on vestibular processing pre-treatment. All the control children remained within the 'definite deficit level' after the waiting period. By contrast, only 5 children remained with 'definite deficit level' after balance treatment, whereas 13 children in this group improved into a 'sub-clinical level', and 7 children advanced to a 'typical performance level', $\chi^2 = 32.4$, $p < .001$.

Analysis of Nystagmus revealed abnormal response to rotation during the pre-treatment session in 47 children and only 2 children (one from each group) showed normal response. At post-treatment, however, seven treated children displayed normal nystagmus, while all of the control children, but one, continued displaying abnormal nystagmus ($\chi^2 = 7.8$, $p < .01$).

4.2.2. Treatment effect on anxiety measures

Table 2 presents means and SDs of anxiety measures by group and time. Analysis of *Self-reported anxiety* (*FSSC*) confirmed group by time interaction, $F(1, 47) = 310.2$, $p < .001$. Follow-up *t*-tests showed similar anxiety levels in both groups at the pre-treatment/waiting session ($p > .19$). At post-treatment/waiting, treated children reported lower anxiety compared with control children, $t(47) = 21.9$, $p < .001$. Paired *t*-tests showed a decrease in anxiety after treatment, $t(24) = 22.6$, $p < .001$, but not after waiting period, $p > .22$.

Analysis of Parental reported anxiety/depression (CBCL—Anxious/Depressed) also revealed a group by time interaction, $F(1, 47) = 180.7$, $p < .001$. Follow-up *t*-tests showed similar anxiety levels in both groups at pre-treatment, $p > .10$. At post-treatment, parents of treated children reported lower anxiety/depression levels compared to parents of children in the waiting-list control group, $t(47) = 10.0$, $p < .001$. Paired *t*-tests showed a decrease in anxiety/depression level after treatment, $t(24) = 13.3$, $p < .001$, but not after a waiting period, $p > .30$. Analysis of clinical cutoff scores at pre-treatment revealed that all but two children (one in each group) featured above clinical cutoff on the CBCL's anxious/depressed scale. During post-treatment/waiting, however, 18 of the treated children no longer surpassed the clinical cutoff, while all children in the waiting-list control group did, $\chi^2 = 27.3$, $p < .001$.

4.2.3. Treatment effect on self-perceived competence and acceptance measures

Table 2 presents means and SDs of self-esteem by group and time. A group by time interaction was found for children's self-perceived competence, $F(1, 47) = 49.9$, $p < .001$. Follow-up *t*-tests revealed similar self-perceived competence in both groups at the pre-treatment assessment, $p > .19$. At post-treatment/waiting, treated children reported higher self-perceived competence compared with control children, $t(47) = 9.4$, $p < .001$. Paired *t*-tests showed an increase in self-perceived competence following treatment, $t(24) = 7.6$, $p < .001$, but not after a waiting period.

Analysis of the self-perceived acceptance also revealed a group by time interaction, $F(1, 47) = 62.7$, $p < .001$. Unexpectedly, the treatment group had higher self-perceived acceptance scores compared with the control group, already at the pre-treatment assessment, $t(47) = 2.4$, $p < .05$. As expected, at post-treatment/waiting, treated children reported higher self-perceived acceptance compared with control children, $t(47) = 10.9$, $p < .001$. More importantly, however, paired *t*-tests showed a significant increase in self-perceived acceptance after treatment, $t(24) = 8.4$, $p < .001$, and a decrease in self-perceived acceptance after a waiting period, $t(23) = 2.0$, $p = .06$.

4.2.4. correlations between balance improvement and anxiety reduction and self-esteem enhancement

To evaluate the association between treatment-related improvement in balance and change in anxiety and self-esteem, correlations were computed between change scores for these variables. These calculations were derived in the following manner: first, change scores (post-treatment minus pre-treatment) were computed for the balance, vestibular processing, FSSC, CBCL anxious/depressed scale, and self-perceived competence and acceptance. Second, these change scores were transformed to *Z*-scores for standardization. Third, three aggregate variables were generated: (1) balance change score as the average of *Z*-scores on the balance and vestibular processing scales; (2) anxiety change score as the average of *Z*-scores on the FSSC and CBCL anxious/depressed scales; (3) self-esteem change score as average of *Z*-scores on the self-perceived competence and acceptance scales.

For the treatment group, significant correlations were found between the balance and anxiety aggregate change scores, $r = -.47$, $p < .05$, and between the balance and self-esteem aggregate change scores, $r = .40$, $p < .05$. These correlations indicate that improvement in balance function was associated with decrease in anxiety and increase in self-esteem. No such correlations were found for the control group.

4.3. Discussion

The results of Study 2 demonstrate that the balance treatment was effective in improving children's balance functions. By contrast, children in the waiting-list condition showed a stable balance deficiency, which confirms the notion that lack of treatment maintains the developmental gap

in balance function (Taylor, 1997). In fact, some of the children in the control group showed time-related deterioration in balance functions, even during the short period while waiting for treatment. Children with balance difficulties tend to avoid balance challenges. If gone untreated, such children do not practice balance and may experience further deterioration in balance skills (Smyth & Anderson, 2000, 2001; Taylor, 1997).

Importantly, the present study shows that successful balance treatment is also effective in reducing children's anxiety and in increasing their self-esteem. Furthermore, the reduction in anxiety and increase in self-esteem significantly correlated with the improvement in balance. Proper balance allows children to move efficiently in space and participate in everyday activities. Impaired balance can affect children's subjective experience of the world transforming it into an intimidating place. Therefore, balance dysfunction might promote feelings of incompetence and anxiety while confronting the world's most basic demands. Indeed, treating the core deficiency of balance, proved to decrease anxiety and increase self-esteem in young children. Such changes were not observed in children from the waiting-list control group assuring that the observed improvements in anxiety and self-esteem did not result from simple time effects.

The high compliance with the balance treatment along with the marked improvements in anxiety and self-esteem may prove to have important clinical implications for the treatment of anxiety in young children with the comorbidity of balance dysfunction and anxiety. Specifically, the balance treatment employed in the present study relies on physical stimulation and motor action, and does not require the sophisticated cognitive abilities which are often considered a prerequisite for CBT or other cognitively oriented treatments. Although the typical CBT in youth shows great promise for amelioration of symptoms and associated functional impairment, the empirical evidence base for the efficacy of CBT in youth has some significant limitations, particularly as related to treating the very young children, under the age of seven (Freeman et al., 2007). As such, balance treatment may prove to be an effective anxiety treatment for children with balance dysfunction under the age of 7 years.

Although the balance treatment was effective in reducing anxiety and increasing self-esteem on a group means level, it is important to note that anxiety was still above the clinical cutoff on the CBCL in 40% of the children at the end of therapy. The residual anxiety in these children could be associated with non-balance factors such as cognitive biases, inhibited temperament, or dysfunctions in other neural circuits not related to balance (for a review see Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van-IJzendoorn, 2007).

The findings of the present study bear theoretical promise as well as potential clinical implications for children with comorbid balance and anxiety disorders. However, further research is needed to rule out three potential factors that may be related to the balance treatment effects on anxiety and self-esteem. First, the amelioration of anxiety may be the outcome of a psychological desensitization process that was embedded in the balance treatment. Like classic systematic desensitization procedures, the balance treatment canonic procedure consists of gradual exposure of children to balance challenges in a context of a supportive environment (Bundy, Lane, & Murray, 2002). Thus, gradual exposure to challenging events, rather than improvement in balance, may explain the amelioration of anxiety and increased self-esteem in the treated group. Second, the positive and rewarding attitude of the therapists may have significantly contributed to the observed reduction in anxiety and increase in self-esteem. Finally, the potential change in parents' understanding of their child's difficulties in terms of balance function might have lead to a more supportive attitude toward the child, resulting in the reported improvements in anxiety and self-esteem. Clearly, more research is needed in order to determine the specific contribution of balance treatment to the reduction of anxiety symptoms.

Finally, it is important to note that most of the participants in this study were boys and thus the results may not be readily generalized for girls. That being said, boys are more likely than girls to have developmental coordination disorders (Cairney, Hay, Faught, Mandigo, & Flouris, 2005).

5. Conclusion

Taken together, the present findings are in accord with the observations of comorbidity between balance and anxiety disorders in adults and older children (Balaban & Jacob, 2001; Erez et al., 2004;

Levinson, 1989a, 1989b) and confirm their validity in children younger than 7 years of age. This profile of comorbidity between balance dysfunction and anxiety also includes lower self-esteem in terms of motor, cognitive, and perceived social acceptance.

A central question, that remains open, is whether balance and anxiety disorders are causally related and what may be the direction of such causality. A related question is what may be the most efficient treatment for children presenting with this profile of comorbidity. We show that targeting balance problems reduce children's anxiety and increased their self-esteem in a direct relation to their improvement in balance functions.

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