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Title: Effect of Wii-intervention on balance of children with poor motor performance

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Abstract: The purpose of this study was to investigate the effects of training with the Wii-balance board on balance and balance-related skills of children with poor motor performance. Twenty-nine children (23 boys, 6 girls; aged 7-12 years) participated in this study and were randomly assigned to an experimental and control group. All children scored below the 16th percentile on a standardized test of motor ability and balance skills (Movement Assessment Battery for children (M-ABC-2). Before and after a six-week Wii-intervention (M=8.5 hrs), the balance skills of the experimental group and control group were measured with the M-ABC-2 and the Bruininks-Oseretsky Test of Motor Proficiency (BOT-2). Both groups improved on all tests. The M-ABC-2 and the BOT-2 total balance-scores improved significantly at post intervention, whereas those of the control group showed minimal progress. This resulted in significant interaction-effects, favoring the experimental children. Additionally, significant interaction-effect were found for four balance-items. No transfer-effects of the intervention on balance-related skills were demonstrated. Our findings showed that the Wii-balance board is an effective intervention for children with poor balance control. Further development and investigation of the intervention could be directed towards the implementation of the newly acquired balance-skills in daily life.

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The Editor of *Research in Developmental Disabilities*

Manuscript submission
10 february , 2013

Dear Sir,

We are enclosing a manuscript titled "Effect of Wii-intervention on balance of children with poor motor performance" by R. Mombarg, D. Jelsma and E. Hartman.
The purpose of this study is to investigate the effects of the Wii-balance board on balance of children with poor motor performance. The study builds further on previous research by trying to develop an effective balance –intervention for children with poor motor development. As far as we know, there is little research on this topic. We feel that our study adds to the existing knowledge in this field and to the sport participation of children.

We would like to submit the manuscript for publication in the Research in Developmental Disabilities. The results have not been published elsewhere, and will not be submitted for publication elsewhere in their present form. The paper has been read and approved by all authors.

Yours sincerely,
Remo Mombarg

Highlights: Effect of Wii-intervention on balance of children with poor motor performance

- We investigated the effects of the Wii-balance board on balance skills of children.
- The Wii-balance board is an effective intervention for children with poor balance.
- No transfer-effects of the intervention on balance-related skills were found.
- Task-oriented approach combined with a implicit way of learning seemed successful.

Effect of Wii-intervention on balance of children with poor motor performance

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Effect of Wii-intervention on balance of children with poor motor performance

Abstract

The purpose of this study was to investigate the effects of training with the Wii-balance board on balance and balance-related skills of children with poor motor performance. Twenty-nine children (23 boys, 6 girls; aged 7-12 years) participated in this study and were randomly assigned to an experimental and control group. All children scored below the 16th percentile on a standardized test of motor ability and balance skills (Movement Assessment Battery for children (M-ABC-2). Before and after a six-week Wii-intervention (M=8.5 hrs), the balance skills of the experimental group and control group were measured with the M-ABC-2 and the Bruininks–Oseretsky Test of Motor Proficiency (BOT-2). Both groups improved on all tests. The M-ABC-2 and the BOT-2 total balance-scores improved significantly at post intervention, whereas those of the control group showed minimal progress. This resulted in significant interaction-effects, favoring the experimental children. Additionally, significant interaction-effect were found for four balance-items. No transfer-effects of the intervention on balance-related skills were demonstrated. Our findings showed that the Wii-balance board is an effective intervention for children with poor balance control. Further development and investigation of the intervention could be directed towards the implementation of the newly acquired balance-skills in daily life.

Short title: Wii-intervention on balance of children

Keywords: balance; motor performance; Wii-intervention; children

Abbreviations:

M-ABC-2: Movement-Assessment Battery for Children-two
BOT-2: Bruininks–Oseretsky Test of Motor Proficiency-two
Wii: Nintendo- Wii®

1. Introduction

Children with a developmental delay in motor performance often show problems with their balance-skills (Cantell, Smyth, & Ahonen, 1994). This implies that they have problems maintaining an upright position and keeping the center of gravity within the limits of support (Winter, 1995). This problem is particularly apparent in difficult, unexpected or novel situations (Geuze, 2005). Approximately 73-87% of children with poor motor performance have problems with balance (Macnab, Miller, & Polatajko, 2001). This could be regarded as an acceptable part of the normal variation between children. Regrettably, however, the impact of these underdeveloped balance-skills is enormous as it has far-reaching influences on many gross motor skills such as skateboarding, biking, running and climbing (Skinner & Piek, 2001). As a consequence, these children are unable to participate successfully in physical education lessons (Bouffard, Watkinson, Thompson, Dunn, & Romanow, 1996; Wall & Kentala, 2010; Wilson, 2005). Therefore, an effective early intervention to improve balance is essential for children with poor motor performance.

Research shows that children with motor problems typically display increased amounts of postural sway in static balance (Geuze, 2003). Subsequently, effective interventions have been developed to overcome this difficulty (Granacher, Muehlbauer, Maestrini, Zahner, & Gollhofer, 2011). Less attention has been paid to dynamic balance problems, despite the fact that these children have considerably more problems in maintaining dynamic balance (Deconinck, Savelsbergh, De Clercq, & Lenoir, 2010). Training of dynamic balance is needed, because children have to learn to alter their center of gravity and anticipate more on changing positions. Based on the task-specificity of a training for children with motor developmental problems (Niemeijer, Smits-Engelsman, & Schoemaker, 2007; Pless & Carlsson, 2000; Revie & Larkin, 1993) an effective intervention should include static and dynamic-balance training.

Another intriguing aspect is the use of sensory input during instructions. Several researchers examined the contribution of visual, vestibular and proprioceptive information on postural control of sway. Children with motor problems seem to be more dependent on visual cues, especially during stressful circumstances (Deconinck et al. , 2010). Despite these dependency on visual cues there also seems to be a compensating mechanism between the different sensory channels. Children with motor problems are able to compensate the lack of information of one channel with another (Schoemaker et al. , 2001). However, the relative contribution of sensory information seems to be dependent on the individual capacities (p. e. motor abilities, sensory preferences) and changes in environmental conditions (Jeka, Oie, & Kiemel, 2000). A skiing child will see the upcoming curves, but during the curve he has to rely more on the vestibular and proprioceptive information to uphold his balance. In natural conditions children can make use of compensating strategies, it therefore seems useful to train the effective integration of all sensory channels in different situations.

It could be argued that the regular instruction and feedback during interventions should be more adjusted to the needs of children with motor developmental problems. Traditionally motor learning is based on explicit learning of cognitive processes that generate declarative knowledge. In the initial stage of learning new movements this explicit information is used to improve the movement until it has been learned (Fitts & Posner, 1967). More recently several authors promoted a more implicit way of learning in which the learner focuses on the result of the movement instead of the performance. The explicit use of cognitive processes could therefore be circumvented (Wulf, 2001). This method could be beneficial for children with motor problems as these children seem to have diminished abilities on processing information (Peters, Maathuis, & Hadders-Algra, 2011) and working memory capacity (Alloway, Rajendran, & Archibald, 2009). Although some studies have examined the effect of implicit learning on the motor skills of regular children (Candler & Meeuwsen, 2002; Capio, Sit, Abernethy, & Masters, 2012), none of these studies focused on balance training with children with motor problems.

Based on the above mentioned studies an effective balance training program should incorporate the implicit training of dynamic and static balance skills and stimulate postural control abilities based on visual, proprioceptive and vestibular awareness. To combine these ingredients, the upcoming interactive video games could offer a low-cost and stimulating intervention. A good example of an attractive interactive video game is the Nintendo-Wii-fit® which seems a promising tool to improve dynamic and static balance (Shih, Shih, & Chu, 2010). Consequently, the first aim of this study was to investigate the effects of a Wii-balance board training on balance performance of children with motor delay after a six-week intervention period in a randomized controlled trial. The second aim was to examine the effects of the Wii-intervention on balance related skills .

2. Methods

2.1. Participants

We recruited 30 children, aged 7-12, with balance problems from three schools for special education in the northern regions of the Netherlands. The inclusion criteria consisted of balance problems and an intelligence score above 70 and no indication of any neurological or physical impairment. As a first step, the physical education teacher selected the children with poor balance control. Informed consent to participate was obtained from the children's parents. Secondly, these children were assessed with the Movement-Assessment Battery for Children-2 (M-ABC-2) (Smits-Engelsman, 2010) to confirm their balance problems. Children were included if they scored below the 6th percentile (standard score <6) on the total score and on the balance component. This resulted in a group of 6 girls and 23 boys. The children were randomly assigned to an experimental and a control group. Descriptive statistics on sex, age and M-ABC-2 scores can be found in Table 1. Approval for this study was obtained from the Ethics Committee of the Department of Psychology of the University of Groningen. Written informed consent was obtained from the children's parents/guardians.

** Table 1 near here **

Table 1: Characteristics of the experimental and the control group: sex, age and baseline standard scores on the M-ABC-2 test.

2.2. M-ABC-2 and BOT-2

In order to measure the effects of the Wii-intervention, both groups were pre- and post-tested with two motor development tests. Firstly, we used the M-ABC-2 to determine the amount of motor coordination deficits (Henderson, Sugden, & Barnett, 2007). There are three components: manual dexterity, ball skills and balance. The item scores are converted into norm scores which range from 0 to 20. In general, high scores indicate better developed motor skill performance. The total score, i. e. the sum of all scores can be converted into a percentile rank. We used the standard scores (motor problem: scores < 5, at risk:6-7, average/normal performance >7) on the balance-component to measure the effect of the Wii-intervention. The M-ABC-2 test has acceptable validity and reliability. Inter-rater reliability ranges from . 92- 1. 00 and the test-retest reliability from . 62 - . 92. In addition, the test has recently been validated for Dutch children (Smits-Engelsman, 2010).

Secondly, we used the BOT-2 (Bruininks & Bruininks, 2005) to collect more information on balance and balance-related skills. The BOT-2 test consists of eight gross and fine motor tests. In this study, only the gross motor items for balance, running speed and agility were utilized. These specific tests were chosen because they measure the ability to maintain balance during walking and running with objects. The raw results can be converted to point scores which range from 0 to 10. The BOT-2 test has a sufficient test-retest reliability of . 85 and inter-rater reliability of 0. 98. There is also strong support for adequate construct validity (Deitz, 2007).

2.3. Intervention

The experimental group trained on the Wii-balance board for a period of six weeks; three training-periods of 30 minutes per week. The intervention took place during their lunchtime break in a regular classroom and was attended by trained physical education students under supervision of a physical therapist. The control group had no intervention. Prior to the intervention, each child performed a balance-test on the Wii-balance board to determine the appropriate difficulty level. This test has been validated (test-retest reliability within-device: ICC=0. 66-0. 94 and between-device: ICC=0. 77-0. 89) in comparison with a force-platform (Clark et al. , 2010). During each session, the children chose between 18 balance games like Ski- jump, Segway circuit, Obstacle course and Skate Boarding. The games were selected for the training program because they all appealed to the children's ability to adjust their center of gravity in a different way. In addition, they received various direct visual feedback on a tv-screen to implicitly regulate their balance based on sensory information. For instance, the snowboard-slalom appealed on balance regulation by eliciting repeated sideways displacement of weight. These displacements were visible as an skier on the screen who moved accordingly around the slalom poles. Furthermore, the games all provided for limitless exercises, visual feedback and motivational reinforcement, in terms of rewards such as new games and points. To induce sufficiently varied training, they had to choose different games each session. The trainers guided the children to assure sufficient time spent on each balance game. During the intervention the difficulty levels were automatically adjusted, depending on the skill-growth of the children which resulted in better game-scores.

2.4. Data analysis

In order to analyze the differences between the experimental and control groups, we used a quasi-experimental design. To test the effectiveness of the intervention, the M-ABC-2 and the BOT-2 tests were used as a pre- and post-test. Hereby, the M-ABC-2 and BOT-2 balance tests were used to measure the direct effects of the intervention on balance-skills, whereas the BOT-2 test measured running speed and agility which directed more towards the transfer-effects of the acquired balance skills. The raw scores were converted into standardized scores and checked for violation of the needed statistical assumptions. To analyze differences on the outcome parameters in the experimental and the control group prior to the intervention (T_0), t-test and Chi-square analyses were conducted on sex, age and M-ABC-2 -scores. Repeated-measures ANOVAs were used to examine the pre- and post-intervention standard scores of the experimental and control group. To calculate the strength of the results, partial-eta-squared was applied. These effect-sizes were defined: ή2=. 01 as small, ή2=. 06 as medium and ή2=. 14 as large (Field, 2010). For statistical analysis, SPSS (version 18) was used and p<0. 05 was considered statistically significant.

3. Results

3. 1. Baseline characteristics

The formation of the experimental and control group resulted in comparable baseline characteristics (Table 1). The two groups did not statistically differ from each other on age (t=-. 36, p=. 72), M-ABC-2 -total-scores (t=-. 15, p=. 88), M-ABC-2 balance scores (t=1. 10, p=. 28) and sex (χ =. 51, p=. 47). All children of the experimental group completed the intervention. They received an average of eight hours and twenty minutes of training on the Wii-balance board. Due to various circumstances like extra class work, school activities and dentist visits, several children missed one or more training-sessions, which resulted in slightly different total training hours between the children in the experimental group (M=8 hours, 20 minutes, SD=1 hour, 4 minutes).

3. 2. Effect of Wii-intervention on balance skills (M-ABC-2 and BOT-2)

The M-ABC-2 and BOT-2 balance-scores achieved by the experimental group on post-test were improved from those on the pre-test, whereas those of the control group showed minimal progress (Table 2). ANOVA of the BOT-2 and M-ABC-2 total scores resulted in a significant main effect of time on: M-ABC-2 balance F (1,28)=22,09, p=. 00, ή2=. 45 and BOT-2 balance F (1,28)=23,44, p=. 00, ή2=. 47. No main effects of group were found, but ANOVA revealed significant interaction-effects group x pre-post measures on: M-ABC-2 balance F (1,28)=5. 34, p=. 03, ή2=. 17 and BOT-2 balance F (1,28)=11. 76, p < . 01, ή2=. 30.

Further analysis of the items of the M-ABC-2 showed that both groups made progress on all three tests, which resulted in two significant effects of time (Walking on a line F (1,28)=12. 20, p < . 01, ή2=. 31; Jumping F (1,28)=8. 50, p =. 01, ή2=. 24). Additionally, a significant interaction-effect was measured for dynamical balance, jumping F (1,28)=5. 57, p=. 03, ή2=. 17. Further analysis of the items of the BOT-2-test resulted in significant time effects on four tests: standing with feet apart: *F* (1,28)=7,69, *p*=. 01, *ή2*=. 22, walking forward on a line: *F* (1,28)=6,50, *p*=. 02, *ή2*=. 19, standing on one leg on a line: *F* (1,28)=8. 98, *p* = . 01, *ή2*=. 25 and standing on one leg on a balance beam *F* (1,28)=13,54, *p* <. 01, *ή2*=. 33. Only on three of the nine tests also significant interaction effects group x pre-post measures were found. These items were standing with feet apart: *F* (1,28)=7,69, *p*=. 01, *ή2*=. 22, standing on one leg on a balance beam (eyes open): *F* (1,28)=10. 80, *p* < . 01, *ή2*=. 29 and standing on one leg on a balance beam (eyes closed) *F* (1,28)=6,38, *p*=. 02, *ή2*=. 19. Taken together, these results on the balance-tests indicate a small to medium intervention effect of the Wii-fit for balance in general. In addition, significant interaction-effects were found on four specific balance items.

3. 3. Effect of Wii-intervention on running speed and agility skills (BOT-2)

The BOT-2 scores on running speed and agility achieved by the experimental and the control group on post-test were improved from those on the pre-test, but no significant difference was found between the groups. Analysis of the variances of the BOT scores (Table 2) resulted in a significant main effect of time: BOT running and agility F (1,28)=9. 37, p=. 01, ή2=. 26. There were no significant main effects of group or interaction-effects group x pre-post measures: BOT running and agility F (1,28)=1. 23, p=. 28, ή2=. 04. Although the experimental group improved more than the control group, no significant differences were found. Therefore, these results reveal no intervention-effect of the Wii-intervention for running speed and agility.

** Table 2 near here **

Table 2:Mean, standard deviation, time-, group- and interaction-effects of balance- and running speed and agility scores for the experimental and control group at pre- and post-tests (T0 and T1)

3. 4 Individual effects on balance

Conclusive analysis of the individual results of the experimental and control group revealed great differences. Although all the children in the experimental group showed some progress on the M-ABC balance-scores (Figure 1) the difference in growth was considerable. Nine from the fifteen children in the experimental group moved from a clinical score (below the standard score 6) on the balance factor to a score at risk. (at or above the standard score 6). The children in the control group showed a more irregular pattern (Figure 2). In this group five children increased their balance-scores, but nine children did not establish any progress. Comparable results were found for the BOT-2 balance-scores. No relationship was found with age or gender.

** Fig 1 and 2 near here **

Figure: 1 and 2: Individual standard scores of M-ABC-2 total balance score on pre- and posttest for the experimental group (N=15) and control group (N=14).

4. Discussion

The primary aim of this study was to investigate whether a Wii-intervention in a randomized controlled trial.has a positive influence on the balance skills of children with poor motor performance. The fifteen children who trained on the Wii-balance board during a six week period, with an average of eight hours, showed a significant increase on their balance skills. The M-ABC2 and the BOT-2 total balance-scores achieved by the experimental group at post-test were significantly improved from those at the pre-test, whereas those of the control group showed minimal progress. In addition, significant interaction-effects were found on four specific balance items. The secondary aim was directed towards the transfer-effects of the Wii-balance training on the running and agility skills. No significant interaction-effect between group and pre-post measures were found.

The improvement on the specific balance-skills and lack of transfer-effects are in line with the findings on other task-oriented approaches to motor development (Pless & Carlsson, 2000). In this meta-study, effective interventions were typically task-oriented and repetitive. The outcome of this study is consistent with these characteristics. The difference between this study and the aforementioned task-oriented approach is the use of visual feedback during the balance-exercise on a Wii-balance board. In this Wii-experiment, the children could view their actions immediately on the video-screen. Such an immediate dynamic visual feedback constitutes a new effective method of learning: implicit learning (Steenbergen, van der Kamp, Verneau, Jongbloed-Pereboom, & Masters, 2010). As a supplement to the task-oriented approach, the focus shifts from more declarative conscious knowledge on how to perform the task, to more implicit way of knowing how to react in different situations. The benefit of this implicit way is that implicitly learned skills are more robust to stress and more easily combined with other skills (Mullen, Hardy, & Oldham, 2007). In this study, the live visual feedback could have led to a more implicit way of learning in which the complex postural control abilities of the balance skills were learned in order to adapt to changing circumstances.

Despite the fact that all children in the experimental group showed progress on their balance skills, the significant interaction-effect are relatively small (ή2:. 18 -. 30). This is mainly the result of the unexpected progress some children made in the control-group. In Figure 1a en 1b it is clearly visible that some children in the control group showed considerable growth on balance skills whereas others decreased their scores. This could have been the result of the variability in performance by children with poor motor performance as has been found in a comparable intervention study of Revie & Larkin (1993).

The second aim of the study was to investigate the transfer-effects of the improved balance-skills on balance related aspects of the motor development. In this study there was no clear proof of significant progress in running speed and agility, which limits the generalizability of this intervention-effect. On the other hand, these findings of the current study are consistent with those of other task oriented studies in which no transfer-effect was found from the targeted skills to other motor skills (Niemeijer et al. , 2007). In this study there was, aside from the balance-skills, no training time for other gross-motor skills.

A limitation of the present study was the type of assessment. As a consequence of the theoretical framework of task specific training the test should be also task specific. In this case the dynamic balance-movement should be measured in the trained situation on the Wii and in a real live situation, like on a skateboard or during skiing. Although there is no dynamic test, a combination of response-time measurement on a force plate combined with video analyses could overcome this constraint (Karlsson & Frykberg, 2000). The video-analysis could give a more qualitative impression of the coordination strategy children use to influence their center of gravity. Based on this video a trained observant could distinguish a hip-strategy from a more advanced ankle-strategy.

Taking our findings together, the results of this study are encouraging for further development of computer-based, game-like balance exercises for children. The low-cost of this intervention combined with the possibility to utilize this intervention in a home or school based environment provides a new solution for children with a severe delay in balance-skills. In this study, nine from the fifteen trained children moved from a clinical score (below the 6 percentile) on the balance factor to a score at risk (above the 9 percentile), which gives them a better opportunity to learn other balance related skills in daily classes and regular sport environments. The results of this study are also encouraging for the research in more implicit ways on motor learning. Despite the proven effectiveness of a more task-oriented approach there is little research on the combination of this approach with an implicit visual feedback system. This more implicit way of learning could be especially useful for children with learning problems or stress related situations, because it makes little use of capacity of the working memory. However, more research on this topic needs to be undertaken before the association between working memory, stress and motor learning is more clearly understood.

5. Conclusion

Considering the limitations and merits, this research has shown that a Wii-intervention which incorporates exercises on timing, repetitive internal modeling, near limitless exercises, visual feedback and motivational reinforcement seems to improve the static and dynamical balance skills of children with poor balance control. The results suggest no transfer from the acquired balance skills to other related motor skills, like running from side to side or hopping over a beam. In general, this study provides additional evidence to the findings of the more task-oriented approaches combined with a more implicit way of learning to guarantee the success for these children with poor balance control.

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Table 1: Characteristics of the experimental and the control group: sex, age and baseline standard scores on the M-ABC-2 test.

	Experimental group (n=15)	Control group (n=14)
Age (mean year. month, SD)	9.5 (1.8)	9.7 (1.11)
Sex (m; f)	12; 3	11; 3
M-ABC-2 total score (M, SD)	2.80 (1.82)	2.71 (1.14)
M-ABC-2 balance score (M, SD)	3.33 (1.45)	4.07 (2.09)

Table 2:Mean, standard deviation, time-, group- and interaction-effects of balance- and running speed and agility scores for the experimental and control group at pre- and post-tests (T0 and T1)

	Experimental Group N=15		Control Group N=14		Time effects (pre-post) (DF=1)			Group effects (exp-cont) (DF=1)			Interaction-effects (between groups) (DF=28)		
Test balance-scores	T0 (SD)	T1 (SD)	T0 (SD)	T1 (SD)	*F*	*p*	*ή2*	*F*	*p*	*ή2*	*F*	*p*	*ή2*
M-ABC-2: balance skills													
1. Static balance	4.33 (1.80)	5.47 (2.62)	5.00 (2.29)	5.29 (2.67)	2.76	.11	.09	.10	.75	.00	.99	.33	.04
2. Walking on a line	4.00 (4.09)	7.60 (4.15)	5.00 (3.62)	6.86 (3.76)	12.20	.00	.31	.01	.92	.00	1.24	.27	.04
3. Jumping	5.00 (4.54)	8.40 (3.46)	5.36 (3.73)	5.71 (3.43)	8.50	.01	.24	.85	.37	.03	5.57	.03	.17
M-ABC-2 Total balance scores	3.33 (1.45)	6.27 (2.40)	4.07 (2.09)	5.07 (2.84)	22.09	.00	.45	.10	.75	.00	5.34	.03	.17
BOT-2: balance skills													
1. Standing on a line	3.60 (.63)	3.87 (.35)	3.71 (.73)	3.71 (.73)	2.82	.11	.10	.00	.93	.00	2.82	.11	.10
2. Walking forward on a line	3.73 (.59)	3.73 (.70)	3.57 (.94)	3.43 (.94)	.34	.56	.01	.74	.40	.03	.34	.56	.01
3. Standing on one leg on a line	3.33 (.82)	3.53 (.92)	3.36 (.93)	3.64 (.84)	2.17	.15	.07	.05	.81	.00	.07	.80	.00
4. Standing with feet apart on a line (eyes closed)	2.40 (.99)	3.47 (.83)	3.36 (1.01)	3.64 (.84)	7.69	.01	.22	1.88	.18	.07	7.69	.01	.22
5. Walking forward on a line (heel to toe)	2.87 (1.36)	3.47 (1.12)	3.64 (.84)	3.86 (.54)	6.50	.02	.19	2.87	.10	.10	1.46	.24	.05
6. Standing on one leg on a line (eyes closed)	1.73 (.96)	2.33 (1.11)	2.79 (.70)	3.21 (1.07)	8.98	.01	.25	10.92	.00	.29	.25	.62	.01
7. Standing on one leg on a balance beam	2.20 (1.14)	3.47 (.64)	3.29 (.80)	3.36 (.84)	13.54	.00	.33	2.64	.11	.09	10.80	.00	.29
8. Standing Heel-to-toe on a balance beam	3.13 (.83)	3.13 (1.06)	2.86 (.77)	3.29 (.83)	1.68	.21	.06	.05	.83	.00	1.68	.21	.06
9. Standing on one leg on a balance beam (eyes closed)	1.53 (.83)	2.13 (.92)	2.93 (1.27)	2.43 (1.02)	0.05	.82	.00	7.50	.01	.22	6.38	.02	.19
Total Balance scores	2.73 (.56)	3.24 (.44)	3.28 (.58)	3.37 (.56)	23.44	.00	.47	3.25	.08	.11	11.76	.00	.30
BOT-2: test running speed and agility													
1. Shuttle run	5.13 (2.30)	5.07 (1.16)	6.07 (1.44)	6.14 (1.03)	.00	.99	.00	3.53	.07	.11	.09	.77	.00
2. Stepping sideways over a balance beam	6.27 (1.87)	6.87 (1.30)	6.50 (1.40)	6.64 (1.15)	1.51	.23	.05	.00	.99	.00	.57	.46	.02
3. Stationary Hop	6.13 (2.70)	7.40 (1.64)	6.07 (1.69)	7.07 (1.73)	6.48	.02	.19	.11	.74	.00	.09	.77	.00
4. One-legged side hop	3.53 (2.10)	4.13 (1.96)	4.07 (1.54)	4.21 (1.67)	4.26	.05	.14	.22	.64	.01	1.61	.22	.06
5. Two legged side hop	4.67 (2.09)	5.93 (1.49)	4.64 (1.22)	5.00 (1.57)	11.17	.00	.29	.74	.40	.03	3.51	.07	.12
Total Running speed and agility	5.15 (1.69)	5.88 (.98)	5.47 (1.06)	5.81 (1.15)	9.37	.01	.26	.09	.77	.00	1.23	.28	.04

FIG1individualstandardscoreexperimentalgroup.JPG
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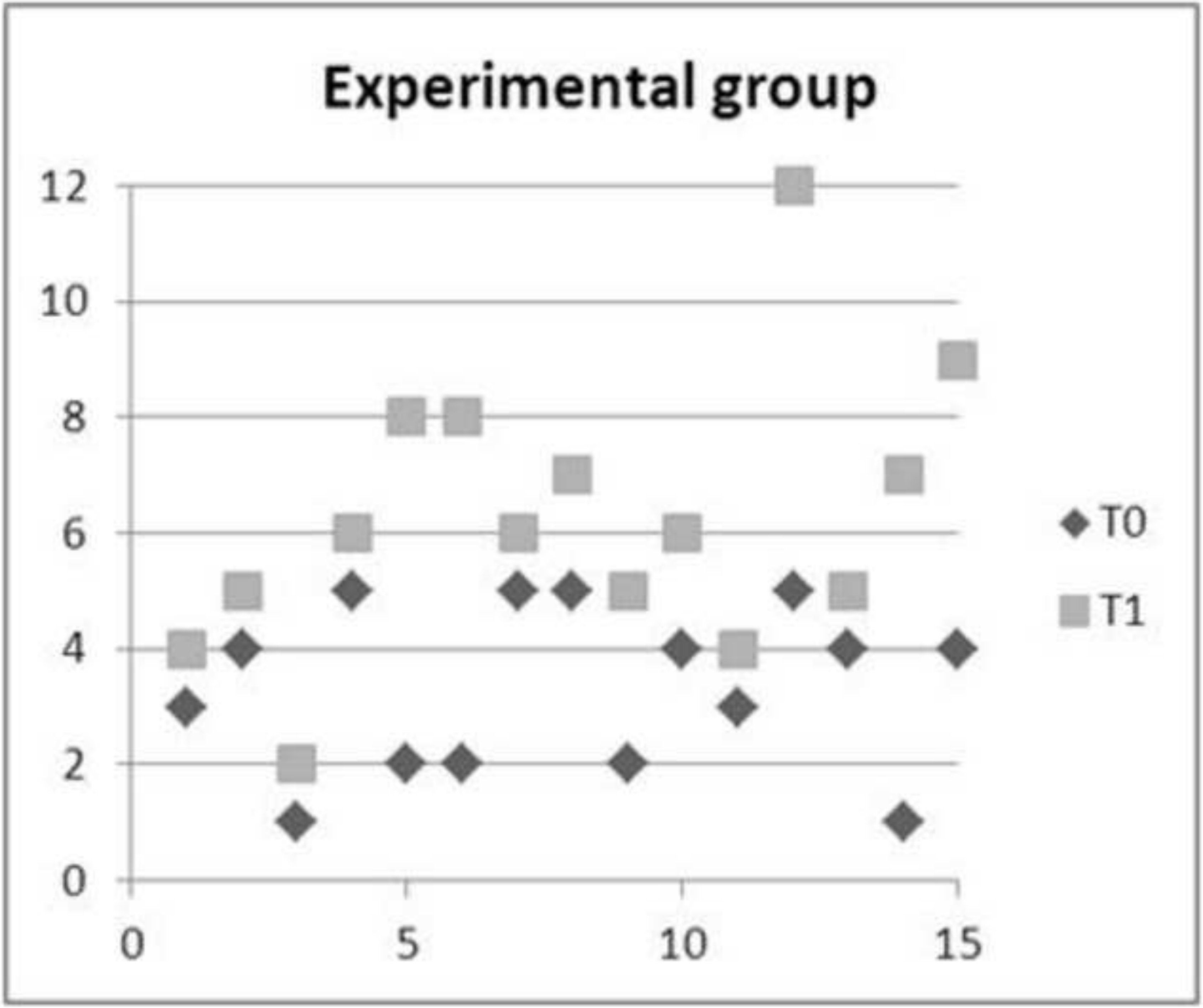

FIG2individualstandardscorecontrolgroup.JPG

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