International Journal of Scientific Reports
Ziaka A et al. Int J Sci Rep. 2024 Mar;10(3):67-74
http://www.sci-rep.com
pISSN 2454-2156 | eISSN 2454-2164

DOI: https://dx.doi.org/10.18203/issn.2454-2156.IntJSciRep20240443

Original Research Article

Sort-term adaptations on bilateral body weight-bearing symmetry and postural control through the application of rotary prisms in healthy children

Aikaterini Ziaka[1], Ioannis Giakas[1], Panagiotis Tsaklis[1-3]*

[1]Department of Physical Education and Sport Science, ErgoMech-Lab, University of Thessaly, Trikala, Greece
[2]Department Molecular Medicine and Surgery, Growth and Metabolism, Karolinska Institute, Solna, Sweden
[3]Center of Orthopaedics and Regenerative Medicine (C.O.RE.) / (C.I.R.I.) - Aristotle University Thessaloniki, Greece

Received: 13 January 2024
Revised: 13 February 2024
Accepted: 15 February 2024

***Correspondence:**
Dr. Panagiotis Tsaklis,
E-mail: tsaklis@uth.gr

ABSTRACT

Background: Motor-control is organized by coordinated sensory systems which integrate for the preparation of movement. Certain visuoperceptive disorders may impair proper development of motor control during childhood, thereby impacting functional aspects like bilateral weight-bearing symmetry. Rotary prisms (RPs) are a rehabilitation modality that have shown promise in facilitating motor-control and spatial-realignment for adults, improving weight-bearing symmetry, often evaluated by indexes like the normalized symmetry index (NSI%). However, less is known for the short-term effect of RPs on NSI% and consequent effects on functional capacity in healthy children.
Methods: We evaluated the acute and short-term chronic effect of RPs in fourteen healthy children (8.8±1.1 years) on NSI% and the total execution time (s) of a dynamic balance sit-to-stand task (SITS). Measurements were performed at baseline, immediately following RP application (immediate phase) and 10 min following RP removal (spatial re-alignment).
Results: We detected an overall main effect of time on NSI% ($F=15.1$, $p<0.001$, $\eta^2=.54$), improving both immediate (-67.3%, 3.4±4.46%, $p<0.001$) and spatial re-alignment phases (-55.3%, 5.2±4.3%, $p<0.001$) compared to baseline (9.7±1.9 %). Moreover, no significant differences for NSI% between immediate and spatial re-alignment phases were detected ($p>0.05$). However, TUT of the SITS task remained unaffected ($F=1.13$, $p>0.05$).
Conclusions: Non-significant differences for NSI% between immediate and spatial re-alignment phases indicate that short-term neural adaptations may persist following the removal of RPs in healthy children. Indicating the potential suitability of RPs in neurorehabilitation for children with balance impairments, such as pre-existing sensory motor dysfunctions and others.

Keywords: Motor control, Neuroadaptations, Posture, Rotary prisms, Weight distribution

INTRODUCTION

For individuals to navigate physical space safely and successfully, the necessity to continually adapt to the conditions of a given environment is paramount. Overall, human motor-postural control rely on the continual integration of multiple sensory systems, including vestibular, proprioceptive and visual systems in the preparation of movement.[1] These systems can be modulated using training modalities like motor-learning, balance and mobility exercises.[2] Similarly, continuous postural control is required to maintain equilibrium of the body while standing upright, providing a foundation for day-to-day activities like standing and walking, in addition to preventing harmful falls. Thereby, conveyed neural information of different sensory systems and corresponding sets of neural strategies must be continuously incorporated in the motor system's preparation of movement and postural control.[1] During childhood, visual perception plays a crucial role in the development of spatial perception and motor control, and consequently any impairments of visual perception during this time may prove detrimental on the developing organizational strategies and synergy of bodily movements of the child.[3-5] In pathological conditions where visual perception is impaired, like a prismatic displacement, sensory-motor asymmetries can occur that can adversely affect crucial stages of their developing motor-postural control prior to ages six to seven.[6-9]

The evaluation of static posture can provide important information about the impact of sensory-motor pathologies on spatial orientation and motor-postural control. By convention, static bilateral weight distribution is used to assess motor-postural control, using measures such as center of pressure (COP), bilateral weight distribution and dynamic tasks, like the sit-to-stand test with the use of force plates. Recently, the normalized symmetry index (NSI%) was suggested by Queen and co-workers as a measure of bilateral weight-bearing symmetry, taking in to account the initial discrepancies of weight bearing-distribution between two limbs, often observed in certain sensorimotor conditions.[10] The NSI% is derived by the division of the averaged value from the postural variable, denoting the dominant and non-dominant leg, respectively, by the average of the two measures expressed as a percentage. This is interpreted as lower percentages indicating low bilateral asymmetries (i.e., increased symmetry) and a higher percentage corresponds to increased levels of bilateral asymmetry.[10] Previously, a NSI% of ~5-15% have been reported in healthy adult populations.[11]

While the use of contemporary postural and motor-ability training strategies are shown to induce acute and chronic improvements for balance, agility, and reaction abilities in healthy and pathological adult populations.[2] few studies have evaluated the effect of specific neurorehabilitation modalities on children's motor-postural control. Rotary prisms (RPs) have shown promise as a neurorehabilitation modality, making it possible to alter the perception of spatial orientation when aligned with the user's visual field, demonstrated to acutely influence aspects like static tone, static reaction time, and balance recovery.[12,13] RPs are transparent pyramid shaped, three-sided ocular devices that are fixated within rotating spectacle frames which orient in different directions around its base.[14-16] The immediate effects of RPs are mainly mediated by the afferent information conveyed to the visual cortex by sight. Subsequently, this has been shown to alter the spatial perception of the individual, inducing a mechanistic provocation to re-align proximal and distal segments of the body.[13] Following the immediate effect, a short-term chronic effect of spatial re-organization that persists following the discontinuation of RPs have been termed spatial re-alignment, owed to the afferent information conveyed to the visual cortex acting as a stimulus for neural adaptations.[17] Therefore, this type of modality may constitute a potential tool for motor-sensory neurorehabilitation, due to its ability to induce acute visuomotor adaptations within the visual-sensory-motor system.

However, while prior studies have focused their attention towards the implementation of RPs to facilitate motor-postural control in both healthy and pathological adult populations, there is still a lack of research evaluating the effect of RPs in children, which may prove especially important in the context of developmental motor control during childhood.[3,5] Therefore, the aim of the present study was to evaluate the effect of the prismatic orientation on a group of healthy children aged 7-10, during the immediate (i.e., wearing RP) and spatial realignment phase (i.e., following removal), on bilateral weight-bearing symmetry (NSI%) in the standing position. Secondarily, we aimed to evaluate the effect of prismatic application on physical function, by quantifying the total execution time (TET) of a dynamic sit-to-stand task for the same timepoints.

METHODS

Participants

The participants, fourteen healthy children, consisting of nine boys and five girls were recruited in the Thessaloniki and Trikala cities, for participation in the study (Table 1). The study was conducted at the Laboratory of Biomechanics and Ergonomics @ErgoMechLab, at the Department of Physical Education and Sport Science, University of Thessaly (DPESS UTH), during the period April to August 2021. All participants were healthy and had not been diagnosed with any form of visual, auditory, vestibular, or motor dysfunctions. Both the participants and their legal guardians received detailed verbal and written information regarding the details and potential benefits of the study. If willing to participate, a voluntary consent form was signed by their respective legal guardians. Each child visited the laboratory twice, accompanied by their guardian to carry out the study tasks. The study protocol was approved by the ethics and deontology committee of DPESS UTH and was carefully performed in accordance with the Declaration of Helsinki and general safe laboratory procedures.

Experimental set-up and procedure

The present study was carried out in a pseudo-experimental setting, due to a lack of controls. Participants visited the laboratory on two occasions separated by two days. For the first occasion, the participants and their legal guardians were introduced to the outline of the study, experimental environment, and protocols. Emphasis was placed on making sure the participants felt comfortable in the experimental environment. For the second occasion, the participants were reacquainted with the experimental protocols and determination NSI% and the total duration of a sit-to-stand task was performed in parallel for each of the phases (i.e., baseline, immediate and spatial realignment phase (Figure 1). All recordings were collected and conducted by the same examiner and supervised by the same senior investigator throughout all the tests.

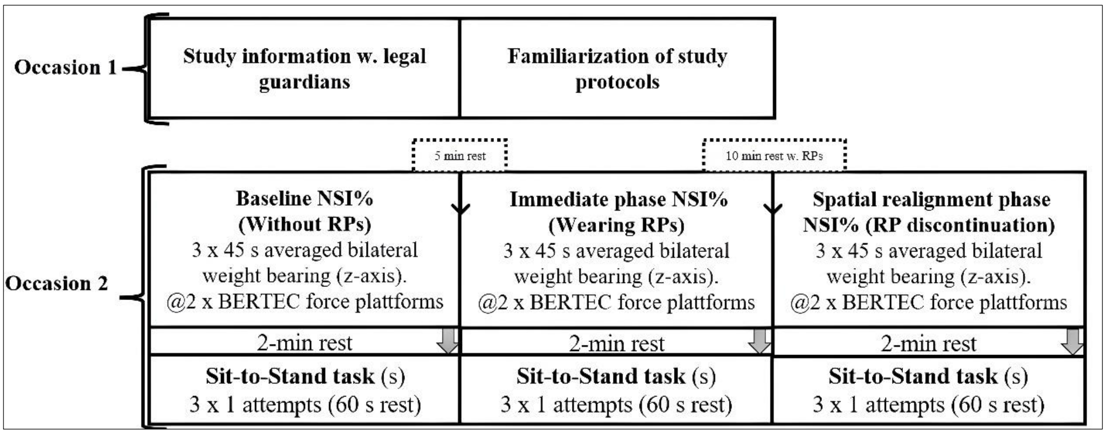

Figure 1. Normalized symmetry index percentage, NSI%.

Data collection

The data collection for the sit-to-stand test was based on the previously described prisms protocol of R.M. Benabib.[15] Both NSI% and the sit-to-stand measurements were performed using two calibrated, time-synchronized force plates (FP40X60-07-1000, Bertech Corp™, Columbus OH, USA). A sampling frequency of 1000 Hz was used to record vertical (Fz) ground reaction forces (GRF) during the measurements. The measurements, absolute and relative were calculated with the Vicon Polygon 3.5.1, software (Vicon Motion Systems Ltd™, UK) and the NSI% was calculated as described by Queen and co-workers (Equation 1).

Assessment of static bilateral weight-bearing symmetry and dynamic function

Baseline phase

While standing with each foot firmly planted on two force plates (FP40X60-07-1000, BERTEC Corp™, Columbus, OH, USA), the participant was asked to remain still for 45 seconds with their arms to their sides and feet situated in a neutral position, keeping their line of sight focused on a target at a 5 m distance, elevated to eye-level of the participant. This position was used to record the baseline vertical GRF acted on the platforms for each limb. This procedure was repeated three times and the average bilateral NSI% was calculated from the absolute values of the attempts, using the determined dominant and non-dominant leg of the participant (Equation 1). For the sit-to-stand task, participants were asked to be seated on a stool, placed at a height which corresponded to 90° knee flexion of the individual participant, when comfortably seated and making sure they sat firmly with their feet planted on the force plates. Once seated and following a brief countdown (“3-2-1-Go”) the participant was asked to stand up as fast as possible and stay still for a period of 10 seconds, and between the attempts the participant was allowed to rest for 60 s. The procedure was repeated three times and the average duration (s) was calculated from the attempts. The chair was placed by the force plates with the intention of avoiding any bias on data collection of the dynamic loading.

Immediate phase

Following the baseline phase and a 5-minute rest, the participant was asked to wear a pair of rotary prisms (5th order Fresnel lens, Figure 2), with the prism base facing the same side as the disproportionally loaded side, previously determined during the baseline phase (e.g., if the weight shifts right, the base of the prisms is adjusted to face to the right for both eyes). To evaluate the immediate effect of the prism orientation on NSI%, the participant was asked to again stand on the two platforms, using the previously described protocol. Absolute vertical GRF values were recorded from three attempts and the NSI% for the immediate phase was calculated. For the sit-to stand task, while still wearing the RPs the participant sat on the chair, using the previously recorded height. Again, once seated and following a brief countdown (“3-2-1-Go”) the child was asked to stand up as fast as possible and stay still for a period of 10 seconds. The procedure was repeated three times and the average duration (s) was calculated from the attempts. Following the immediate phase, the participant was allowed to rest for 10 minutes while wearing the prisms to induce a state of spatial re-alignment (Figure 2).

Spatial re-alignment phase

Following a 10-min rest from the immediate phase, the participant was asked to remove the RP for the final recording. To evaluate the effect of RPs on bilateral weight bearing symmetry for the spatial re-alignment phase the participant were asked to stand on the two platforms, using the previously described protocol. The absolute vertical GRF values were recorded from three attempts and used in the calculation of NSI% for the spatial re-alignment phase. Lastly, using the previously described protocol and settings, the total-duration of the sit-to-stand task was determined by asking the participant to stand up as fast as possible and stay still for a period of 10 seconds following a brief countdown. The procedure was repeated three times and the average duration (s) was calculated from the attempts.

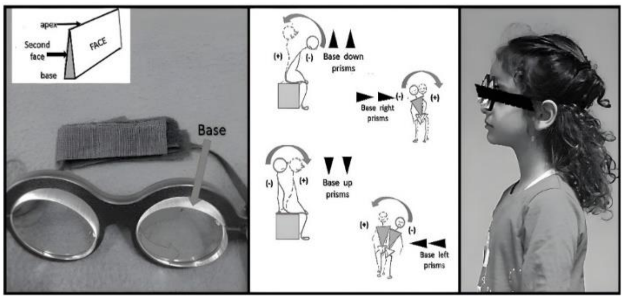

Figure 2: Rotary prism as described in text and effect following prismatic orientation.

Data processing

For the vertical component of GRF, a single mean value was determined for each limb of the participant based on the averaged values of three attempts, consisting of 45 s static standing on the two force platforms. Following comparison of the absolute weight distribution between the two limbs, the highest averaged value of three attempts was defined as the dominant limb, and the lower value was defined as the non-dominant limb. Accordingly, NSI% was calculated by dividing mean value of the postural variable of the dominant and non-dominant leg by the summed average for the two legs, divided by the two legs. NSI was expressed as percentage where NSI=0% denotes complete symmetry and NSI=100% denotes complete asymmetry (Equation 1). For the purpose of this study, bilateral weight bearing asymmetry was defined as a NSI% >15%, as previously suggested by Gallagher and co-workers.[18] For the total-duration of the sit-to-stand task, average duration (s) was calculated from three attempts.

$$\text{NSI\%} = \left[\frac{(\text{Dominant Limb} - \text{Non Dominant Limb})}{(\text{Dominant Limb} + \text{Non Dominant Limb})}\right] \div 2$$

Statistical analysis

For the present study, statistical analyses were performed using the statistical package for the social sciences (SPSS) 23.0 software (IBM Inc., Chicago, IL, USA). Prior to analyses all data were tested for normality of distribution using Kolmogorov-Smirnov tests. The baseline values of vertical GRF acted on each force platform was used to determine the dominant and non-dominant leg to calculate the NSI% according to Equation 1. For the parameters of NSI% between the three measurement occasions, a one-way repeated measures ANOVA were used to assess differences over time, using measurement occasion as related between subject factors and measurement occasion × NSI%, as a within subject factor. For the TET (s) of the sit-to stand test of the three occasions, one-way repeated measures ANOVAs were used to assess differences over time, using the measurements occasions as related between-subject factor, and measurement occasion × TET as a within subject factor. If significant differences were found over time or time x within subject factor, a post hoc test was performed, and a Sidak correction of the p-value was applied. For variables where the assumption of sphericity of variance was violated (i.e., Greenhouse-Geisser epsilon <0.75), a Greenhouse-Geisser correction was applied. Otherwise, the Huynh-Feldt correction was used. Data are presented in tables as mean values ±SD, and in figures as mean values ± SE. Statistical significance was set at $p<0.05$ and cut-off levels for effect size (ES) for partial eta squared (η^2) were defined arbitrarily as small=0.01, medium=0.06 and large=0.14 as recommended by Cohen and co-workers.[19]

RESULTS

Anthropometrics

Fourteen healthy children, with a mean age of 8.8±1.1 years and height (cm) and weight (kg) of 135.3±5.2 and 29.1±2.9, were recruited in the [REDACTED] for participation in the study. Descriptive characteristics of the participants are shown in Table 1.

Table 1: Anthropometric and personal data of the participants.

Parameter	N	Means±SD
Weight (kg)	14	29.1±2.9
Height (cm)	14	135.3±5.2
Age (years)	14	8.8±1.1

*Data represent mean values±SD

Bilateral weight-bearing symmetry (NSI%)

Descriptive statistics for bilateral weight-bearing symmetry for each measurement is depicted below in Table 2. Data is expressed as a percentage of the total bilateral weight distribution of the two limbs and the calculated NSI%, with grey fields denoting the dominant limb. By observing Table 2, it can be gathered that during the use of the RPs, a "switch" in the dominant leg could be observed (i.e., shaded fields), appearing to persist following the removal of the RPs.

A one-way repeated-measures ANOVA was conducted to compare the effect of RPs on changes of the NSI% across the three time points. The results revealed a significant main effect of time on NSI% ($F=15.1$, $p<0.001$, $\eta^2=0.54$). Furthermore, meeting the assumption for post-hoc analysis, a pairwise comparisons using the estimated marginal means (Figure 3), revealed that NSI% showed an initial, significant decrease of -67.3 % (p<0.001) during the immediate phase (3.4±4.46%) compared to baseline (10.2±4.6%). Following this, for the spatial realignment phase, NSI% decreased significantly by 55.3% (5.2±4.3%) in comparison to baseline (p<0.05). Of note, there were no significant increase of NSI% following the removal of the RPs, shown by a modest 6.2% increase of NSI% between the immediate and spatial realignment phases (p>0.05, Figure 3). The overall effect size for the main effect was classified as large, with η^2 of 0.54 (Table 3).

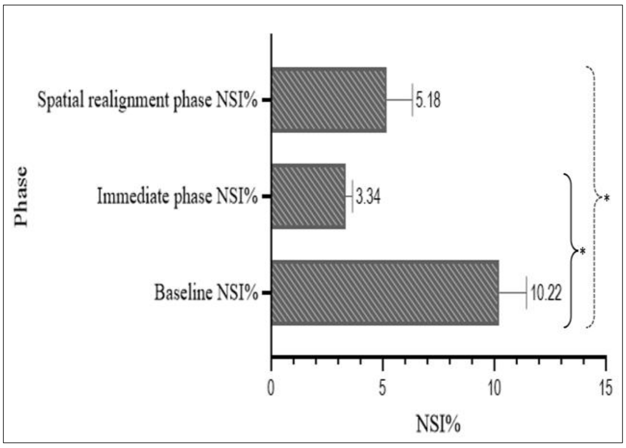

Figure 3: The normalized symmetry index over the three time-points.

Mean NSI% values for the three measurements, expressed as a percentage ranging between 0-100%. A high value indicates a high level of bilateral weight-bearing asymmetry. Asterisks (*) indicate significant effects between the marked phases (p<0.05)

The sit-to-stand task

The dynamic sit-to-stand balance task was evaluated using the TET duration, denoting the duration required for COP velocity to minimize and recover balance (Figure 4). This was expressed as the total duration seconds of the active time from the onset of movement to the end of the static balance recovery time (e-f, Figure 4). The one-way repeated-measures ANOVA was conducted to compare the effect of RPs on changes of the TET duration over the three time points. However, there appeared to be no effect of RP on TET, as no significant main effect was observed (Table 4, F=1.13, p>0.05).

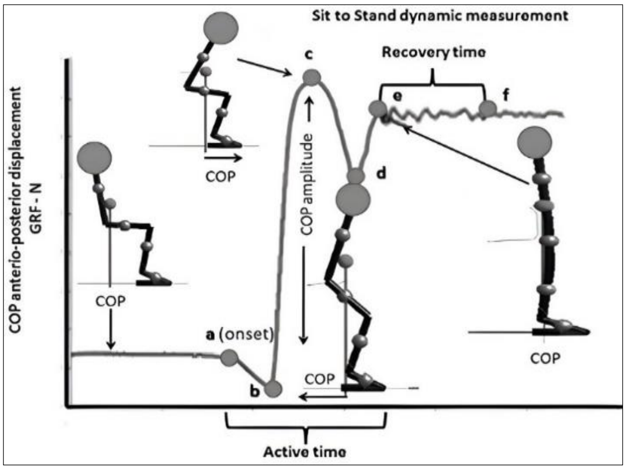

Figure 4: Illustration of the sit to stand task and phases.

COP: centre of pressure

Table 2: Normalized symmetry index (NSI%) and percentual distribution of total load between the lower limbs for measurements 1-3.

S. no.	Leg/measure	R 1st	L 1st	Leg/measure	R 2nd	L 2nd	Leg/measure	R 3rd	L 3rd
	Baseline NSI%±SD	%	%	Immediate NSI%±SD	%	%	Spatial realignment NSI%±SD	%	%
1	11.85±0.81	52.95	47.05	4.95±0.81	45.07	54.93	6.07±4.95	48.49	51.51
2	9.65±2.38	47.59	52.41	4.61±0.39	54.61	45.39	4.40±4.61	51.11	48.89
3	14.87±2.33	53.73	46.27	4.92±0.79	45.07	54.93	3.25±4.92	49.17	50.83
4	7.94±1.14	51.99	48.01	3.14±0.10	46.85	53.15	4.40±3.14	48.91	51.09
5	12.16±0.97	46.97	53.03	3.40±0.03	53.40	46.60	6.93±3.40	51.73	48.27
6	14.30±2.04	53.57	46.43	3.67±0.17	45.84	54.16	6.96±3.67	48.26	51.74
7	0.58±4.82	49.84	50.16	3.16±0.09	53.15	46.85	2.24±3.16	52.56	44.44
8	2.69±3.77	50.66	49.34	3.78±0.22	46.22	53.87	5.09±3.78	47.72	52.28
9	4.97±2.63	48.75	51.25	1.21±1.07	51.21	48.79	2.37±1.21	50.60	49.40
10	14.80±2.29	53.70	46.30	2.42±0.46	47.58	52.42	6.00±2.42	48.51	51.49
11	12.44±1.11	46.89	53.11	2.90±0.22	52.90	47.10	2.45±2.90	50.60	49.40
12	11.75±0.77	47.07	52.93	3.19±0.07	53.18	46.82	18.58±3.19	54.65	45.35
13	14.40±2.09	53.61	46.39	3.83±0.25	46.16	53.84	2.67±3.83	49.33	50.67
14	10.70±0.24	52.68	47.32	1.55±0.90	48.45	51.55	1.15±1.55	49.71	50.29

R: Right leg, L: left leg, NSI%: normalized symmetry index, N: participant. Shaded field indicates dominant loading leg and white fields indicates non-dominant leg

Table 3: ANOVA statistics showing p values for main effects of time and time × related group interactions.

Parameter	Measurement stages	N	Mean	SD	F-value	P value	Partial η^2
NSI% main effect	Baseline phase	14	10.2	4.6	15.1	<0.001*	0.54
	Immediate phase	14	3.4	4.5			
	Spatial realignment phase	14	5.2	4.3			

Mean NSI% values, standard deviation, F-value, and effect size (partial eta2) between the three measures, *significant effects (p<0.05)

Table 4: Mean values and standard deviation (s) differences between the TET between measures.

Aspect	Measurement stages	N	Mean time	Standard deviation	F	P value
Sit to stand TET (s)	Baseline	14	3.183	0.919	1.132	0.334
	Immediate phase	14	3.243	0.802		
	Spatial realignment phase	14	2.815	0.746		

DISCUSSION

While previous research has primarily addressed the potential use and efficacy of RPs in the correction of human motor-postural control in healthy and pathological adult populations, there is still a lack of research evaluating the effect of RPs in children. This may be especially important in the context of developmental motor control during childhood, as it has been suggested that weight-bearing lateralization completes around ages six to seven.[9,11] To our knowledge, no previous study have evaluated the implementation of RPs on the modulation of bilateral weight bearing (NSI%) and motor-postural control in the static standing position in healthy children. The findings of the present study show that the participants initially demonstrated only minor bilateral weight-bearing distribution asymmetries during static stance. However, it could be said that above mentioned results were expected, considering that similar degrees of bilateral asymmetry have been shown in healthy adult individuals.[11,18] Furthermore, these values were overall within the <15% NSI cut-off limits, previously suggested by Gallagher and co-workers, indicating that the participants included in the study displayed normal levels of bilateral symmetry, even by adult standards.[18] Our one-way repeated-measures ANOVA revealed a significant main effect of time on NSI%, and our post-hoc, pairwise comparisons subsequently showed that NSI% significantly decreased by 67.3% following baseline and the immediate phase compared to baseline. These findings are in alignment with the results of prior studies evaluating the effect of RP in healthy adults.[2,17,20] Following the removal of the RPs, during the spatial realignment phase, NSI% decreased significantly by 55.3%, compared to baseline (p<0.05). When observing this in parallel with Table 2, a prominent "switch" in the dominant leg during and following the use of the RPs was observed. While it could be argued that this was somewhat expected, when considering previous studies in both healthy and pathological adult populations, we noted that there was only a 6.2% increase of NSI% between the immediate phase and the spatial realignment phase, indicating that improvement in bilateral weight-bearing symmetry persisted following the removal of the RPs (p>0.05). We believe this indicates that a state of persistent spatial realignment had been successfully achieved by producing a shift in the body's midline centre of gravity, likely influenced by short-term neuroadaptations.

Previously, it has been stated that the use of RPs may acutely provoke postural changes, by altering spatial perception. These alterations include aspects as the re-alignment of head-neck-trunk and limbs, contributing to a reorganization of posture.[3,21,22] It may be argued that these adaptations are caused in part by the mechanistic provocation to re-align proximal and distal segments to accommodate the altered visual field, manifesting acutely during the immediate phase. Particularly, head positioning has been previously reported as a key factor in the static control of posture, and secondarily, as a short-term neural adaptation during the spatial realignment stage, where postural changes persist following the removal of the RPs.[2,24] For the TET as a measure of functional capacity during a dynamic balance task, no significant changes were detected. It may be speculated that this were due to the participants displaying normal levels of NSI% at baseline, thereby making baseline impairments of dynamic balance unlikely. However, it may be possible that pathological conditions where sensory-motor function is impaired, that functional improvements would have been observed, similar to previous findings in adult pathological populations.[17,25]

We previously stated that, in order for organisms to successfully comprehend and navigate their physical environment, there is a continuous demand to adapt to the conditions of a given environment.[26,27] Therefore, even these short-term neural adaptations, represented by spatial realignment, demonstrate the extraordinary ability of the human brain to rapidly accommodate not only new environments, but also novel states of spatial perception. Shown by the rapid recalibration of motor control strategies observed in the present study. In normal circumstances, these control strategies exist to serve the continual optimization of motor patterns in accordance with the changing spatial environment. Thus, these adaptations are dependent on the capacity of sensory systems to receive, process and organize sensory-motor information, which is integrated within the schemata of a specific planned movement.[15,26,27] Therefore, it stands to reason that purposeful manipulation of the afferent pathways conveyed to the somatosensory cortex may elicit beneficial adaptations that may be used in rehabilitation purposes. In the context of rotary prisms, the artificially induced afferent discrepancies between visual and proprioceptive input, likely acts as a stimulus for the re-organization of sensory-motor information. Possibly, this sensory disorganization provokes the central command to alters the individual's spatial perception, producing the state of spatial re-alignment.[26,27] However, a limitation acknowledged in the present study is our lack of controls, producing a pseudo-experimental setting. However, in accordance with the law of accommodation, more well adapted individuals that demonstrate normal levels of bilateral symmetry, should by logic require a robust stimulus to adapt. Accordingly, our participants, all demonstrated normal levels of initial bilateral weight-bearing symmetry (i.e., NSI <15%), making our findings somewhat noteworthy. Conversely, this indicates that likely children with sensory-motor impairments would have displayed more pronounced adaptations with the use of RPs. However, future studies which implement adequate controls and stratification by gender may be needed to recommend the use of RPs in the clinical setting with children with issues relating to sensory-motor asymmetries, due to prismatic displacement.[26,27] We encourage future studies to enquire in the clinical application of RPs, as a potential treatment modality in the area of neurorehabilitation.[17,25,28]

CONCLUSION

The findings of the present study showed a strong main effect with the use of rotary prisms on bilateral body weight-bearing symmetry (NSI%), during the static stance in children aged 7-10 years. Following the discontinuation of the rotary prisms, participants maintained improved bilateral weight-bearing symmetry compared to baseline. We did not however, detect any changes in the total execution time of the dynamic sit-to-stand task, believed to have been influenced by the normal levels of bilateral symmetry for the participants. Based on the findings in the present study, we argue that appropriate inclusion of RPs in rehabilitation strategies may improve bilateral weight-bearing symmetry in children with pre-existing sensory-motor impairments.[15] The results of the present study may be used in the formulation therapeutic intervention strategies for children with balance impairments, such as pre-existing sensory motor dysfunctions.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Huitema RB, Brouwer WH, Mulder T, Dekker R, Hof AL, Postema K. Effect of ageing on the ability to adapt to a visual distortion during walking. Gait Posture. 2005;21(4):440-6.
2. Gottshall KR, Hoffer ME, Cohen HS, Moore RJ. Active head movements facilitate compensation for effects of prism displacement on dynamic gait. J Vest Res. 2006;16(1–2):29-33.
3. Sacheli LM, Candidi M, Pavone EF, Tidoni E, Aglioti SM. And Yet They Act Together: Interpersonal Perception Modulates Visuo-Motor Interference and Mutual Adjustments during a Joint-Grasping Task. Plos One. 2012;7(11):e50223.
4. Heed T, Röder B. Motor coordination uses external spatial coordinates independent of developmental vision. Cognition. 2014;132(1):1-15.
5. Wang Z, Jordan K, Newell KM. Coordination Patterns of Foot Dynamics in the Control of Upright Standing. Motor Control. 2012;16(3):425-43.
6. Bedford FL. Perceptual and cognitive spatial learning. J Exp Psychol. 1993;19:517-30.
7. Redding GM, Wallace B. Adaptive spatial alignment and strategic perceptual-motor control. J Exp Psychol. 1996;22:379-94.
8. Redding GM, Tharp DA. Processing line location and orientation. J Exp Psychol. 1981;7:115-29.
9. Sobera M, Siedlecka B, Syczewska M. Posture control development in children aged 2-7 years old, based on the changes of repeatability of the stability indices. Neurosci Lett. 2011;491(1):13-7.
10. Queen R, Dickerson L, Ranganathan S, Schmitt D. A novel method for measuring asymmetry in kinematic and kinetic variables: The normalized symmetry index. J Biomechanics. 2020;99:109531.
11. Stodółka J, Sobera M. Symmetry of lower limb loading in healthy adults during normal and abnormal stance. Acta Bioeng Biomech. 2017;19(3):93-100.
12. Redding GM, Wallace B. Prism Adaptation During Target Pointing From Visible and Nonvisible Starting Locations. J Motor Behav. 1997;29(2):119-30.
13. Benabib RM. Use of rotary prisms as a modality during physical handling. Clinicians View. 2018;1-18.
14. Redding GM, Wallace B. Asymmetric Visual Prism Adaptation and Intermanual Transfer. J Motor Behav. 2009;41(1):83-96.
15. Redding GM, Wallace B. Adaptive Mechanisms in Perceptual-Motor Coordination. J Motor Behav. 1988;20(3):242-54.
16. Redding GM, Wallace B. Intermanual Transfer of Prism Adaptation. J Motor Behav. 2008;40(3):246-64.
17. Pisella L, Rode G, Farnè A, Tilikete C, Rossetti Y. Prism adaptation in the rehabilitation of patients with visuo-spatial cognitive disorders. Curr Opin Neurol. 2006;19(6):534-42.

18. Gallagher KM, Nelson-Wong E, Callaghan JP. Do individuals who develop transient low back pain exhibit different postural changes than non-pain developers during prolonged standing? Gait Posture. 2011;34(4):490-5.
19. Fritz CO, Morris PE, Richler JJ. Effect size estimates: Current use, calculations, and interpretation. J Exp Psychol Gen. 2012;141:2-18.
20. Martin TA, Norris SA, Greger BE, Thach WT. Dynamic Coordination of Body Parts During Prism Adaptation. J Neurophysiol. 2002;88(4):1685-94.
21. Redding GM, Wallace B. Prism adaptation in alternately exposed hands. Atten Percept Psychophys. 2013 Aug 1;75(6):1168-85.
22. Berberovic N, Pisella L, Morris AP, Mattingley JB. Prismatic adaptation reduces biased temporal order judgements in spatial neglect. NeuroReport. 2004;15(7):1199-204.
23. Redding GM, Wallace B. Perceptual-motor coordination and prism adaptation during locomotion: A control for head posture contributions. Perception Psychophysics. 1987;42(3):269-74.
24. Assaiante C, Amblard B. Ontogenesis of head stabilization in space during locomotion in children: influence of visual cues. Exp Brain Res. 1993;93(3):499-515.
25. Jacquin-Courtois S, Rode G, Pisella L, Boisson D, Rossetti Y. Wheel-chair driving improvement following visuo-manual prism adaptation. Cortex. 2008;44(1):90-6.
26. Redding G, Rossetti Y, Wallace B. Applications of prism adaptation: A tutorial in theory and method. Neurosci Biobehav Rev. 2005;29:431-44.
27. Redding GM, Wallace B. Prism adaptation and unilateral neglect: Review and analysis. Neuropsychologia. 2006;44(1):1-20.
28. Rode G, Klos T, Courtois-Jacquin S, Rossetti Y, Pisella L. Neglect and prism adaptation: A new therapeutic tool for spatial cognition disorders. Restor Neurol Neurosci. 2006;24(4–6):347-56.

Cite this article as: Ziaka A, Giakas I, Tsaklis P. Sort-term adaptations on bilateral body weight-bearing symmetry and postural control through the application of rotary prisms in healthy children. Int J Sci Rep 2024;10(3):67-74.