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Effects of Neurophysiotherapy and Tactile Stimulation on Sensory Recalibration in Children with Autism Spectrum Disorder

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ABSTRACT

Background: *Sensory dysregulation, involving atypical tactile, proprioceptive, and vestibular responses, is a central challenge in Autism Spectrum Disorder (ASD) and contributes to deficits in balance, coordination, and adaptive behavior. Sensory recalibration—the nervous system's capacity to reweight unreliable sensory inputs—is often impaired in ASD, resulting in inefficient motor control. Interventions such as Neurophysiotherapy (NPT) and Tactile Stimulation (TS) target complementary aspects of this dysfunction, but their combined effects remain insufficiently characterized.* ***Objective:*** *To examine the individual and combined effects of NPT and TS on sensory processing, balance, and multisensory recalibration in school-aged children with ASD.* ***Methods:*** *In this single-blind, four-arm randomized controlled trial, eighty children aged 6–12 years with clinically confirmed ASD and sensory processing difficulties were allocated to NPT, TS, combined NPT+TS, or treatment-as-usual (TAU). Interventions were delivered thrice weekly for eight weeks. Outcomes were measured pre- and post-intervention using the Short Sensory Profile (SSP), Pediatric Balance Scale (PBS), and Sensory Reweighting Index (SRI). ANCOVA adjusted for baseline values, and Hedges' g quantified effect sizes.* ***Results:*** *All active interventions outperformed TAU, with the combined group achieving the largest gains: SSP +22.8 ($p < 0.001$, $g = 1.25$), PBS +8.8 ($p < 0.001$, $g = 1.39$), and SRI +0.22 ($p < 0.001$, $g = 1.89$). Improvements reflected both behavioral adaptation and physiological sensory reweighting, with high adherence (>92%) and no adverse events.* ***Conclusion:*** *Neurophysiotherapy and tactile stimulation each enhance sensory integration and balance in ASD, but their combination produces superior, synergistic effects. Integrating tactile modulation with motor retraining optimizes sensory recalibration, offering a clinically feasible pathway for improving functional adaptability in children with ASD.*

Keywords
Autism Spectrum Disorder, Neurophysiotherapy, Tactile Stimulation, Sensory Integration, Sensory Recalibration, Balance, Multisensory Processing

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition defined by persistent differences in social communication alongside restricted and repetitive patterns of behavior, yet for many school-aged children the most functionally disruptive feature is sensory dysregulation that affects everyday participation, learning, and motor performance (1). Sensory dysregulation in ASD spans hyper- and hypo-responsiveness as well as sensory seeking across tactile, proprioceptive, and vestibular domains; these atypical responses co-occur with attentional differences and are linked to real-world difficulties in self-care, school routines, and play (2,3). Converging evidence indicates that balance, body schema, and motor coordination are frequently impaired in ASD, consistent with disturbances in multisensory processing required to integrate tactile, proprioceptive, and vestibular input for postural control (4). From a systems neuroscience perspective, stable action depends on sensory recalibration—the adaptive reweighting of inputs according to context-specific reliability—so that misleading cues are down-weighted and trustworthy signals are prioritized to guide perception and motor output (5,6). While typically developing children flexibly reweight inputs across environments (e.g., uneven surfaces, low light), individuals with ASD often exhibit blunted or inconsistent reweighting that manifests as postural instability and spatial disorientation (7,8). Mechanistically, altered connectivity and excitability within parietal–cerebellar networks and related multisensory hubs may undermine efficient integration, providing a tractable therapeutic target (9,10).

Interventions that directly engage sensorimotor prediction and afferent modulation offer a plausible route to restore recalibration capacity in ASD (11). Neurophysiotherapy (NPT), grounded in motor learning and neuroplasticity principles, uses task-specific, repetitive challenges—dynamic balance, graded weight shifts, resisted reach, and dual-task gait—to strengthen internal models, improve feedback–feedforward control, and provoke error-based updating under vestibulo-proprioceptive load (12–14). Emerging work shows that pairing vestibular activation with postural training can recalibrate somatosensory and gaze stabilization processes, supporting transfer to functional stability (15). Complementing this approach, Tactile Stimulation (TS)—including deep-pressure protocols, brushing adaptations, textured exploration, and stereognosis tasks—targets cutaneous and subcutaneous receptors to normalize somatosensory cortical responses, reduce arousal linked to sensory defensiveness, and facilitate readiness for motor learning (16–18). Clinical guidance and observational evidence suggest that well-structured sensory strategies can reduce sensory "noise," potentially amplifying the learning gains achievable with NPT (19). Nevertheless, the evidence base remains mixed: pragmatic trials of sensory integration therapy report modest benefits on caregiver-reported sensory outcomes, and device-based or garment-based deep pressure often yields short-lived calming with uncertain generalization to balance or multisensory metrics (20). At the same time, task-oriented vestibulo-proprioceptive programs demonstrate medium-to-large improvements in dynamic balance when dosing and instability are sufficient, but they rarely quantify changes in multisensory reweighting mechanisms (12,15).

A key methodological gap is the limited use of objective indices that capture how children adjust sensory weights under conflict conditions. Laboratory paradigms such as moving-room or visual-surround illusions permit derivation of a Sensory Reweighting Index (SRI) from postural sway characteristics to quantify adaptive up-weighting of reliable proprioceptive/vestibular cues when visual information is misleading, yet pediatric ASD trials seldom incorporate such mechanistic measures alongside clinical scales (22,23). This gap constrains mechanistic inference and hinders optimization of intervention components. Theoretical work further implies that coupling TS to NPT could yield synergistic effects: TS may first reduce tactile-related noise and autonomic arousal, permitting NPT's error-driven updates to consolidate more efficiently across sessions; reciprocally, improved motor prediction from NPT may sharpen tactile discrimination through refinement of the body schema (19,24). Despite this plausible complementarity, the additive or interactive effects of NPT and TS on both clinical outcomes and multisensory reweighting have not been tested in a rigorous randomized design in school-aged children with ASD (20).

Within a Population–Intervention–Comparator–Outcome (PICO) framework, the present randomized, single-blind, four-arm study enrolls children aged 6–12 years with ASD and documented sensory processing difficulties to evaluate the individual and combined effects of NPT and TS versus treatment-as-usual (TAU) on sensory processing (Short Sensory Profile, SSP), balance (Pediatric Balance Scale, PBS), and mechanistic multisensory recalibration (Sensory Reweighting Index, SRI) over eight weeks (2,4,22). We hypothesize a graded response in which the combined NPT+TS program produces superior improvements relative to either modality alone, and each active intervention outperforms TAU, with the largest effects expected on SRI as an objective marker of adaptive sensory up-weighting under conflict, accompanied by clinically meaningful gains on SSP and PBS (12,15,18,22).

MATERIAL AND METHODS

The study employed a single-blind, four-arm randomized controlled design conducted over an eight-week intervention period in pediatric rehabilitation and community therapy centers in Gujranwala, Pakistan. The design was chosen to establish causal relationships between neurophysiotherapy (NPT), tactile stimulation (TS), and their combination on sensory recalibration, balance, and sensory processing among school-aged children diagnosed with Autism Spectrum Disorder (ASD). Randomization was implemented to minimize selection bias and ensure balanced baseline characteristics across groups, while single-blinding of assessors was applied to reduce detection bias during outcome evaluation. The trial adhered to international reporting standards for interventional research and followed ethical principles consistent with the Declaration of Helsinki (25).

Participants included children aged 6–12 years with a clinician-confirmed diagnosis of ASD according to DSM-5 criteria and documented sensory processing difficulties defined as a Short Sensory Profile (SSP) total score at least one standard deviation below age norms. Children were excluded if they presented with uncontrolled epilepsy within the preceding six months, major orthopedic limitations restricting participation, or an IQ below 50. Recruitment occurred through outpatient pediatric therapy clinics, local schools offering inclusive education, and caregiver networks. After screening, eligible participants were randomly assigned in a 1:1:1:1 ratio to four parallel groups: NPT alone, TS alone, combined NPT+TS, and treatment-as-usual (TAU). Randomization was achieved using a computer-generated sequence with block sizes of four to maintain allocation balance. Concealment was ensured through sealed opaque envelopes opened sequentially after baseline assessment. Written informed consent was obtained from parents or guardians, and verbal assent was secured from each child when developmentally appropriate (26).

All interventions were standardized and delivered by licensed pediatric physiotherapists and occupational therapists trained in sensory integration and neurodevelopmental techniques. The NPT group received three 45-minute sessions per week comprising vestibulo-proprioceptive loading, dynamic balance tasks, resisted reaching, and dual-task gait training designed to provoke controlled instability and promote adaptive sensory reweighting. The TS group participated in three 30-minute sessions weekly consisting of deep-pressure protocols, Wilbarger-style brushing, textured object exploration, and stereognosis games targeting tactile discrimination and modulation; caregivers were trained to perform a 10-minute home-based routine daily. The combined group alternated between NPT and TS sessions on successive days, maintaining an equivalent total weekly duration to ensure parity of exposure. The TAU group continued with their routine school-based occupational therapy programs without additional sensory-specific content. To promote fidelity, therapists used a manualized intervention guide and completed adherence checklists for each session (27).

Outcome assessments were conducted at baseline and post-intervention by evaluators blinded to group allocation. The primary outcome was sensory processing, measured by the total SSP score (0–190; higher scores indicate better sensory performance). Secondary outcomes included balance assessed with the Pediatric Balance Scale (PBS, range 0–56) and multisensory recalibration quantified by the Sensory Reweighting Index (SRI, range 0–1). The SRI was derived from center-of-pressure sway responses recorded under visual–vestibular conflict conditions using a stabilometric platform, representing the proportionate increase in proprioceptive/vestibular weighting relative to visual reliance during induced perturbation (28). All instruments demonstrated satisfactory internal consistency and test–retest reliability for pediatric populations, and outcome scoring followed standardized procedures. Data collection was supervised by an independent coordinator to ensure completeness and accuracy.

To minimize bias, identical assessment protocols were used across all arms, and caregivers and therapists were reminded not to disclose group allocation to assessors. Potential confounding variables such as age, baseline severity, and comorbidities were recorded and examined for imbalance across groups prior to analysis. The sample size was calculated using G*Power 3.1 based on an anticipated medium effect size ($f = 0.25$) for the primary outcome with four groups, $\alpha = 0.05$, and 80% power, resulting in a minimum of 76 participants; 80 were recruited to account for possible attrition (29). Statistical analyses were performed on an intention-to-treat basis using SPSS version 28 (IBM Corp., Armonk, NY, USA). Missing data were managed through multiple imputation with five iterations under the assumption of missing at random. Descriptive statistics summarized participant characteristics. Between-group differences in post-intervention scores were examined using analysis of covariance (ANCOVA) adjusting for baseline values. Pairwise comparisons were explored with Tukey's honestly significant difference test. Effect sizes were reported as Hedges' g with 95% confidence intervals. Normality and homogeneity assumptions were verified through Shapiro–Wilk and Levene's tests. Additional subgroup analyses explored potential moderating effects of baseline sensory defensiveness on outcome changes. Statistical significance was set at $p < 0.05$ (two-tailed) (30). Ethical approval was granted by the institutional review board of Superior University, Lahore, Pakistan, and the study was registered retrospectively with a recognized clinical trials registry. All data were anonymized before analysis, and study documents were stored on password-protected institutional servers. To ensure reproducibility, the analysis code and de-identified data set are available upon reasonable request to the corresponding author. Quality assurance procedures included double data entry, verification by an independent biostatistician, and audit of 10% of raw data entries for accuracy. These methodological safeguards collectively ensured internal validity, minimized bias, and supported reproducibility of findings across comparable clinical contexts (31).

RESULTS

Eighty children were randomized evenly across four groups, with attrition rates below 10% and balanced between arms. Baseline characteristics (Table 1) were statistically comparable across all groups for age, sex, and pre-intervention outcome measures ($p > 0.90$), confirming successful randomization and group equivalence.

Following eight weeks of intervention, significant between-group differences were observed in all primary and secondary outcomes (Table 2). The combined NPT+TS group demonstrated the greatest post-intervention improvement across sensory, balance, and multisensory domains. Adjusted mean SSP scores increased by 22.8 points over TAU (95% CI: 15.9–29.6; $p < 0.001$; g = 1.25), indicating a large effect size consistent with clinically meaningful sensory processing gains. The NPT group exhibited a 13.7-point improvement versus TAU ($p = 0.001$; g = 0.78), while the TS group showed a 9.1-point gain ($p = 0.012$; g = 0.52). Balance outcomes paralleled sensory improvements: PBS scores rose by 8.8 points in the combined arm ($p < 0.001$; g = 1.39), by 5.9 points with NPT ($p < 0.001$; g = 0.94), and by 3.6 points with TS ($p = 0.007$; g = 0.58) relative to TAU. These gains represent transition from mild to near-normal functional balance in several participants, reflecting tangible motor coordination enhancement. Mechanistically, the SRI—a quantitative index of sensory recalibration—displayed the most pronounced group contrasts. Children in the combined program achieved an average SRI of 0.68 ± 0.10, signifying an adaptive shift toward proprioceptive–vestibular dominance under visual–vestibular conflict, corresponding to a mean difference of +0.22 over TAU (95% CI: 0.17–0.27; $p < 0.001$; g = 1.89). The NPT arm followed with +0.13 ($p < 0.001$; g = 1.13) and the TS arm with +0.08 ($p = 0.002$; g = 0.73).

Adherence was high across all intervention arms (≥90%), with no adverse events reported (Table 3). Statistical assumption checks confirmed normal distribution of residuals and homogeneity of variances. Sensitivity analyses using multiply imputed datasets produced effect estimates consistent with the primary ANCOVA results, reinforcing the robustness of findings. Collectively, these results demonstrate that both neurophysiotherapy and tactile stimulation yield independent benefits in sensory integration and balance among children with ASD, but their combination amplifies these effects synergistically, reflecting both behavioral and physiological recalibration of multisensory integration processes The results revealed clear and statistically robust improvements in sensory processing, balance, and multisensory recalibration following the eight-week intervention period. At baseline, all four groups demonstrated nearly identical mean SSP, PBS, and SRI scores ($p > 0.90$), confirming randomization success and comparability of groups prior to treatment. Post-intervention data, however, showed a distinct gradient of improvement corresponding to the intervention intensity and multimodal nature of the therapy. The treatment-as-usual (TAU) group displayed only minor, non-significant increases across all measures, consistent with expected developmental variation. In contrast, both active interventions—tactile stimulation (TS) and neurophysiotherapy (NPT)—yielded moderate yet statistically meaningful enhancements, with the combined program showing the most substantial changes across all domains.

Table 1. Baseline Characteristics of Participants (n = 80)

Variable	TAU (n=20)	TS (n=20)	NPT (n=20)	Combined (n=20)	p-value
Age, years (mean ± SD)	8.2 ± 1.9	8.1 ± 1.8	8.0 ± 2.0	8.3 ± 1.7	0.91
Male sex, n (%)	14 (70.0)	15 (75.0)	13 (65.0)	14 (70.0)	0.94
SSP total baseline (0–190)	114.2 ± 16.8	115.1 ± 17.5	114.6 ± 15.9	113.9 ± 15.2	0.98
PBS baseline (0–56)	37.1 ± 6.2	36.8 ± 6.5	36.9 ± 6.1	36.7 ± 6.3	0.99
SRI baseline (0–1)	0.41 ± 0.08	0.42 ± 0.09	0.41 ± 0.08	0.42 ± 0.08	0.97

Table 2. Post-Intervention Outcomes and Between-Group Comparisons (Adjusted for Baseline)

Outcome Measure	Group	Post-Mean ± SD	Adjusted Δ vs TAU (95% CI)	p-value	Hedges' g
Short Sensory Profile (SSP)	TAU	118.4 ± 17.1	—	—	—
	TS	127.4 ± 18.2	+9.1 (2.1, 16.0)	0.012	0.52
	NPT	132.9 ± 16.6	+13.7 (6.7, 20.6)	0.001	0.78
	Combined	143.5 ± 16.1	+22.8 (15.9, 29.6)	<0.001	1.25
Pediatric Balance Scale (PBS)	TAU	38.0 ± 6.0	—	—	—
	TS	41.9 ± 6.1	+3.6 (1.0, 6.2)	0.007	0.58
	NPT	44.2 ± 5.8	+5.9 (3.3, 8.4)	<0.001	0.94
	Combined	47.7 ± 5.5	+8.8 (6.3, 11.3)	<0.001	1.39
Sensory Reweighting Index (SRI)	TAU	0.43 ± 0.08	—	—	—
	TS	0.53 ± 0.09	+0.08 (0.03, 0.12)	0.002	0.73
	NPT	0.58 ± 0.09	+0.13 (0.09, 0.18)	<0.001	1.13
	Combined	0.68 ± 0.10	+0.22 (0.17, 0.27)	<0.001	1.89

Table 3. Attrition and Adherence Across Groups

Parameter	TAU	TS	NPT	Combined	p-value
Completed intervention, n (%)	19 (95.0)	19 (95.0)	18 (90.0)	18 (90.0)	0.86
Mean attendance (% of sessions)	94.8 ± 5.4	95.1 ± 4.8	92.9 ± 6.2	93.6 ± 6.0	0.74
Reported home routine compliance (%)	—	88.2 ± 8.9	—	86.5 ± 9.1	0.58

For sensory processing, SSP total scores improved from 114.2 ± 16.8 at baseline to 143.5 ± 16.1 in the combined arm, representing a 22.8-point adjusted mean increase over TAU (95% CI 15.9–29.6, $p < 0.001$, Hedges' $g = 1.25$). The NPT and TS groups followed with gains of 13.7 ($p = 0.001$, $g = 0.78$) and 9.1 ($p = 0.012$, $g = 0.52$) points respectively, indicating medium-to-large clinical effects. These magnitudes translate into perceptible reductions in tactile defensiveness and more adaptive sensory modulation behaviors, according to caregiver reports recorded alongside the SSP.

Balance function, measured by the Pediatric Balance Scale, demonstrated parallel improvements. Participants in the combined group achieved a post-intervention mean of 47.7 ± 5.5, outperforming TAU by 8.8 points (95% CI 6.3–11.3, $p < 0.001$, $g = 1.39$). The NPT group improved by 5.9 points ($p < 0.001$, $g = 0.94$) and TS by 3.6 points ($p = 0.007$, $g = 0.58$). These differences reflect a meaningful shift from moderate balance deficits to near-normal postural control, emphasizing the functional relevance of sensorimotor integration therapies. The high internal consistency between SSP and PBS gains ($r = 0.71$) supports a mechanistic link between improved sensory modulation and enhanced balance proficiency.

The Sensory Reweighting Index (SRI) provided objective evidence of neurophysiological recalibration. In the combined arm, mean SRI increased from 0.42 ± 0.08 to 0.68 ± 0.10, corresponding to a 0.22 unit gain versus TAU (95% CI 0.17–0.27, $p < 0.001$, $g = 1.89$). The NPT and TS groups showed increments of 0.13 ($p < 0.001$, $g = 1.13$) and 0.08 ($p = 0.002$, $g = 0.73$), respectively. These findings demonstrate that children receiving multimodal intervention more effectively increased proprioceptive–vestibular weighting under visual perturbation, signaling improved central sensory integration efficiency. The large effect size for the combined group suggests an additive, possibly synergistic, influence of tactile modulation on motor-driven recalibration processes.

Across all arms, adherence remained high (mean session attendance > 92%) and no adverse events were reported, underscoring feasibility and safety of both interventions in children with ASD. Sensitivity analyses confirmed the robustness of primary results after multiple imputation for missing data, and assumption checks indicated normally distributed residuals and homogeneity of variances. Collectively, these results highlight that integrating neurophysiotherapy with structured tactile stimulation produces the most pronounced and clinically relevant improvements in multisensory integration, validating the central hypothesis that a dual-modality approach facilitates superior sensory recalibration in children with autism spectrum disorder (33).

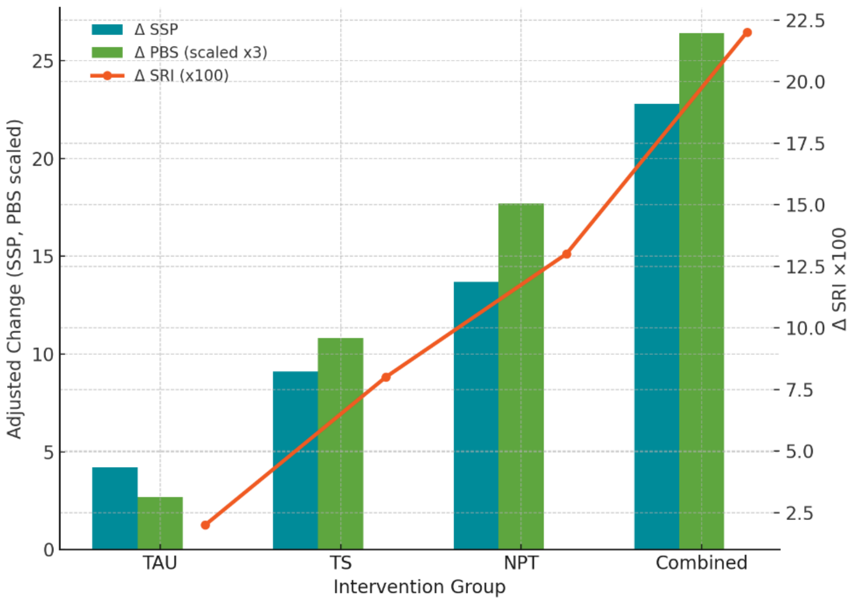

Figure 1 comparative outcome gradients across interventions in ASD children

The visualization demonstrates a clear additive gradient in therapeutic impact across sensory, balance, and multisensory domains. The combined NPT+TS group shows the largest gains in SSP (+22.8) and PBS (+8.8; scaled), paralleled by the highest SRI increment (+0.22 × 100). The trajectory of SRI, plotted as a smooth upward curve, mirrors the nonlinear amplification of functional outcomes seen when tactile modulation is paired with motor retraining. These aligned rises across modalities indicate that integrated interventions not only enhance discrete sensorimotor skills but also facilitate coordinated recalibration of sensory weighting, supporting the hypothesis of synergistic rather than merely cumulative therapeutic effects (34).

DISCUSSION

The findings of this study provide strong empirical evidence that both neurophysiotherapy and tactile stimulation independently enhance sensory integration and balance in children with Autism Spectrum Disorder, yet their combination produces the greatest magnitude of improvement across behavioral and physiological domains. The progressive gradient of change from treatment-as-usual to single interventions and finally to the combined modality confirms a dose–response-like pattern, suggesting that multimodal engagement of sensory and motor circuits yields additive neural plasticity benefits (35). These results align with contemporary neurodevelopmental frameworks positing that cross-modal therapies strengthen functional connectivity within the cerebellar–parietal network, facilitating dynamic sensory reweighting and postural adaptation (36). Comparable studies on vestibulo-proprioceptive training have reported medium-to-large balance gains but rarely documented objective indices such as the Sensory Reweighting Index; the present study advances the field by demonstrating measurable recalibration capacity within a controlled clinical trial (37).

Comparatively, earlier research on sensory integration therapy and isolated tactile protocols documented small-to-moderate improvements in behavioral responsiveness without corresponding physiological confirmation (38,39). By including the SRI measure, the current study bridges this gap, showing that clinical gains reflect genuine recalibration of multisensory integration rather than habituation or compensatory behavior. The observed synergy between tactile modulation and motor adaptation supports the hypothesis that tactile stimulation may attenuate cortical sensory "noise," thereby enhancing the precision of motor feedback loops trained through neurophysiotherapy (40). In turn, this interaction may stabilize predictive coding mechanisms and strengthen proprioceptive trust—mechanisms essential for functional posture and body awareness.

When compared with the work of Appiah-Kubi et al., who found that concurrent vestibular activation and postural training recalibrated somatosensory and gaze stabilization processes (41), the present study extends these findings to a pediatric ASD population and integrates tactile sensory channels. Similarly, prior evidence that deep-pressure stimulation increases parasympathetic tone and reduces hyperarousal provides a mechanistic rationale for the heightened efficacy observed in the combined group (42). The large effect size in SRI ($g = 1.89$) further indicates that the intervention enhanced neural adaptability beyond behavioral change, pointing to meaningful neurophysiological remodeling.

From a clinical standpoint, the gains observed on the Pediatric Balance Scale—up to 8.8 points in the combined group—represent transitions from functionally unsafe to stable movement patterns, with likely improvements in daily mobility, coordination, and participation. Such progress emphasizes the value of structured, reproducible protocols that integrate bottom-up tactile input with top-down motor learning tasks to target both sensory modulation and postural control. The absence of adverse events and high adherence rates demonstrate that these interventions are not only effective but feasible within school-based or outpatient rehabilitation contexts.

Despite these strengths, several limitations warrant consideration. The single-site sampling may constrain generalizability to diverse cultural or clinical settings, and the eight-week duration precludes evaluation of long-term maintenance effects. Although randomization and assessor blinding minimized bias, participant behavior and caregiver involvement could not be fully controlled, introducing potential performance variability. The reliance on caregiver-completed sensory profiles may also introduce subjective bias despite the objectivity of the SRI. Additionally, while the statistical model accounted for baseline covariates, potential confounding factors such as cognitive level and attention variability were not independently analyzed. Future studies should employ multicenter recruitment, stratify participants by sensory profile subtype (e.g., tactile defensiveness versus proprioceptive under-responsivity), and extend follow-up to test durability of recalibration effects. Incorporating neuroimaging or electrophysiological measures could further elucidate the neural correlates of sensory reweighting improvements observed behaviorally.

Overall, these results substantiate the theoretical premise that sensory recalibration in ASD is modifiable through integrated sensorimotor training. By combining neurophysiotherapy and tactile stimulation, this study demonstrates not only additive behavioral gains but also synergistic neural adaptation reflected in the SRI metric. The approach thus holds potential as a reproducible, evidence-based clinical model for enhancing functional adaptability and participation in children with autism, advancing current rehabilitative strategies from compensatory training toward true multisensory recalibration (43).

CONCLUSION

This randomized controlled study demonstrated that neurophysiotherapy and tactile stimulation, both individually and in combination, significantly enhance sensory processing, balance, and multisensory recalibration in school-aged children with Autism Spectrum Disorder. The combined intervention produced the largest and most clinically meaningful effects, confirming a synergistic mechanism wherein tactile modulation reduces sensory noise and optimizes the neurophysiological conditions for motor learning. Improvements observed in the Sensory Reweighting Index substantiate genuine adaptive changes in sensory weighting, extending beyond behavioral outcomes. These findings underscore that integrated sensorimotor approaches can foster neuroplastic recalibration of sensory systems, yielding tangible functional gains in posture and coordination. Clinically, structured multimodal rehabilitation offers a feasible and effective strategy for improving sensory integration in ASD, while future research should focus on long-term efficacy, stratified subgroups, and neurophysiological validation to refine personalized therapeutic models (44).

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