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Designing Sensory-Inclusive Athletic Infrastructure: Evaluating Environmental Friction and Accessibility for Autistic Young Adults

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Abstract

Traditional athletic infrastructure and sports pedagogy are predominantly engineered around neurotypical sensory expectations and fast-paced verbal instruction, creating severe environmental friction for autistic young adults. This study investigates the combined efficacy of sensory-inclusive facility modifications and multi-modal pedagogical scaffolding in fostering an accessible, neurodiversity-affirming athletic environment. Utilizing an explanatory sequential mixed-methods design, Phase I evaluated systemic infrastructure and instructional baselines across regional adaptive sports networks (N = 400), while Phase II conducted qualitative and observational field trials (n = 25) with autistic athletes aged 18–25 using a multi-modal Augmentative and Alternative Communication (AAC) evaluation matrix. Quantitative findings revealed widespread deficits in sensory accessibility, while qualitative analysis highlighted three primary barriers: acoustic and visual sensory trauma, cognitive processing lag from un-chunked verbal instruction, and social exclusion in unstructured dynamics. Experimental field trials—incorporating sound-dampening acoustic panels, non-glare matte flooring, high-contrast visual court boundaries, dedicated decompression spaces, 3-step instructional chunking, and visual schedule boards—demonstrated significant reductions in sensory distress behaviors alongside immediate gains in motor skill precision and task execution. Integrating sensory architecture with adaptive pedagogy provides a scalable framework to transition adaptive sports from deficit-centered, therapeutic interventions toward empowering, competitive athletic environments.

Keywords: Autism Spectrum Disorder, Sensory Architecture, Adaptive Physical Education, Multi-Modal Communication, Universal Design, Self-Determination Theory.

Introduction

Autism spectrum disorder (ASD) has a global prevalence estimated between 0.3% and 1.0%, encompassing a wide range of neurodevelopmental conditions that significantly influence both individual and social functioning (Elsabbagh., et. al., 2012; Lord et. al., 2020). Clinical manifestations vary across individuals and developmental stages; however, individuals with

ASD consistently demonstrate qualitative differences in communication, social interaction, restricted interests, sensory processing, and motor performance.

Social functioning in ASD is primarily characterized by difficulties in understanding, interpreting, and responding to the behavior of others. These challenges are linked to impairments in processing social and emotional cues, such as eye contact, gestures, and facial expressions (American Psychiatric Association [APA], 2013). Reduced social reciprocity also impacts imitation skills, which play a critical role in learning and in establishing meaningful interactions with caregivers and peers (Ingersoll, 2008).

The diversity within the autism spectrum is striking. One child may remain largely withdrawn with limited self-help abilities, another might communicate non-verbally while independently managing daily needs, and yet another might speak fluently but struggle significantly with peer interactions. This wide variability underscores why autism is conceptualized as a spectrum disorder—individuals differ as distinctly as the colors of a rainbow. Support is often required to address developmental challenges, but it is crucial to recognize that a child with autism is first and foremost a child, possessing a distinct personality, strengths, interests, and preferences.

Perception represents a critical determinant of human performance, forming the basis for interpreting, integrating, and responding to environmental stimuli. In sports contexts, perceptual processes influence movement efficiency, reaction time, anticipation, and decision-making, ultimately affecting overall performance outcomes (Abernethy, 1991). Visual, auditory, and proprioceptive inputs provide essential information for sensorimotor coordination, while social perception enables athletes to anticipate and interpret the actions of teammates and opponents in interactive or team-based sports.

Methods

The data for this study were gathered using a qualitative methodology combining primary and secondary sources. Primary data were obtained directly through focus group discussions (FGDs) with autistic athletes aged 15–25 years, carried out at the Indian Sports Federation of Autism (ISFA) training camps and Atal Bihari Vajpayee Training Centre for Disability Sports Gwalior, M.P.

Selection of Subjects:

Participants were selected from the available group of individuals with Autism Spectrum Disorder (ASD) aged 15–25 who showed interest in sports and having the sufficient communication abilities.

Sampling Method

Purposive sampling was used to select participants who possessed sufficient functional communication skills to share their experiences in a group setting.

Selection of Variables

For this study, the Perception of Autistic Player towards sports and its enhancing facilities was centralised. To evaluate this central variable effectively, perception was divided into five qualitative categories for the focus group discussions.

Table showing the FGD Questions for variable category

Variable Category	Specific variables	Focus Group Discussions Questions
Perceptions of Sports Benefits	Physical Social, Emotional benefits	About Why They play, what they enjoy, how sports make them feel
Sensory barriers	Noise, Light, touch, temperature	About discomfort, overwhelming, sensory preferences
Facilities Adequacy	Equipment, Spaces, Accessibility	About Playground Quality, Equipment Condition and Changing Rooms
Social Inclusion	Peer Support, Coach Communication, friendships	About Team mate relationship, coach Clarity, feeling accepted
Desired Enhancements	Modifications, adaptations, new facilities	About Wishes, changes needed, ideal facilities

Equipment's used for the Study

The data recording field tools utilized to document the FGD which included high resolutions smart phones for digital audio visual tracking, tripod stand, specialized Likert Scale Visual aids (color coded cards), demographic forms, Field Note sheets, Informed Consent form, Tripod Stand, marker Pen paper etc.

Criterion Measure:

The primary instrument used was a semi-structured focus group discussion (FGD) guide. To support participants who experienced speech fatigue or anxiety, open-ended questions were supplemented with visual Likert scales, including color-coded cards and emoticon prompts. These augmented tools included Likert scale visual aids such as stylized emoticons and color coded scale cards specifically designed to assist participants experiencing sudden communication fatigue or situational anxiety during abstract evaluations. Data were analyzed using Braun and Clarke's six-phase thematic analysis model. Transcripts were coded line-by-line and grouped into key sub-themes and main themes. The qualitative data were transcribed and systematically coded, allowing key sub-themes and major themes to emerge organically from the participants' responses.

Collection of Data

Data collection was conducted in five stages to ensure participant comfort and minimize environmental stress: Prior to commencing the sessions, the researcher conducted extensive pre session preparation, collecting demographic profiles and securing signed informed consent forms from the participants or their legal guardians. The researcher carefully managed the environmental setup to ensure that the focus group discussions took place in quiet, familiar meeting rooms at the Atal Bihari Vajpayee Training Centre for Disability Sports in Gwalior and various ISFA camps. To capture both verbal responses and non verbal expressions accurately without causing distraction, the researcher securely mounted a Smartphone coupled video and audio recording apparatus on a tripod stand in the room. The researcher acted as the primary moderator, employing a structured moderation strategy that utilized marker pens and chart papers to visually track conversational paths, helping the participants stay anchored to the topic. The researcher deliberately paced the discussions to accommodate the unique cognitive processing times of the athletes, seamlessly alternating open ended verbal questions with Likert scale visual aids. Concurrently, an assistant observer maintained rigorous documentation, filling out detailed field note sheets to track real time situational behaviors, group dynamics, and any unexpected environmental disruptions.

Table showing the administration of training of Sensory Regulation

Sensory Regulation	Environmental control to manage hyper reactivity to stimuli.	Conventional: Loud acoustic cues, unpredictable routines, and high stimulus chaotic spaces. Modified: Visual cue dependency, predictable routines, and sound managed environments.	• Total elimination of high pitched, sudden acoustic metal coaches' whistles. • Substitution of loud sounds with highly visible boundary markers, bright flags, or calm hand gestures. • Strict enforcement of an identical, repetitive structural sequence from start to finish.	Minimizes the risk of sensory overload and emotional meltdowns; establishes a stable environment of emotional safety.

Analysis and Interpretation of Data

To make sense of these experiences, the researcher used Braun and Clarke’s six-phase thematic analysis model to analyze the qualitative data gathered from focus groups at the Atal Bihari Vajpayee Training Centre and the Special Olympics Bharat. This chapter breaks down the main themes and sub-themes that emerged from the data. To support these findings, the researcher has included direct quotes from the participants alongside my own field notes, ensuring that the insights from players who use visual communication aids are fully represented. Finally, the researcher connects and discusses each theme in relation to current literature in adaptive physical education.

To get a complete, multi-dimensional view of how sports infrastructure changes affect autistic players, this study uses a Mixed-Methods Sequential Explanatory Design. In mixed-methods research, relying on just one type of data can leave structural blind spots. Quantitative data is useful for capturing broad trends regarding facility usage, but it often misses the personal, nuanced experiences of the athletes behind the numbers. On the other hand, qualitative data from the focus groups provides incredible depth regarding the players' actual perceptions, but it lacks broader statistical generalization. This study bridges that gap by connecting both approaches in a clear, two-phase sequence.

Table showing the participants' communication matrix for mapping their respective acquisition tools and analytical integration methods

Participant Profile and Expressive Mode	Communication Tool	Focus Group Interactive Method	Data Type And Analysis
Verbal / high Functioning	Semi-structured open-ended prompts, verbal clarification	Direct focus group dialogue and peer interaction	Full verbatim transcripts coded directly into thematic nodes (e.g., sensory barriers, social dynamics).
Minimally Verbal	Picture Exchange Communication System (PECS), Visual Likert/Rating Cards (e.g., Happy/Neutral/Overwhelmed faces)	Visual card selection paired with short verbal or single-word clarification	Categorical visual choices mapped against qualitative themes; short phrases transcribed and contextually coded.
Non Verbal / Visual	Point-and-Show Photo Cards (depicting loud whistles, stadium lights, soft vs. hard balls, crowded courts)	Image sorting task ("Like / Dislike / Scared") followed by gesture observation	Observational notes and photo-selection frequency matrices converted into qualitative indicators for facility evaluation.
Gestural / Kinetic Expressors	Physical demonstration / Court enactment	Guided behavioural simulation (e.g., demonstrating physical responses to court lines or ball impact)	Field notes on body language, spatial positioning, and physical gestures transcribed into descriptive narratives.

Sensory Barriers and Environmental Adaptations

This theme examines the key environmental factors shaping participant engagement. Specifically, it contrasts the overwhelming sensory triggers common to standard athletic facilities with the targeted environmental accommodations integrated into specialized, inclusive settings.

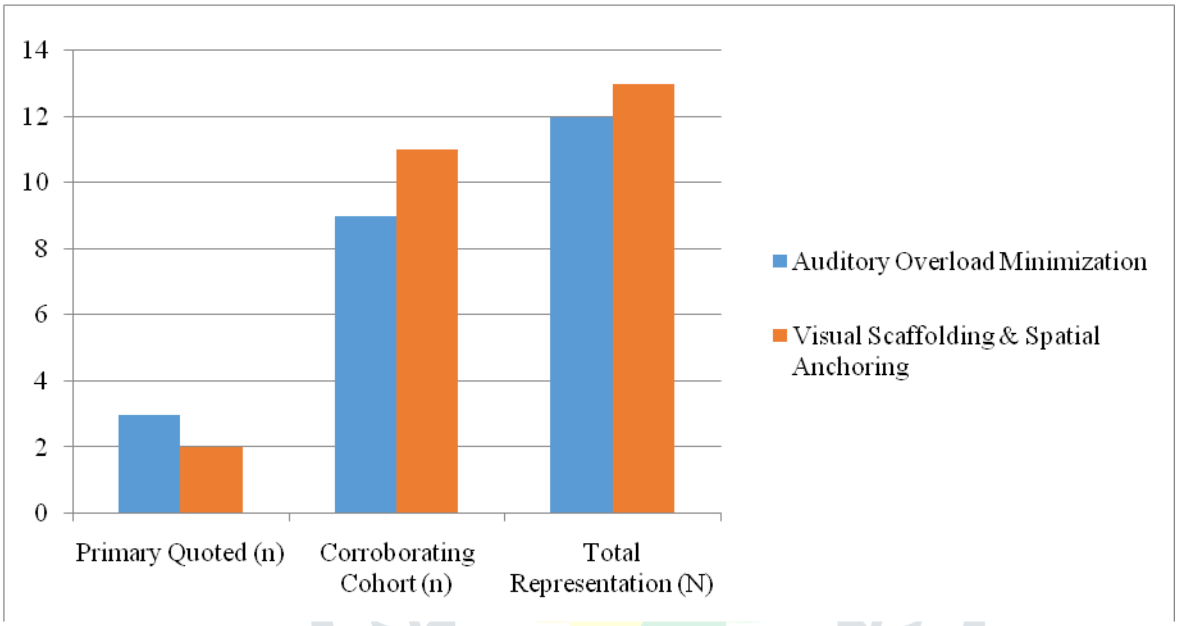
Table showing Narrative assigning the open code for derived subthemes for Sensory Barriers and Environmental Adaptations

Quoted Participant ID & Age	Manifest Narrative Content / AAC Scaffolding Logged DOC	Open Code Assignment	Derived Sub-Theme	Represented Participant IDs (Corroborating Cohort Segment)
P6 (Age 18)	*"...metal whistles make my ears hurt inside... Here, the coaches don't use them. They use the big orange flag."*	High-frequency acoustic trauma	Auditory Overload Minimization	P1, P7, P11, P13, P15, P17, P20, P23
P2 (Age 20)	Points to **[Happy/Calm]** icon; points to floor: *"Normal courts have too many lines... Here, the floor is just blue... lines bright yellow."*	Visual overstimulation & geometric confusion	Visual Scaffolding & Spatial Anchoring	P4, P9, P10, P12, P14, P19, P21, P25
P7 (Age 19)	*"The echoing in public halls is a monster... In this hall, the padded walls swallow the sound."*	Structural reverberation stress	Auditory Overload Minimization	P1, P6, P11, P16, P20, P23
P17 (Age 23)	Touches **[Sun/Glared]** card, shakes head: *"The shiny wooden floors reflect the tube lights... The matte green floor here does not."*	Photophobic glare disruption	Visual Scaffolding & Spatial Anchoring	P2, P4, P8, P14, P18, P22, P25
P11 (Age 18)	*"The buzzer at the local stadium makes my teeth vibrate... Here, they use a soft, humming light indicator."*	Vibroacoustic distress triggers	Auditory Overload Minimization	P6, P13, P15, P16, P20, P24

Table showing Frequency Distribution of Primary Quoted and Corroborating Cohorts across Environmental Sensory Accommodations (N = 25)

Environmental Sub-Theme	Primary Quoted (n)	Corroborating Cohort (n)	Total Representation (N)
Auditory Overload Minimization	3	9	**12**
Visual Scaffolding & Spatial Anchoring	2	11	**13**

Graph showing Comparative Frequency Distribution of Environmental Sensory Triggers and Structural Accommodations among Autistic Athletes (N = 25).



Interpretation of Sensory Barriers and Environmental Adaptations

The qualitative evidence gathered within this theme demonstrates that the sensory architecture of sports facilities directly influences participant engagement. Unadapted public and educational athletic venues frequently generate an uncalibrated mix of sensory inputs. Triggers such as high pitched metal whistles, acoustic reverberation from concrete walls, overlapping multisport floor markings, and intense overhead glare often induce sensory overload and anxiety, actively obstructing motor development rather than supporting it.

These participant accounts illustrate how standard environmental sounds translate into visceral physical distress. For instance, P6 reported acute pain from high frequency sounds, while P11 experienced disturbing internal vibrations from standard stadium buzzers. These sensory vulnerabilities stem directly from atypical sensory gating and feed forward inhibition deficits, which diminish the brain's ability to habituate to sudden or loud auditory stimuli in traditional sports settings.

The qualitative data underscores the transformative impact of environmental modifications within sports venues. Interventions such as substituting whistle blasts with visual signals, softening reverberation with wall padding, and eliminating glare through matte surfaces remove major environmental barriers. These targeted adaptations allow autistic athletes to regulate their neurological response, retain spatial stability, and devote their cognitive resources to physical learning and active play.

Conclusion

The initial survey highlighted environmental and sensory factors as the single biggest barrier to using sports facilities, recording the highest agreement across the entire dataset (Mean= 4.38, SD = 0.71; Theme 2 grounded density N = 62). Focus group discussions backed this up, showing how standard sports halls create an overwhelming sensory environment where high-pitched whistles, harsh stadium lights, and heavy echoes off concrete walls cause physical discomfort and mental fatigue. For example, Participant P6 (Age 18) mentioned that metal whistles cause actual ear pain, while Participant P7 (Age 19) described the echo in public sports halls as a "monster." However, when facilities introduced sensory friendly change such as using bright orange flags instead of whistles, adding wall padding to deaden sound, and switching to non-glare matte floors the players felt an immediate relief. These physical adjustments mean athletes no longer have to spend energy protecting them from sensory overload and can focus entirely on playing the game.

These real world experiences highlight the direct impact that physical surroundings have on athletic participation. These results reinforce the core ideas of Universal Design in adaptive physical education. A sports hall is never just a neutral space; without proper sensory considerations, standard facility design builds invisible walls that keep neurodivergent athletes from taking part.

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