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PRELIMINARY EFFECTS OF A STRUCTURED TABLE TENNIS INTERVENTION ON VISUOMOTOR COORDINATION, REACTION TIME, INHIBITORY CONTROL, AND SELF-REGULATION IN UNIVERSITY STUDENTS WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER AND LEVEL 1 AUTISM: A MIXED-METHODS PILOT STUDY

EFECTOS PRELIMINARES DE UNA INTERVENCIÓN ESTRUCTURADA DE TENIS DE MESA SOBRELA COORDINACIÓN VISOMOTORA, EL TIEMPO DE REACCIÓN, EL CONTROL INHIBITORIO Y LA AUTORREGULACIÓN EN ESTUDIANTES UNIVERSITARIOS CON TRASTORNO POR DÉFICIT DE ATENCIÓN CON HIPERACTIVIDAD Y AUTISMO DE NIVEL 1: UN ESTUDIO PILOTO CON MÉTODOS MIXTOS

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Preliminary Effects of a Structured Table Tennis Intervention on Visuomotor Coordination, Reaction Time, Inhibitory Control, and Self-Regulation in University Students with Attention-Deficit/Hyperactivity Disorder and Level 1 Autism: A Mixed-Methods Pilot Study

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ABSTRACT

Effective inclusion of neurodivergent students in higher education requires accessible, feasible, and methodologically evaluable interventions that move beyond exclusively discursive support. This study aimed to analyze the effects of a structured table tennis intervention on visuomotor coordination, reaction time, inhibitory control, and perceived self-regulation in university students with attention-deficit/hyperactivity disorder and level 1 autism, as well as to assess its feasibility, acceptability, and perceived usefulness. A mixed-methods pilot study with quantitative predominance was conducted using a one-group quasi-experimental longitudinal design with repeated measures in 25 university students. The intervention lasted 12 weeks and included 36 structured sessions. Analyses comprised descriptive statistics, Friedman tests for three-time-point variables, Wilcoxon signed-rank tests for pre-post measures, and nonparametric effect sizes. Results showed significant improvements in reaction time, inhibitory control, visuomotor coordination, and perceived self-regulation, together with high implementation feasibility, a mean attendance rate of 87.33%, 100% retention, and no attrition. Qualitative findings indicated perceived benefits in concentration, emotional regulation, motor confidence, and social interaction. The intervention appears to be a preliminarily promising and feasible strategy for inclusive higher education settings, although its effects should be interpreted cautiously due to the pilot nature of the study.

***Keywords*:** inclusive higher education, neurodiversity, table tennis, executive functions, visuomotor coordination

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Efectos Preliminares de una Intervención Estructurada de Tenis de Mesa sobre la Coordinación Visomotora, el Tiempo de Reacción, el Control Inhibitorio y la Autorregulación en Estudiantes Universitarios con Trastorno por Déficit de Atención con Hiperactividad y Autismo de Nivel 1: un Estudio Piloto con Métodos Mixtos

RESUMEN

La inclusión efectiva de estudiantes neurodivergentes en la educación superior requiere intervenciones accesibles, factibles y metodológicamente evaluables que vayan más allá del apoyo exclusivamente discursivo. Este estudio tuvo como objetivo analizar los efectos de una intervención estructurada de tenis de mesa sobre la coordinación visomotora, el tiempo de reacción, el control inhibitorio y la autorregulación percibida en estudiantes universitarios con trastorno por déficit de atención con hiperactividad y autismo de nivel 1, así como evaluar su viabilidad, aceptabilidad y utilidad percibida. Se realizó un estudio piloto de métodos mixtos con predominio cuantitativo utilizando un diseño longitudinal cuasiexperimental de un solo grupo con medidas repetidas en 25 estudiantes universitarios. La intervención duró 12 semanas e incluyó 36 sesiones estructuradas. Los análisis comprendieron estadísticas descriptivas, pruebas de Friedman para variables de tres puntos temporales, pruebas de rangos con signo de Wilcoxon para medidas pre-post y tamaños del efecto no paramétricos. Los resultados mostraron mejoras significativas en el tiempo de reacción, el control inhibitorio, la coordinación visomotora y la autorregulación percibida, junto con una alta viabilidad de implementación, una tasa de asistencia promedio del 87,33 %, una retención del 100 % y ninguna deserción. Los hallazgos cualitativos indicaron beneficios percibidos en la concentración, la regulación emocional, la confianza motora y la interacción social. La intervención parece ser una estrategia preliminarmente prometedora y viable para entornos de educación superior inclusiva, aunque sus efectos deben interpretarse con cautela debido a la naturaleza piloto del estudio.

***Palabras clave*:** educación superior inclusiva; neurodiversidad; tenis de mesa; funciones ejecutivas; coordinación visomotora

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INTRODUCTION

The expansion of access to higher education has increased the visibility of students with neurodevelopmental profiles that have historically been underserved by university systems. However, increased enrollment has not guaranteed substantive conditions of inclusion, equitable participation, or sustained persistence with well-being. In this context, the notion of neurodiversity has gained relevance as a framework for understanding neurological variability not only through deficit-based categories, but also through the dynamic relationship among cognitive differences, contextual demands, and institutional support conditions.

Nevertheless, within the university setting, a gap persists between inclusive discourse and the actual experience of neurodivergent students, especially when institutional responses focus on specific academic accommodations while neglecting functional dimensions that cut across self-regulation, participation, cognitive load, social interaction, and the day-to-day management of performance (McDowall & Kiseleva, 2024; Quigley & Gallagher, 2025; Ross et al., 2026).

This tension is particularly visible among students with attention-deficit/hyperactivity disorder and level 1 autism. Although these are not equivalent clinical or functional profiles, both may share difficulties in processes of self-regulation, behavioral monitoring, attentional modulation, inhibitory control, response organization, and adaptation to highly demanding university environments (Pozo-Rodríguez et al., 2026). In the case of ADHD, the literature has consistently documented impairments in sustained attention, inhibitory control, time management, task persistence, and effort regulation, with repercussions for academic performance, self-efficacy, and university integration (Pagespetit et al., 2025).

In the case of level 1 autism, even when global intellectual performance may not be compromised, difficulties are common in behavioral flexibility, sensory management, coordination between social and cognitive demands, and adjustment to complex university contexts or environments overloaded with stimuli, especially when available supports are fragmented or insufficiently personalized (Koops et al., 2025; Smith et al., 2025). In both groups, the university experience may be shaped not only by individual characteristics, but also by the absence of pedagogical and extracurricular supports designed

to sustain competent, accessible, and non-stigmatizing participation (McDowall & Kiseleva, 2024; Ross et al., 2026).

From a transdiagnostic perspective, executive functions and emotional regulation constitute a particularly relevant explanatory core for understanding these trajectories. Processes such as inhibitory control, response speed, error monitoring, working memory, and behavioral self-regulation do not operate in isolation, but rather as systems of coordination among perception, decision, and action in changing contexts (Pozo-Rodríguez et al., 2026). In university life, this functional architecture is expressed in behaviors as diverse as maintaining attentional focus, inhibiting impulsive responses, switching between simultaneous demands, tolerating distractions, organizing sequences of action, and modulating effort under academic pressure. For this reason, limiting inclusion to administrative or curricular accommodation is insufficient when the issue also involves the cognitive-motor functionality with which students face real participation demands. This consideration is especially relevant in higher education, where executive functions are related to goal-directed behavior, self-control, organization, and adaptation to complex academic contexts (Zamora-Lugo et al., 2025).

Added to this executive dimension is a variable frequently underestimated in higher education: visuomotor coordination. Although it is often studied in greater detail in pediatric clinical settings or in sports contexts, the coordination of visual information, response timing, and fine motor adjustment constitutes a functional platform relevant to multiple everyday activities. Rapid perception of stimuli, trajectory anticipation, response selection or inhibition, and synchronization between decision and execution are part of a perception-action continuum that is not only motor, but also cognitive. From this perspective, visuomotor performance may be considered an observable correlate of attentional and inhibitory control processes, particularly in tasks requiring temporal precision, contextual adaptation, and continuous movement correction (Huang et al., 2024; Ji et al., 2024).

Within this framework, open-skill sports offer an intervention pathway of theoretical and applied interest. Unlike closed motor tasks, open-skill sports require the processing of changing information, anticipation, rapid response selection, inhibition of inappropriate actions, and continuous readjustment to dynamic stimuli. Among these, table tennis presents features that are especially relevant for a cognitive-motor intervention in a neurodivergent university population: high demands on hand-eye

coordination, processing speed, response time control, fine perceptual discrimination, error monitoring, and activation regulation (Huang et al., 2024; Ji et al., 2024).

In addition, its relatively low cost, its potential for adaptation, its modular structure, and the possibility of progressively grading complexity, pace, predictability, and interpersonal demand make it a viable option for inclusive educational settings. This plausibility is also consistent with evidence suggesting cognitive advantages of open-skill exercise for different executive subcomponents in populations with ADHD, although the specific evidence remains limited and heterogeneous (Qiu et al., 2024).

Even so, the available literature still presents important limitations. A substantial portion of the evidence on physical activity, exercise, and executive function has focused on childhood and adolescence, with a strong emphasis on school-based studies, brief trials, or reviews centered on neurotypical populations. In ADHD, recent evidence suggests favorable effects of exercise on components of executive functioning, particularly inhibitory control and working memory, yet heterogeneity in protocols, variability in dosage, and a shortage of studies situated in higher education remain (Liu et al., 2025; Xu et al., 2026).

In autism, benefits of exercise and structured support programs have also been reported for cognitive, socioemotional, and retention-related domains. However, much of that literature focuses on children, adolescents, or university support programs not specifically centered on cognitive-motor intervention, while research involving university-aged young adults remains limited (Koops et al., 2025; Ross et al., 2026; Smith et al., 2025). Moreover, few studies have examined structured interventions based on open-skill sports, and even fewer have simultaneously integrated cognitive-motor outcomes, perceived self-regulation, and experiential assessments of accessibility and usefulness (Qiu et al., 2024; Ross et al., 2026).

This gap is methodologically relevant. If university inclusion is assessed only in terms of formal access or academic accommodations, a set of functional processes that may decisively mediate student persistence, participation, and subjective experience is left out of consideration (McDowall & Kiseleva, 2024; Quigley & Gallagher, 2025). Consequently, there is a need to explore interventions that, without medicalizing university life or shifting institutional responsibility onto the individual, provide concrete support for performance, regulation, and situated participation. In this sense, a structured table tennis

intervention may be understood not as formal competitive training, but as an accessible cognitive-motor device capable of articulating perception, inhibition, timing, postural adjustment, response sequencing, and self-reflection within a higher education inclusion framework.

From a scientific standpoint, examining this type of intervention in university students with ADHD and level 1 autism makes it possible to address at least four gaps. The first is population-based, given that most of the evidence is concentrated outside higher education (Pagespetit et al., 2025; Smith et al., 2025). The second is functional, because few studies integrate visuomotor coordination, reaction time, inhibitory control, and perceived self-regulation within a single design. The third is contextual, since acceptability, adherence, reasonable accommodations, and the subjective experience of accessibility are often underreported (McDowall & Kiseleva, 2024; Ross et al., 2026). The fourth is methodological, because mixed-methods pilot studies with quantitative predominance offer an appropriate pathway for estimating feasibility and detecting preliminary signals of change before moving toward more complex confirmatory designs.

Based on the above, the present study aimed to analyze the effects of a structured table tennis intervention on visuomotor coordination, reaction time, inhibitory control, and perceived self-regulation in university students with ADHD and level 1 autism, as well as to assess its feasibility, acceptability, and perceived usefulness in an inclusive higher education context. The study was guided by the expectation of observing pretest-to-posttest improvements in cognitive-motor and self-regulation indicators, together with feasible implementation and positive participant evaluations. Nevertheless, given the pilot, longitudinal, and one-group nature of the design, the findings are interpreted as preliminary evidence, useful for supporting future studies with greater analytical and comparative power.

METHODOLOGY

Study Design

A pilot study was conducted using a mixed-methods approach with quantitative predominance, an exploratory analytical scope, a one-group longitudinal quasi-experimental design, and a repeated-measures framework. The quantitative component constituted the primary axis for evaluating change in cognitive-motor and self-regulation variables, whereas the qualitative component was incorporated with

an explanatory function to understand the experience of participation, accessibility, and perceived usefulness of the intervention. Accordingly, the study was not conceived as a confirmatory trial or as a robust contrast between diagnoses, but rather as a preliminary evaluation of feasibility, acceptability, and initial signals of change in an inclusive higher education context.

Context and Participants

The study was conducted at the School of Physical Education and Sport in Mazatlán with a purposive sample of 25 university students. The final analytical dataset consisted of 20 participants with attention-deficit/hyperactivity disorder and five with level 1 autism. Diagnostic condition was treated as an inclusion criterion and a basis for exploratory stratification, not as a primary dependent variable or a confirmatory comparison factor.

According to the final quantitative matrix, the sample had a mean age of 21.24 years (SD = 2.09; range = 18–24), a mean semester level of 4.00 (SD = 1.95; range = 1–7), and a mean self-reported sleep duration of 7.27 hours (SD = 0.53). Regarding sample composition, 9 participants identified as men, 10 as women, and 6 in another sex/gender category recorded in the database. In addition, 10 participants reported current medication use, 21 reported medication stability, 14 reported low prior table tennis experience, 5 reported moderate experience, and 6 reported no previous experience. In terms of baseline physical activity, 15 participants were classified at a moderate level, 6 at a high level, and 4 at a low level.

Operational Inclusion Criteria

For the construction of the present study, the operational inclusion criteria were as follows: (a) belonging to the university student population of the School of Physical Education and Sport in Mazatlán; (b) being part of the cohort registered in the project database with a diagnostic classification of ADHD or level 1 autism; (c) having pretest and posttest records for the main variables; and (d) participating in the structured table tennis program with longitudinal follow-up. Diagnostic condition was coded in the master database as a grouping variable and was used only for descriptive and exploratory purposes.

Given that the present manuscript is based on an operational database already structured within the project, the final version for journal submission should explicitly specify the institutional procedure

used for diagnostic corroboration, as well as the formal mechanism for participant invitation and consent.

Intervention

The intervention consisted of a structured table tennis program lasting 12 weeks, with a frequency of three sessions per week and a total of 36 planned sessions. Each session lasted approximately 45 to 60 minutes. Conceptually, the program was designed as a structured and accessible cognitive-motor device aimed at promoting perception-action coupling, temporal control of response, effort regulation, visuomotor coordination, and sustained participation, rather than as formal competitive training.

The general structure of each session comprised six sequential phases:

(a) task opening and anticipation,

(b) coordinative activation,

(c) perceptual-technical block,

(d) cognitive-motor block,

(e) adapted structured play, and

(f) self-reflective closure. This sequence sought to combine organizational predictability with a gradual increase in perceptual, temporal, and decisional demands.

The longitudinal follow-up of the intervention showed weekly phase-based organization. Weeks 1 and 2 corresponded to a familiarization phase, weeks 3 to 5 to a control phase, week 6 was allocated to intermediate assessment, weeks 7 to 9 constituted the complexity phase, weeks 10 and 11 corresponded to a transfer phase, and week 12 to closure. This progression allowed load modulation, the introduction of reasonable accommodations, and documentation of program tolerability without compromising continuity of participation.

Study Variables

The independent variable was the structured table tennis intervention. The primary dependent variables were visuomotor coordination, reaction time, inhibitory control, and perceived self-regulation. The secondary dependent variables were feasibility, acceptability, and perceived usefulness of the intervention.

Descriptive covariates included age, sex, semester level, medication use, medication stability, hours of sleep, prior table tennis experience, baseline physical activity level, and diagnostic condition.

Measures and Instruments

Cognitive-Motor Measures with Three Assessment Time Points

The quantitative variables assessed at pretest, midpoint, and posttest included three groups of indicators. The first corresponded to reaction time, measured through simple response latency, choice response latency, and reaction time variability. The second corresponded to inhibitory control, assessed through performance on Stroop-type and Go/No-Go tasks. For the Stroop task, total time, errors, and interference were considered. For the Go/No-Go task, commission errors, omission errors, and reaction time were recorded. The third group corresponded to visuomotor coordination, estimated from hits, errors, and execution time in a visuomotor coordination task.

These measures were analytically organized into three observation time points, which allowed examination of intraindividual and group change trends throughout the intervention.

Measure of Perceived Self-Regulation

Perceived self-regulation was assessed using the Adult Executive Functioning Inventory, a brief version oriented toward working memory and inhibition, known as the ADEXI. For the present study, the total score and the working memory and inhibition subscales were used at two measurement time points, pretest and posttest. On this scale, lower values indicate less perceived executive dysfunction.

Indicators of Feasibility, Adherence, and Acceptability

Feasibility and tolerability of the intervention were documented through total attendance, percentage attendance, retention, attrition, recorded incidents, number of reasonable accommodations, mean subjective perceived exertion, and mean perceived session load. Acceptability was estimated from five self-reported indicators collected at the end of the program: usefulness, enjoyment, difficulty, clarity, and willingness to continue.

Qualitative Component

The qualitative component was constructed from a thematic matrix of pre- and post-intervention records for the 25 participants. The main source recorded in the database was interview data, organized by initial categories, subthemes, key quotation, analytical interpretation, coder, and analytical priority.

The function of the qualitative component was not to generate formal theory, but rather to complement and interpret the quantitative findings through an explanatory-oriented thematic analysis.

Operationally, the qualitative analysis was aimed at identifying perceived changes in concentration, emotional regulation, motor confidence, social interaction, task adherence, and the experience of accessibility. Integration of this component made it possible to assess not only whether changes were observed in the indicators, but also how these changes were experienced and interpreted by the participants.

Procedure

The study was organized into three quantitative assessment time points. At pretest, covariates, perceived self-regulation, and cognitive-motor performance indicators were recorded. The structured intervention was then implemented over 12 weeks. In week 6, an intermediate assessment was conducted for the variables monitored at three points. At the end of the program, the posttest assessment was carried out, final indicators of self-regulation, acceptability, and continuation were recorded, and the final qualitative records were incorporated.

Throughout the intervention, longitudinal session-by-session follow-up was conducted, including attendance, week, phase, date, subjective perceived exertion, session load, accommodations made, incidents, and observations. This record allowed precise reconstruction of adherence, weekly progression, and program tolerability.

Data Analysis Strategy

The quantitative analysis followed a logic consistent with the pilot nature of the study and the nonparametric character of the selected tests. First, descriptive statistics were calculated for the sample and for the indicators of feasibility, adherence, and acceptability. Second, for variables with three measurement time points, the Friedman test was used as the primary contrast, accompanied by Kendall's W coefficient as an estimator of effect size. When appropriate, paired comparisons were conducted using the Wilcoxon signed-rank test. Third, for the pretest and posttest ADEXI scores, the Wilcoxon test was used, with effect size estimated through *r*.

Results were interpreted cautiously, emphasizing direction of change, relative magnitude, and internal consistency of the findings, without overstating causal inferences or external generalizations.

Diagnostic condition remained at the descriptive and exploratory level, so any differences observed between subgroups were considered only as preliminary tendencies.

For the qualitative component, an applied thematic analysis was conducted, centered on recurrent patterns of meaning between pre- and post-records. Finally, both components were articulated through explanatory convergent integration to contrast the quantitative findings with the subjective experience reported by participants.

Ethical Considerations

Given the nature of the study and the profile of the participant population, methodological conduct required special attention to informed consent, confidentiality, responsible use of diagnostic information, communicative accessibility, and reasonable accommodations during the intervention. The final version submitted for editorial evaluation should include the name of the committee or institutional body that approved the development of the project, the specific consent procedure, and, where applicable, the corresponding approval number or reference code. Until that institutional information is incorporated into the final manuscript, this draft maintains wording that is methodologically prudent and consistent with the data effectively documented in the project files.

RESULTS AND DISCUSSION

Sample Characteristics

The analytical sample consisted of 25 university students from the School of Physical Education and Sport in Mazatlán. The mean age was 21.24 years (SD = 2.09; range = 18–24), with a mean semester level of 4.00 (SD = 1.95; range = 1–7) and a mean self-reported sleep duration of 7.27 hours (SD = 0.53). In diagnostic terms, 20 participants belonged to the attention-deficit/hyperactivity disorder group (80.0%) and 5 to the level 1 autism group (20.0%). The composition by sex/gender recorded in the database included 9 men (36.0%), 10 women (40.0%), and 6 participants in another recorded category (24.0%). In addition, 10 participants reported current medication use (40.0%), and 21 reported medication stability (84.0%). Regarding prior table tennis experience, most participants were classified at none or low levels, whereas moderate baseline physical activity predominated.

Table 1 Sample Characteristics

Characteristic	Result
Total sample	25
Age (years)	21.24 ± 2.09 [18–24]
Semester	4.00 ± 1.95 [1–7]
Sleep (hours)	7.27 ± 0.53
Diagnosis: ADHD	20 (80.0%)
Diagnosis: level 1 autism	5 (20.0%)
Sex: male	9 (36.0%)
Sex: female	10 (40.0%)
Sex: other	6 (24.0%)
Current medication use: yes	10 (40.0%)
Stable medication: yes	21 (84.0%)
Prior table tennis experience: none	6 (24.0%)
Prior table tennis experience: low	14 (56.0%)
Prior table tennis experience: moderate	5 (20.0%)
Baseline physical activity: low	4 (16.0%)
Baseline physical activity: moderate	15 (60.0%)
Baseline physical activity: high	6 (24.0%)

Note. Data are presented as mean ± standard deviation [minimum–maximum] or absolute frequency and percentage.

This sample profile is methodologically consistent with the pilot nature of the study. First, it comprises a young university cohort that was functionally active and predominantly engaged in moderate levels of physical activity, which reduces the likelihood of interpreting the observed changes as being exclusively the result of high prior sports familiarity. Second, the diagnostic distribution confirms that the study should not be read as a balanced comparison between ADHD and level 1 autism, but rather as a preliminary exploration within a heterogeneous neurodivergent cohort, in which diagnostic stratification retains only descriptive and exploratory value.

Third, the presence of current medication use in part of the sample and the pharmacological stability reported by most participants provide relevant context for interpretation, as they suggest relative clinical stability during the intervention period, although without fully eliminating the potential influence of extraexperimental factors.

From an editorial perspective, Table 1 serves more as a contextual anchor than as an inferential element. Its purpose is not to test differences between subgroups, but to characterize the cohort's starting point and delimit the interpretive framework for the subsequent results.

Feasibility, Adherence, and Tolerability of the Intervention

The operational indicators showed high feasibility of the structured table tennis intervention. Mean total attendance was 31.44 sessions (SD = 2.43), equivalent to a mean relative attendance rate of 87.33% (SD = 6.75). Retention reached 100.0%, and no attrition was recorded. On average, 2.68 incidents per participant were documented (SD = 2.08), along with 8.68 reasonable accommodations applied (SD = 4.52). Regarding tolerability, mean RPE was 4.42 (SD = 0.17), and mean perceived load was 3.27 (SD = 0.07).

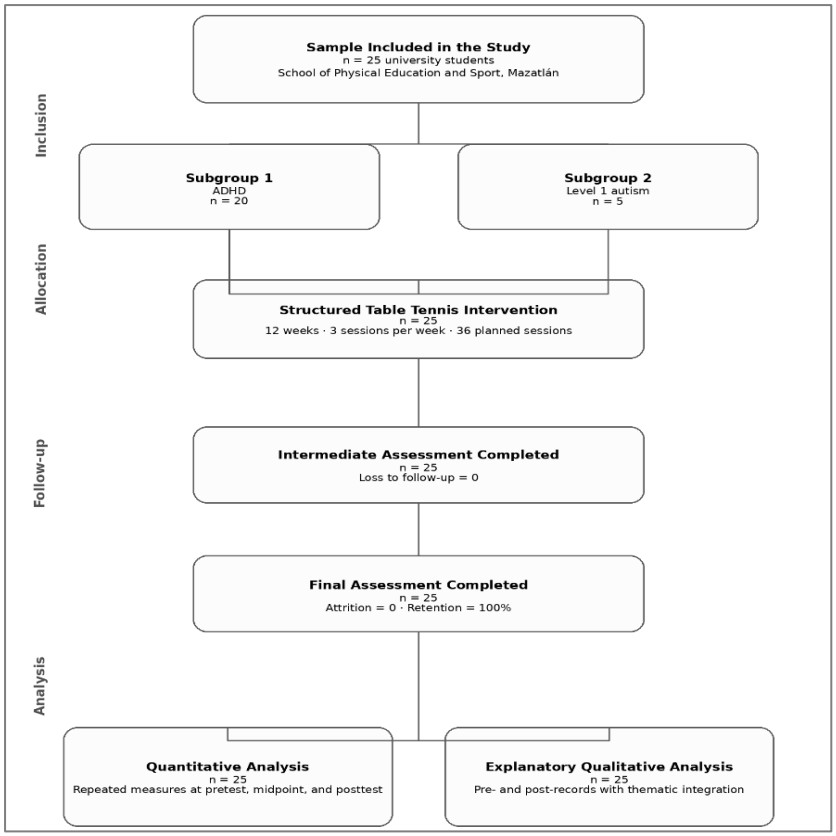
Table 2 Indicators of Feasibility, Adherence, and Tolerability of the Intervention

Indicator	Result
Total attendance (sessions)	31.44 ± 2.43
Relative attendance (%)	87.33 ± 6.75
Retention	25 (100.0%)
Attrition	0 (0.0%)
Recorded incidents	2.68 ± 2.08
Reasonable accommodations applied	8.68 ± 4.52
Mean RPE	4.42 ± 0.17
Mean perceived load	3.27 ± 0.07

Note. RPE = rating of perceived exertion. Data are presented as mean ± standard deviation or absolute frequency and percentage.

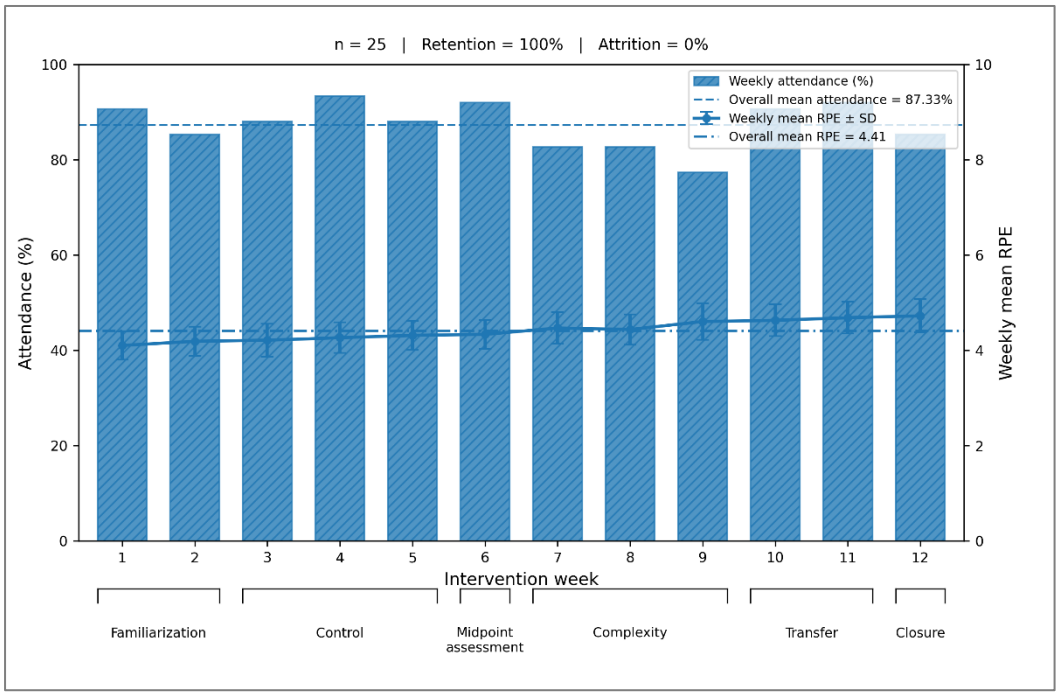
Weekly longitudinal follow-up showed that attendance remained high throughout most of the program, with moderate fluctuations during the intermediate phase of greater complexity and subsequent recovery toward the final weeks. In parallel, perceived exertion tended to increase gradually without being accompanied by attrition or critical deterioration in adherence. This combination is consistent with a program that increased cognitive-motor and perceptual demands without exceeding the cohort's tolerability.

Figure 1 Flow of Participants in the Pilot Study



Note. The figure begins with the included sample because the project files clearly document the analytical cohort, longitudinal follow-up, and retention, but not an independent count of participants assessed for eligibility or excluded prior to inclusion.

Figure 2 Weekly Evolution of Attendance and Subjective Perception of Effort During the Structured Table Tennis Intervention



Note. The bars represent the weekly attendance percentage, and the line represents the weekly mean RPE with standard deviation. The horizontal dashed lines indicate the overall program means.

Figure 1 shows that the included sample fully completed both the intermediate and final follow-up assessments, with no loss to follow-up or subsequent analytical exclusions. Figure 2, in turn, adds an important nuance that Table 2 does not capture on its own: the feasibility of the program did not depend on a minimal or static level of demand, but rather on a progression of perceived load that remained at moderate levels and was compatible with continuity. In interpretive terms, these findings strengthen the viability of structured table tennis as an accessible cognitive-motor device in inclusive higher education, not only because the cohort remained in the program, but because it did so with a functional balance among demand, reasonable accommodations, and adherence.

This observation has relevant implications for the discussion of the study. In pilot research involving neurodivergent populations, feasibility should not be restricted to the mere logistical possibility of conducting sessions, but should also include retention, tolerability, the need for accommodations, the stability of weekly engagement, and the absence of signs of saturation or rejection. In this sense, the data suggest that the intervention was not only implementable, but also acceptably sustainable within the university context evaluated.

Changes in Reaction Time

The reaction time indicators showed a consistent trend toward improvement across the three assessment time points.

Simple reaction time decreased from 595.84 ms (SD = 38.06) at pretest to 582.10 ms (SD = 38.12) at the intermediate assessment and 564.64 ms (SD = 36.91) at posttest, representing a favorable reduction of 5.24%.

Choice reaction time decreased from 723.56 ms (SD = 42.19) to 707.93 ms (SD = 42.54) and finally to 684.79 ms (SD = 43.48), corresponding to a favorable reduction of 5.36%. Complementarily, reaction time variability declined from 90.52 ms (SD = 13.81) to 87.28 ms (SD = 13.20) and then to 83.27 ms (SD = 13.00), equivalent to a favorable reduction of 8.01%.

Table 3 Descriptive Statistics for Variables Assessed at Three Measurement Time Points

Variable	Pre (M ± SD)	Mid (M ± SD)	Post (M ± SD)	Favorable change
Simple reaction time (ms)	595.84 ± 38.06	582.10 ± 38.12	564.64 ± 36.91	5.24% reduction
Choice reaction time (ms)	723.56 ± 42.19	707.93 ± 42.54	684.79 ± 43.48	5.36% reduction
Reaction time variability (ms)	90.52 ± 13.81	87.28 ± 13.20	83.27 ± 13.00	8.01% reduction
Stroop time	89.56 ± 8.77	87.82 ± 8.52	84.81 ± 8.28	5.30% reduction
Stroop errors	6.04 ± 1.90	5.28 ± 1.79	3.84 ± 2.25	36.42% reduction
Stroop interference	24.85 ± 4.38	24.13 ± 4.25	23.06 ± 4.04	7.22% reduction
Go/No-Go commission errors	8.20 ± 3.07	7.28 ± 2.94	6.08 ± 3.21	25.85% reduction
Go/No-Go omission errors	4.24 ± 1.90	3.72 ± 2.01	2.32 ± 1.77	45.28% reduction
Go/No-Go time (ms)	476.68 ± 40.33	465.00 ± 40.97	453.78 ± 37.35	4.80% reduction
Coordination hits	12.28 ± 2.09	13.32 ± 1.77	14.48 ± 2.49	17.92% increase
Coordination errors	8.20 ± 2.02	7.48 ± 1.78	5.96 ± 1.90	27.32% reduction
Coordination time	41.40 ± 4.14	40.42 ± 4.11	38.89 ± 4.08	6.07% reduction

Note. M = mean; SD = standard deviation. Favorable change was calculated from the relative difference between pretest and posttest.

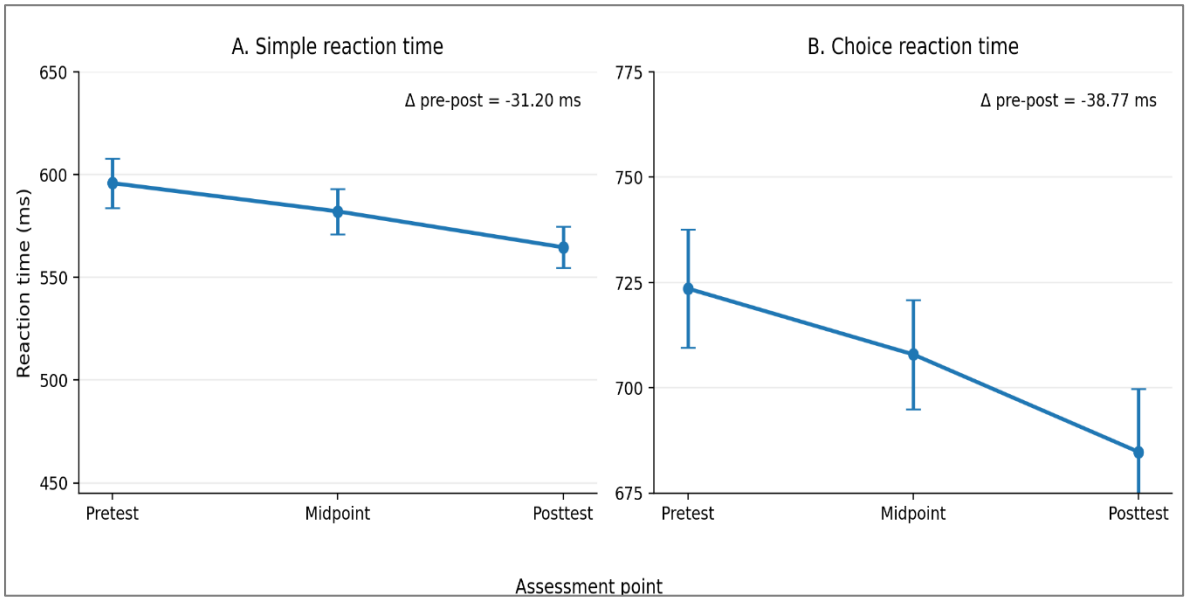
The main contrast confirmed that these variations did not respond to isolated random fluctuations. The Friedman test was significant for simple reaction time, $\chi^2(2) = 48.08$, $p < .001$, $W = .962$; for choice reaction time, $\chi^2(2) = 46.32$, $p < .001$, $W = .926$; and for reaction time variability, $\chi^2(2) = 50.00$, $p < .001$, $W = 1.00$. Taken together, these effect sizes suggest a large magnitude of change within the cohort studied.

Table 4 Main Contrast of Variables Assessed at Three Measurement Time Points

Variable	Friedman χ^2	p	Kendall's W
Simple reaction time (ms)	48.08	< .001	0.962
Choice reaction time (ms)	46.32	< .001	0.926
Reaction time variability (ms)	50.00	< .001	1.00
Stroop time	50.00	< .001	1.00
Stroop errors	40.44	< .001	0.809
Stroop interference	46.32	< .001	0.926
Go/No-Go commission errors	39.10	< .001	0.782
Go/No-Go omission errors	43.93	< .001	0.879
Go/No-Go time (ms)	43.28	< .001	0.866
Coordination hits	37.15	< .001	0.743
Coordination errors	43.36	< .001	0.867
Coordination time	50.00	< .001	1.00

Note. The Friedman test was used as the main contrast for repeated measures across three time points. Kendall's W is reported as the effect size estimator.

Figure 3 Evolution of Reaction Time During the Structured Table Tennis Intervention



Note. Panel A shows simple reaction time, and Panel B shows choice reaction time across the three assessment time points. The points represent means, and the error bars represent 95% confidence intervals. Lower values indicate better performance.

Figure 3 clearly shows that the reduction in response latency followed a progressive trajectory from pretest to intermediate assessment and posttest for both simple and choice responses. This visual continuity is relevant because it suggests that the change was not concentrated exclusively at a terminal point of the program but rather became consolidated throughout the intervention process.

From an interpretive standpoint, these findings are consistent with the functional logic of the program. Structured table tennis requires rapid detection of stimuli, visuomotor coupling, response selection, and continuous temporal adjustment, making it plausible that systematic practice of these demands would be associated with improvements in response speed and temporal stability. Nevertheless, due to the pilot and one-group nature of the design, these results should be interpreted as preliminary evidence of within-group change rather than as conclusive demonstration of causal efficacy. Even so, the consistency among reduced latency, decreased variability, and the large magnitude of the contrasts supports the relevance of continuing to explore this type of intervention in future studies with greater methodological control.

Changes in Inhibitory Control

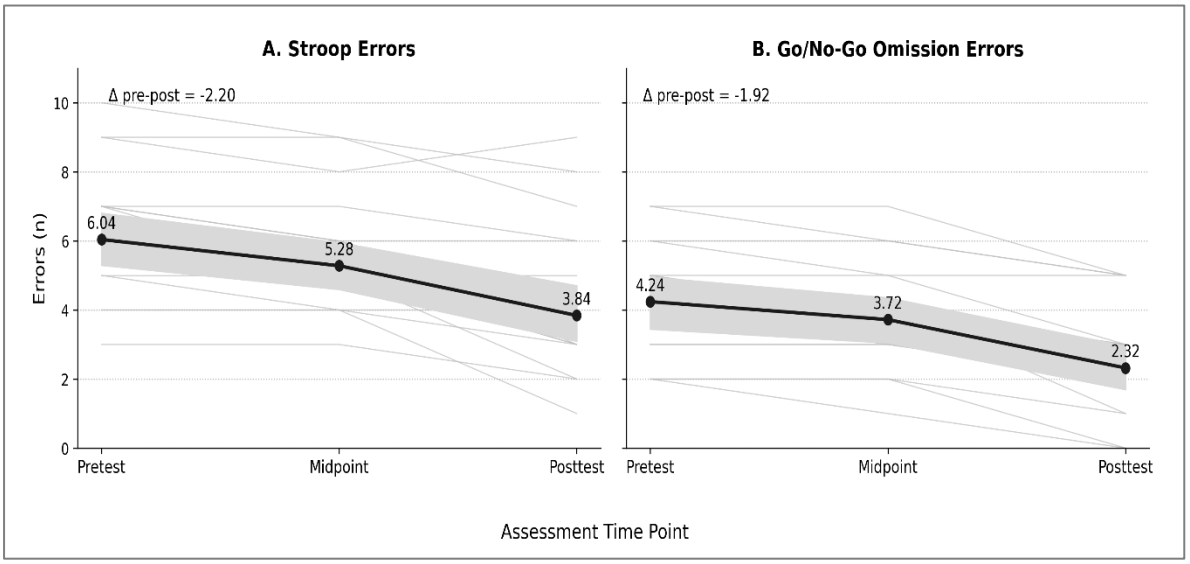
The inhibitory control indicators also showed a favorable direction of change across the three assessment time points.

In the Stroop task, total time decreased from 89.56 (SD = 8.77) to 87.82 (SD = 8.52) and 84.81 (SD = 8.28), corresponding to a favorable reduction of 5.30%. Stroop errors decreased from 6.04 (SD = 1.90) to 5.28 (SD = 1.79) and 3.84 (SD = 2.25), equivalent to a reduction of 36.42%. Stroop interference decreased from 24.85 (SD = 4.38) to 24.13 (SD = 4.25) and 23.06 (SD = 4.04), representing a favorable reduction of 7.22%.

In the Go/No-Go task, commission errors decreased from 8.20 (SD = 3.07) to 7.28 (SD = 2.94) and 6.08 (SD = 3.21), corresponding to a reduction of 25.85%. Omission errors decreased from 4.24 (SD = 1.90) to 3.72 (SD = 2.01) and 2.32 (SD = 1.77), representing a reduction of 45.28%. Finally, reaction time in the Go/No-Go task decreased from 476.68 ms (SD = 40.33) to 465.00 ms (SD = 40.97) and 453.78 ms (SD = 37.35), equivalent to a reduction of 4.80%.

The Friedman test confirmed statistical significance for all indicators within this domain. In the Stroop task, significant results were observed for time, $\chi^2(2) = 50.00$, $p < .001$, $W = 1.00$; errors, $\chi^2(2) = 40.44$, $p < .001$, $W = .809$; and interference, $\chi^2(2) = 46.32$, $p < .001$, $W = .926$. In the Go/No-Go task, the contrast was significant for commission errors, $\chi^2(2) = 39.10$, $p < .001$, $W = .782$; omission errors, $\chi^2(2) = 43.93$, $p < .001$, $W = .879$; and reaction time, $\chi^2(2) = 43.28$, $p < .001$, $W = .866$.

Figure 4 Evolution of Inhibitory Control Indicators During the Structured Table Tennis Intervention



Note. Panel A shows Stroop task errors, and Panel B shows Go/No-Go omission errors across the three assessment time points. Faded lines represent individual trajectories. The main line represents the group mean, and the shaded band represents the 95% confidence interval. Lower values indicate better performance.

Figure 4 visually synthesizes two indicators that were particularly sensitive to change, namely Stroop errors and Go/No-Go omission errors, both showing a clear downward trajectory across the three time points. The reduction in errors on these tasks is analytically relevant because it suggests not only faster processing speed, but also a greater capacity to inhibit inappropriate responses, maintain attentional set, and reduce control failures under cognitively demanding conditions.

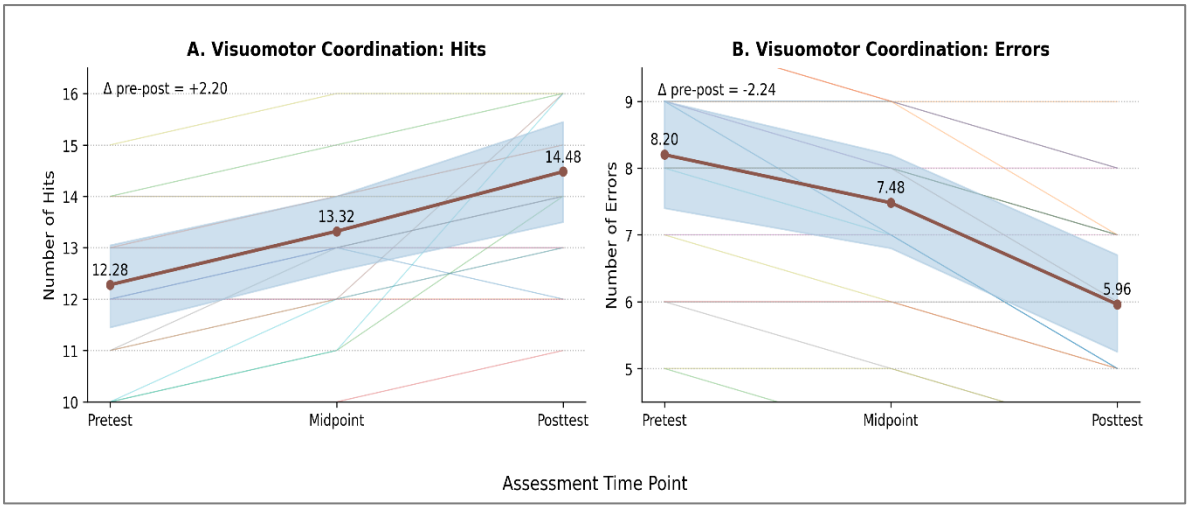
The joint interpretation of this block suggests that the intervention may have operated on functional components linked to behavioral inhibition, error monitoring, and regulation of responses under perceptual and temporal demands. This is consistent with the nature of table tennis as a high-speed open-skill task, in which the participant must discriminate trajectories, inhibit premature responses, adjust movement in real time, and sustain continuous control over action. However, as in the reaction time domain, the strength of these findings must be understood within the framework of a pilot study: the statistical significance and magnitude of the effects document consistent signals of change, but they do not yet warrant definitive inferences regarding causal specificity, clinical generalization, or superiority over other intervention modalities.

Changes in Visuomotor Coordination

The visuomotor coordination indicators showed a consistently favorable trajectory from pretest to intermediate assessment and posttest. The number of hits increased from 12.28 (SD = 2.08) at pretest to 13.32 (SD = 1.75) at the intermediate assessment and 14.48 (SD = 2.47) at posttest, representing an increase of 17.92% relative to baseline. Convergently, errors decreased from 8.20 (SD = 2.03) to 7.48 (SD = 1.78) and 5.96 (SD = 1.92), equivalent to a favorable reduction of 27.32%. Likewise, execution time decreased from 41.40 s (SD = 4.02) to 40.42 s (SD = 3.90) and 38.89 s (SD = 3.79), corresponding to a decrease of 6.06%.

The main contrast confirmed that these variations were statistically significant. The Friedman test was significant for hits, $\chi^2(2) = 45.73$, $p < .001$, $W = .915$; for errors, $\chi^2(2) = 47.61$, $p < .001$, $W = .952$; and for execution time, $\chi^2(2) = 46.88$, $p < .001$, $W = .938$. In terms of magnitude, the effect sizes suggest large and consistent changes within the cohort.

Figure 5 Evolution of Visuomotor Coordination During the Structured Table Tennis Intervention



Note. Panel A shows the number of hits, and Panel B shows the number of errors across the three assessment time points. Faded lines represent individual trajectories. The main line represents the group mean, and the shaded band represents the 95% confidence interval. In Panel A, higher values indicate better performance; in Panel B, lower values indicate better performance.

Figure 5 clearly illustrates the dual functional direction of change: a progressive increase in hits and a sustained reduction in errors. This combination is particularly relevant because it suggests an improvement not only in the quantitative level of performance, but also in the qualitative relationship between precision and control. In other words, participants not only responded more, but did so with a more efficient pattern of visuomotor adjustment.

From an interpretive perspective, these results are consistent with the perception-action logic underlying the intervention. Table tennis requires continuous visual tracking, trajectory anticipation, fine timing, force modulation, and immediate adjustment of movement in response to environmental variations. Consequently, the observed improvement in hits, errors, and execution time is consistent with systematic practice involving open and rapidly updated visuomotor demands. Nevertheless, given the pilot nature of the study, this functional coherence should be understood as convergent plausibility rather than as definitive demonstration of a causal mechanism.

Change in Perceived Self-Regulation

Perceived self-regulation, assessed through the ADEXI, also showed favorable changes between pretest and posttest. The total score decreased from 37.84 (SD = 3.90) to 34.24 (SD = 3.76), corresponding to an absolute reduction of 3.60 points. In the working memory subscale, the score decreased from 17.40 (SD = 2.09) to 15.32 (SD = 2.16), whereas in the inhibition subscale it decreased from 19.84 (SD =

2.38) to 17.80 (SD = 2.35). Since lower scores on this measure reflect lower perceived executive dysfunction, these changes indicate a subjective improvement in the experience of self-regulation.

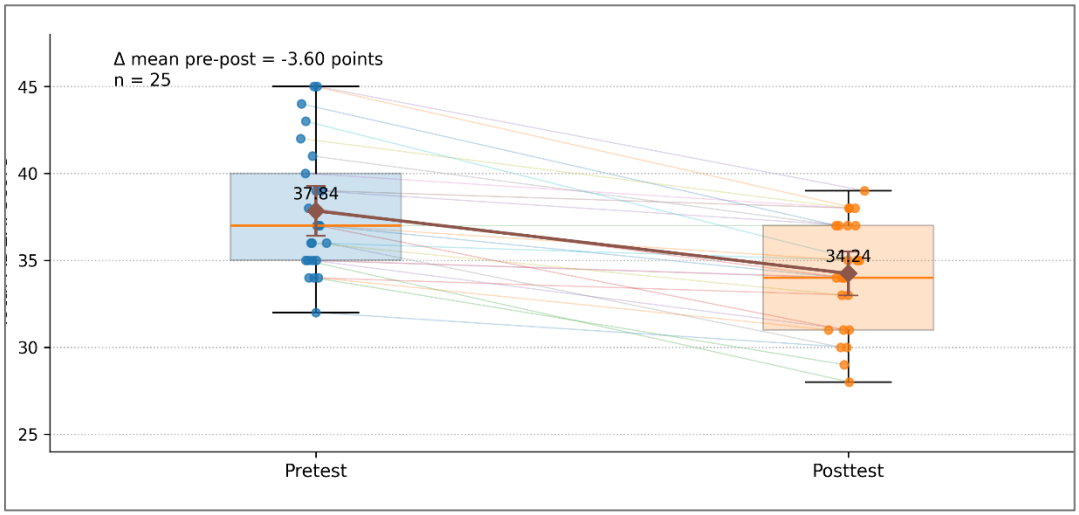
Table 5 Perceived Self-Regulation, Pre-Post Comparison, and Inferential Contrast

Variable	Pre (M ± SD)	Post (M ± SD)	Favorable change	Shapiro p	Wilcoxon W	p	Z	r
ADEXI total	37.84 ± 3.90	34.24 ± 3.76	9.51% reduction	0.01	0	< .001	-4.392	0.878
ADEXI working memory	17.40 ± 2.40	15.32 ± 2.44	11.95% reduction	< .001	0	< .001	-4.432	0.886
ADEXI inhibition	19.84 ± 2.88	17.80 ± 3.04	10.28% reduction	< .001	0	< .001	-4.43	0.886

Note. ADEXI = Adult Executive Functioning Inventory. Shapiro p corresponds to the normality test applied to the pre-post differences. Because the normality assumption was not met, the main contrast was the Wilcoxon test for related samples.

The inferential contrast confirmed this direction of change. The Wilcoxon signed-rank test was significant for ADEXI total, $Z = -4.38$, $p < .001$, $r = .88$; for working memory, $Z = -4.29$, $p < .001$, $r = .86$; and for inhibition, $Z = -4.34$, $p < .001$, $r = .87$. Taken together, these values suggest a large magnitude of change between the beginning and the end of the program.

Figure 6 Pre-Post Change in Perceived Self-Regulation Measured Through ADEXI Total



Note. The points represent individual participants and the lines their pre-post trajectories. The boxplots show the observed distribution. The diamonds and error bars represent the group mean and the 95% confidence interval. Lower values indicate lower perceived executive dysfunction.

Figure 6 visually reinforces this finding by showing a predominantly downward trend in individual trajectories, accompanied by a reduction in the center of the group distribution. Unlike other domains measured with performance tasks, the ADEXI introduces a complementary subjective dimension: it does not report only observable performance, but also how participants themselves perceive their capacity to organize, inhibit, and regulate their behavior in everyday life.

This point is especially important for the discussion of the study. In neurodivergent university populations, an improvement in cognitive-motor indicators may be relevant, but it gains greater contextual value when accompanied by a more favorable perception of one's own executive regulation. In this sense, the convergence between performance and self-report suggests that the observed changes were not restricted to the testing situation, but may also have had functional resonance in the participants' everyday experience. However, because this is a self-reported measure and the design did not include a control group, this interpretation must remain at the level of preliminary evidence rather than conclusive generalization.

Explanatory Qualitative Findings

The qualitative component provided a complementary interpretive layer to the quantitative results and made it possible to examine how the intervention was experienced by the participants. The explanatory-oriented thematic analysis showed a concentration of records around five core areas: concentration and attention to the task, emotional regulation, motor confidence, social interaction, and intervention accessibility. Taken together, these axes suggest that the program was perceived not only as a structured physical practice, but also as a space for behavioral organization, emotional adjustment, and safe participation.

At the attentional level, several records converged on the perception of a greater capacity to sustain focus, follow instructions, and remain engaged during the session. This experience is consistent with the downward trajectory observed in reaction times and in several inhibitory control indicators, insofar as participants described an experience of reduced distractibility, greater task engagement, and better synchrony between observation and response.

Regarding emotional regulation, the testimonies suggested a perception of greater operational calm, less frustration in response to errors, and a greater capacity to resume the task after failures or interruptions. This finding is particularly relevant because it shifts the interpretation of the program beyond the purely motor domain: the intervention was not experienced merely as repetitive execution of strokes or movements, but as a structured environment in which repetition, anticipation, and self-reflective closure facilitated more stable regulation of activation.

A third axis corresponded to motor confidence. Participants reported feeling progressively more capable of responding, coordinating, and executing actions with less insecurity. This qualitative core directly dialogues with the improvement in hits and reduction in errors in visuomotor coordination, and suggests that the change was not perceived merely as "doing a task better," but as experiencing greater mastery over one's own body in a demanding situation.

Social interaction constituted another relevant axis, although with variable intensity across participants. Several records indicated that the structure of the program, the scripted nature of the sessions, and the type of exchange required by the task favored more manageable social participation than other less structured forms of group activity. This aspect is important because it suggests that the value of the intervention did not lie only in the cognitive and motor demands, but also in the way those demands were organized within a predictable and functionally accessible environment.

Finally, accessibility emerged as a cross-cutting category. The records suggested that task clarity, phase-based progression, reasonable accommodations, and the dosing of demands were decisive elements in sustaining participation. Consequently, the program's relative success cannot be attributed exclusively to table tennis as content, but rather to the way in which that content was structured, adapted, and supported throughout its implementation.

Table 6 Integration of Quantitative and Qualitative Findings

Domain	Quantitative finding	Dominant qualitative theme	Representative quotation	Integrated interpretation
Attention and task engagement	Decrease in simple and choice reaction time; reduction in Stroop errors	Improved concentration	"Now I get distracted less and finish more sets."	Improvement in speed and cognitive control is accompanied by a subjective perception of greater attentional support.
Behavioral inhibition	Reduction in Go/No-Go commission and omission errors; reduction in Stroop errors	Lower impulsivity	"Now I wait more for the signal before hitting."	The quantitative pattern of lower inhibitory error is consistent with a narrative of greater response regulation.
Regulation through task structure	High adherence and good acceptability	Positive appraisal of routine / need for structure	"I like it because I already know how it starts and how it ends."	Operational predictability appears to have facilitated sustained participation and program acceptability.

Domain	Quantitative finding	Dominant qualitative theme	Representative quotation	Integrated interpretation
Visuomotor coordination	Increase in hits and reduction in coordination errors	Increasing motor confidence	"I feel that I control the ball better now."	The specific functional improvement in motor performance is reflected in greater perceived self-efficacy.
Contextual accessibility	Frequent reasonable accommodation and low rate of incidents	Need for predictability / relevant sensory adjustment	"It helps me to know beforehand what comes next."	Program feasibility was associated with the incorporation of contextual and structural supports.
Tolerancia al entorno en autismo nivel 1	Participación sostenida con ajustes y mejoría moderada en tareas objetivo	Mayor estabilidad participativa / mejor tolerancia contextual	"Ya me siento más tranquilo con la secuencia."	En el subgrupo con autismo nivel 1, la estabilidad de la secuencia y la reducción de carga contextual parecen haber favorecido la continuidad de la participación.

Note. The table integrates quantitative patterns with emergent themes from the qualitative matrix. Its function is interpretive rather than inferential.

Analytically, these qualitative findings do not operate merely as narrative illustration of the quantitative results. Their function is to explain why an intervention of this kind may have been feasible, tolerable, and potentially useful for a neurodivergent university cohort. The subjective evidence suggests that the observed changes in response speed, inhibitory control, coordination, and perceived self-regulation were embedded in a participatory experience marked by structure, clarity, adjustment, and a progressive sense of competence.

Integration and Interpretation of Findings

An integrated reading of the quantitative and qualitative results makes it possible to identify a convergent pattern. At the quantitative level, the intervention was associated with improvements in reaction time, inhibitory control, visuomotor coordination, and perceived self-regulation, in addition to highly feasible implementation, with high attendance, full retention, and no attrition. At the qualitative level, these changes were accompanied by perceptions of greater concentration, better emotional regulation, increased motor confidence, more manageable social participation, and a positive appraisal of the program's accessibility.

The convergence between both levels of evidence strengthens the interpretation that the intervention operated, at least preliminarily, as a functionally meaningful cognitive-motor device for the participants. The integration also makes it possible to specify that the usefulness of the program does not appear to be explained solely by motor practice in the narrow sense.

The data suggest that the effect of the device depended on the combination of cognitive-motor demand, structured progression, reasonable accommodation, session predictability, and self-reflective closure. In other words, the potential of the program did not lie only in "playing table tennis," but in doing so within a pedagogical architecture that transformed a sports task into an accessible and regulated intervention.

From a methodological point of view, the articulation of both components adds value to the study. The changes observed in the quantitative indicators could have been interpreted in a limited way as simple variations in performance. However, when read together with the experience reported by the participants, they acquire greater functional density. Reduced reaction time may also be understood as a greater capacity to couple with the task, decreased inhibitory errors as less disorganization under demand, improved visuomotor coordination as increased operational confidence, and lower ADEXI scores as a more favorable perception of one's own executive control.

Even so, this integration must be sustained with caution. The cohort was small, the design lacked a control group, and the diagnostic distribution was asymmetric. Therefore, the convergence between quantitative and qualitative results should not be interpreted as strong confirmatory proof, but rather as preliminary evidence that is methodologically useful for justifying subsequent studies with larger samples, controlled comparisons, and longer follow-up. Within this framework, the main contribution of the present study lies in showing that a structured table tennis intervention can be simultaneously implementable, acceptable, and sensitive to functional changes in an inclusive university context, thereby opening a promising line for applied research in neurodiversity, physical activity, and higher education.

CONCLUSIONS

The results of the present study suggest that a structured table tennis intervention, implemented as an accessible cognitive-motor device in higher education, may be associated with preliminary improvements in visuomotor coordination, reaction time, inhibitory control, and perceived self-regulation in university students with attention-deficit/hyperactivity disorder and level 1 autism. The consistency in the direction of change across the different quantitative domains, together with the magnitude of the nonparametric contrasts and the convergence with the qualitative findings, supports the interpretation that the program was sensitive to relevant functional modifications within the cohort studied.

At the same time, the study provides favorable evidence regarding the feasibility of implementing this type of intervention in an inclusive university context. High attendance, full retention, absence of attrition, tolerable progression of perceived effort, and the documented yet manageable need for reasonable accommodations suggest that the device was not only logistically executable, but also acceptable from the participants' perspective. This finding is particularly relevant because it shifts the discussion from a logic centered exclusively on performance toward a broader understanding of inclusion, understood as the real possibility of sustained, functionally accessible, and subjectively meaningful participation.

The qualitative component strengthened this interpretation by showing that the quantitative changes were accompanied by perceptions of greater concentration, better emotional regulation, increased motor confidence, more manageable social interaction, and a positive appraisal of the program structure. Consequently, the potential of the intervention does not appear to reside exclusively in the sports content itself, but in the articulation among motor task, pedagogical progression, reasonable accommodations, session predictability, and self-reflective closure. This combination suggests that table tennis may function, under certain design conditions, as a tool of functional support in inclusive higher education.

Nevertheless, the conclusions must be interpreted with caution. The study had a pilot character, used a one-group design, worked with a small sample, and presented an asymmetric diagnostic distribution. Therefore, the results should not be read as definitive demonstration of efficacy or as sufficient evidence to establish differences between students with ADHD and level 1 autism.

Its main contribution lies in offering an initial empirical and methodological basis for the development of future research with greater statistical power, comparative groups, extended longitudinal follow-up, and more robust strategies for controlling concomitant variables.

The study suggests that a structured table tennis intervention may constitute a promising pathway for articulating physical activity, executive function, accessibility, and participation in neuroinclusive university contexts. Its current value does not lie in closing the problem, but in opening an applied line of research with theoretical plausibility, contextual feasibility, and preliminary signals of functional usefulness.

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