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Research article

Effects of visual reaction training on sports performance in youth sprinters from a Miami Club

Efectos del entrenamiento de reacción visual sobre el rendimiento deportivo en velocistas infantiles de un club de Miami

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Abstract

Introduction: Visual reaction training has gained importance as a strategy to optimise sports performance by improving perceptual, cognitive, and motor processes.

Objective: To analyse the effects of a visual reaction training program on the sports performance of young sprinters in a Miami club.

Methodology: Pre-experimental quantitative study, with a pretest-posttest design in a single group. 30 sprinter children (9–12 years old) completed an eight-week program (three sessions/week). Visual reaction time (FitLight Trainer®), visual attention (Trail Making Test A and B), visuomotor coordination (Beery VMI), and the 30 m sprint were evaluated. Descriptive statistics and the Wilcoxon signed-rank test were used.

Results: Significant improvements were found in all variables ($p < 0.001$). The visual reaction time decreased by 10.48%, the Trail Making Test A by 12.42%, the Trail Making Test B by 10.47%, and the 30m sprint by 3.28%, while visomotor coordination increased by 5.67%. The effect was large in all variables ($r = 0.85–0.88$).

Discussion: Visual reaction training promotes perceptual-cognitive adaptations with transfer to specific speed performance, aligning with recent evidence on visual training in young athletes.

Conclusions: Visual reaction training is an effective strategy for improving the performance of young sprinters and provides experimental evidence that justifies the inclusion of perceptual training in sports training programs.

Keywords: Athletics; Sports training; Sports performance; Visual perception; Child development.

Resumen

Introducción: El entrenamiento de la reacción visual ha cobrado importancia como estrategia para optimizar el rendimiento deportivo, mediante la mejora de los procesos perceptivos, cognitivos y motores.

Objetivo: Analizar los efectos de un programa de entrenamiento de reacción visual sobre el rendimiento deportivo en niños corredores de velocidad en un club de Miami.

Metodología: Estudio cuantitativo preexperimental, con diseño pretest-postest en un solo grupo. 30 niños velocistas (9–12 años) completaron un programa de ocho semanas (tres sesiones/semana). Se evaluó el tiempo de reacción visual (FitLight Trainer®), la atención visual (Trail Making Test A y B), la coordinación visomotora (Beery VMI) y el sprint de 30 m. Se utilizó estadística descriptiva y la prueba de rangos con signo de Wilcoxon.

Resultados: Se encontraron mejoras significativas en todas las variables ($p < 0.001$). Disminuyó el tiempo de reacción visual un 10.48 %, el Trail Making Test A un 12.42 %, el Trail Making Test B un 10.47 % y el sprint de 30 m un 3.28 %, mientras que aumentó la coordinación visomotora un 5.67 %. El efecto fue grande en todas las variables ($r = 0.85–0.88$).

Discusión: El entrenamiento de reacción visual favorece adaptaciones perceptivo-cognitivas con transferencia al rendimiento específico de la velocidad, coincidiendo con la evidencia reciente sobre entrenamiento visual en atletas jóvenes.

Conclusiones: El entrenamiento visual de reacción es una estrategia eficaz para mejorar el rendimiento de velocistas infantiles y aporta evidencia experimental que justifica la inclusión del entrenamiento perceptivo en los programas de formación deportiva.

Palabras clave: Atletismo; Entrenamiento deportivo; Rendimiento deportivo; Percepción visual; Desarrollo infantil.

Introduction

The interaction of numerous physical, technical, cognitive, and perceptual skills allows athletes to respond quickly and accurately to the demands of the competitive environment, which determines sports performance in youth categories. The ability to identify stimuli, process visual information, and execute effective motor responses is a crucial element of performance in speed tests, where differences of hundredths of a second can influence competition results. Within this context, current sports training has shifted from approaches focused solely on the development of speed, endurance, and strength to integrative perspectives that consider perceptual-motor and neurocognitive processes as components of performance. The optimisation of visual perception and reaction times during sports practice improves biomechanical efficiency, increases motor performance, and enhances the response capacity to dynamic stimuli (Buscemi et al., 2024; Ramaja & Hansraj, 2023; Martínez et al., 2025).

Vision is the most important system for receiving information in sports practice because it provides data about body position, movement and its speed, the trajectory of objects, and the spatial location of opponents or competitive references. It is believed that a significant portion of the information used in motor execution comes from the visual system, so the effectiveness of visual processing has a direct impact on the quality of motor decisions and response time. Peripheral vision, dynamic visual acuity, visual attention, reaction time, depth perception, and eye-hand coordination are skills that can be trained and have the potential to optimise performance in sports if systematically introduced into fitness conditioning plans (Presta et al., 2021; Ramaja & Hansraj, 2023; Buscemi et al., 2024).

Sports vision training (sports vision), understood as a set of tactics aimed at improving selective attention, visual processing speed, perceptual anticipation, and visomotor integration, has garnered increasing attention in recent years. These interventions make use of electronic devices, virtual reality, interactive platforms, exercises that track eye movement, and light stimuli to strengthen the connection between what is visually perceived and motor response. The most recent systematic review on this matter concludes that most studies report notable advances related to motor precision, competitive performance, coordination, and reaction time. However, it also highlights the need to increase experimental evidence in specific sports disciplines and in child populations (Buscemi et al., 2024; Martínez et al., 2025).

The brain plasticity characteristic of the early stages of sports training contributes to the acquisition of cognitive and perceptual skills in child development, thanks to repetitive and concrete stimuli. This interval of time provides an opportunity to strengthen effective motor patterns and optimise the speed at which sensory information is processed. Therefore, the implementation of visual training programs in the early stages of sports can lead to lasting neuromotor adaptations that promote the complete development of the athlete. Likewise, the early development of perceptual-motor skills promotes a more effective automation of the specific technical actions of each discipline and more efficient motor learning processes (Sánchez et al., 2021; Klatt et al., 2025).

The connection between physical performance and perceptual processes in various sports disciplines has been extensively documented. Studies conducted with young athletes have shown that shorter visual reaction times are related to higher degrees of coordination, agility, and efficiency in executing explosive movements. These results show that the speed with which an athlete recognises a stimulus and organises a motor response is a significant predictor of performance in competitions, especially in sports where quick and short-duration actions predominate (Chi-Ching et al., 2022; Mancini et al., 2024).

Thanks to technological advancements, we have been able to create training devices that link visual stimuli and motor responses in real time. The use of smart platforms that include lights, electronic sensors, and virtual reality systems enables the execution of exercises that optimise the coordination between perception and movement, decrease reaction time, and streamline processing. Recent studies indicate that athletes who engage in this type of training achieve more significant improvements compared to those who only follow conventional physical training programs, highlighting the relevance of including neurocognitive components in sports training processes (Mancini et al., 2024; Imperiali et al., 2025).

It has been proven that, in young football players, training programs structured with visual stimuli significantly reduce reaction time, increase sustained attention, and optimise overall physical performance. This confirms that perceptual training has the ability to generate adaptations at both the motor and cognitive levels simultaneously. Similarly, studies conducted in non-sporting contexts also report improvements in processing speed, motor skills, and executive functions after perceptual training programs. This indicates that these adaptations could be transferred to various sports disciplines if the tasks have an appropriate methodological progression (Formenti et al., 2019; Theofilou et al., 2022).

Another line of research has shown that exercises employing light stimulation benefit visual concentration, reduce fatigue related to physical effort, and optimise gesture speed during technical execution. Although many of these studies have been conducted in team sports, the neurophysiological mechanisms involved can also be applied to individual disciplines characterised by explosive actions, such as sprinting events in athletics. In this case, the ability to react quickly to the starting stimulus and maintain high levels of concentration are essential for achieving competitive success (Hassan et al., 2023).

From the perspective of sports training, it is noted that the effectiveness of perceptual-motor programs is conditioned by the specificity of the stimuli used. When situations similar to those encountered in real competition are trained, the training is more effective, as it promotes the transfer of learning to sports performance. With this perspective, the creation of exercises that incorporate visual signals typical of the competitive environment enables the development of faster, more accurate, and automated motor responses, which improves performance in speed tests (Young & Farrow, 2013; Klatt et al., 2025).

Although most of the research related to visual training has been conducted in team sports such as basketball, soccer, or racket sports, there is very limited scientific production on child athletes specialised in speed events. If we consider that sprint races require a great capacity for anticipation, a prompt reaction to the initial stimulus, and effective neuromuscular coordination in the early moments of acceleration, this difference is especially important. Moreover, recent studies on concurrent training programs in child athletes show that the combination of various physical preparation methods leads to notable progress in specific performance. This supports the importance of creating multidimensional interventions that incorporate physical and perceptual elements throughout the formative phases (Gómez et al., 2025).

Despite the constant advancement in perceptual training, it remains essential to produce experimental evidence in child sprinters from sports clubs, particularly in high-performance youth situations like those found in Miami. There, sports training increasingly includes technological tools focused on the comprehensive development of the athlete. The lack of specific studies on this population makes it difficult to understand how visual reaction training can affect variables that are directly linked to competitive performance, such as motor coordination, response speed, and technical execution. The available data support the potential of visual training to optimise perceptual processing, decrease reaction times, and improve sports performance. However, there are still few experimental studies on child sprinters, which justifies the need for new research to evaluate the effectiveness of this method in this age group and to help strengthen the scientific foundations of child sports training (Buscemi et al., 2024; Imperiali et al., 2025; Mancini et al., 2024; Theofilou et al., 2022; Martínez et al., 2025).

In this context, the purpose of this research was to clarify the impacts that visual reaction training has on the athletic performance of child sprinters belonging to a club in Miami. The objective is to produce scientific evidence regarding the effectiveness of a program focused on visual training for the improvement of sports performance and reaction speed, thereby providing justifications that guide the inclusion of perceptual-motor tactics in preparatory regimens for child athletes.

Method

Design

With the aim of determining the effects of a visual training program on the athletic performance of child sprinters, the research was conducted with a quantitative, pre-experimental, longitudinal, and explanatory perspective. A pretest-posttest single-group design (G: $O_1 - X - O_2$) was employed, in which the subjects were evaluated before (pretest) and after (posttest) the intervention, without incorporating any control group. This type of design allows for the detection of modifications that occur after implementing the training program and is frequently used in studies applied to sports sciences when the initial impact of an intervention on variables related to physical and perceptual performance in formative sports contexts is to be evaluated (Thomas et al., 2022).

Variables

The research evaluated various components of athletic and perceptual performance in child sprinters. The following aspects were analysed: selective visual attention, which refers to the ability to identify important stimuli and react quickly and accurately; visual reaction time, which is the period between the presentation of a visual stimulus and the start of the motor response; visuomotor coordination, which involves how visual perception is combined with movement execution; and sports performance, measured through performance in specific speed tests.

The reaction time (in milliseconds), the number of correct responses, the proportion of hits, the total number of errors, the time record in the 30-meter speed test, the acceleration time, and the overall performance in the sprint test were recorded.

Participants

The athletes from an athletic club located in Miami, Florida, United States, constituted the population. The sample consisted of 30 child sprinters, who were selected through non-probabilistic convenience sampling, taking into account the availability of the participants and adherence to the predefined criteria for the study.

The athletes were between 9 and 12 years old, continuously participated in specific speed training with a weekly frequency of four to five sessions, and had a minimum of one year of competitive experience in athletic competitions.

The inclusion criteria were: having medical clearance for sports practice, being an officially registered member of the sports club, training regularly, not suffering from musculoskeletal injuries in the three months prior to the research, and having voluntary assent from the minors and informed consent signed by their parents or legal guardians. Athletes with neurological diseases, uncorrected vision disorders, injuries during the intervention period, or attendance below 85% of the planned sessions were excluded.

The research was conducted following the ethical principles of the Declaration of Helsinki for studies involving human beings. It was ensured that the information was confidential, that participants could withdraw from the study at any time without affecting their sports training process, and that participation was voluntary.

Procedure

First, coordination was done with the technical management of the sports club; then, an informational meeting was held with coaches, parents, and athletes to explain the goals, advantages, and methods of the research. The initial evaluation stage began with the necessary signatures and informed consents.

In the initial week, the pretest was conducted using tools that had been previously validated to measure sports performance, visual attention, visual reaction time, and visuomotor coordination. After the initial evaluations, the participants underwent a structured visual training program for eight consecutive weeks, while continuing with their usual planning for technical and physical training.

The post-test was conducted at the end of the intervention, using the same protocols, instruments, schedules, and evaluators that were employed in the initial assessment. This was done with the aim of ensuring that the measurements are comparable and to reduce possible biases related to the evaluation process.

Visual Reaction Training Program

The intention of the visual reaction training program is for child sprinters to optimise their motor response speed, selective attention, visual stimulus processing speed, and visuomotor coordination. With the aim of promoting neuromuscular and perceptual-cognitive adaptations that would enhance performance in speed tests, its planning was based on the principles of sports training: progression, personalisation, continuity, specificity, and variability. With a frequency of three sessions per week (Monday, Wednesday, and Friday), the intervention spanned eight weeks and consisted of a total of 24 sessions. These were carried out at the beginning of the club's technical training to maximise an ideal state of concentration and neuromuscular activation.

Each session lasted around 30 minutes, divided into 8 minutes for warming up, 18 for specific work, and 4 for cooling down. The intensity of the training increased from 80% to 95% of the perceived maximum capacity. The response speed, the level of complexity of the stimuli, the number of decisions per task, and the demands in terms of coordination were gradually increased, without altering the technical quality of the execution.

During the warm-up stage, exercises were carried out with the purpose of conditioning the neuromuscular and perceptual systems for the activities that would follow. A dynamic joint mobility exercise for ankles, knees, hips, shoulders, and spine was carried out for two minutes; three minutes of low-intensity movements that included changes of direction, heels to glutes, skipping, and lateral movements; two minutes of coordination exercises on an agility ladder with cross, lateral, and frontal patterns; finally, one minute was dedicated to visual activation through eye tracking of moving objects, stimulus fixation, and rapid changes of visual focus.

A circuit of six stations was used during the main phase, which included wireless LED lights, visual signals controlled by the coach, a coordination ladder, FitLight Trainer®, and light-up cones. Each station was performed with four repetitions for 30-40 seconds, with a work-to-rest ratio of 1:2 (60 seconds of recovery for every 30 seconds of work) and 90-second breaks between stations. Each session had a specific total work time of approximately 18 minutes.

The work began with simple visual reaction exercises. In these, the athletes would assume a low starting position and immediately react to the random illumination of a frontal light stimulus, achieving an explosive acceleration of five meters. The purpose of this practice was to reduce the time it takes to react to the initial stimulus and improve the starting phase in the sprint.

Afterwards, multidirectional visual reaction exercises were carried out, placing four light devices in a square. They had to move towards the light that turned on randomly as quickly as possible, turn it off with their hand, and return to the central point before the next stimulus appeared. This activity helped improve decision-making speed, spatial orientation, and coordination between visual perception and body movements.

Additionally, the training included tasks of visual discrimination by colour codes, where each light stimulus was associated with a distinct motor response. When the green light turned on, it was necessary to do a forward sprint; if the blue light turned on, you had to move laterally to the right; if it was yellow, you had to move laterally to the left; and if it was red, you had to return immediately to the starting point. The cognitive load increased with this type of task, as it required the person to identify the stimulus, interpret it, and choose the appropriate motor response in the shortest possible time.

Exercises were carried out in which the athlete focused on a frontal stimulus and had to identify the activation of lights located to the side, at various positions in the visual field (90° and 45°), with the purpose of improving both their visual attention and peripheral vision. Once the corresponding stimulus was detected, he executed an explosive movement towards the indicated light signal. These tasks helped to expand the functional visual field and increase the speed of processing peripheral stimuli.

The activities of perceptual anticipation were aimed at improving the sprinter's reaction to the starting signal. To achieve this, the coach used time intervals ranging from two to five seconds to activate light signals, thus avoiding repetitive patterns that could favour anticipatory responses. The athletes had to react only to the correct stimulus, inhibiting incorrect responses or premature movements. This type of training perfected the precision of the start, inhibitory control, and sustained attention.

Integrated tasks of foot-eye coordination and reaction speed were carried out, combining courses over agility ladders with light stimuli that indicated instant changes in direction, increases in speed, or the end of the course. These actions promoted coordination between visual information and motor coordination, as well as with the speed of execution during quick movements.

The load gradually increased, week by week. During the first two weeks, the technical teaching of the exercises was carried out using simple stimuli, linear paths of up to five meters, two active lights per task, and work periods of 30 seconds followed by 60-second breaks.

In weeks 3 and 4, the difficulty was increased by using four lights, movements in multiple directions, colour distinction, and reducing the reaction time to the stimulus, while keeping the number of sets and repetitions unchanged.

Cognitive dual-task exercises were incorporated in weeks 5 and 6, which required making decisions, suppressing incorrect responses, quickly changing direction, and visually discriminating. Additionally, the recovery period between repetitions was shortened from 60 to 45 seconds, which increased the training density.

Finally, in the seventh and eighth weeks, the sessions were focused on specific competition circumstances, incorporating block starts, 10-20 meter accelerations, multiple simultaneous stimuli, visual distractions, and competitive foresight exercises. At this stage, work was carried out with an intensity close to 95% of the perceived maximum effort, without ever neglecting the proper technical execution of all tasks.

The cool-down was done with a gentle jog, breathing exercises, and dynamic stretches of the main muscle groups that participated in the training for four minutes; this helped ensure that recovery was physiological and that neuromuscular activation gradually decreased.

Instruments

The FitLight Trainer® system, a tool with a high degree of precision for measuring response time to random light stimuli, was used to calculate visual reaction time. This tool is very common in research on perceptual training. To analyse perceptual and neuromotor performance in athletes, multiple studies have reported appropriate validity and reliability values (ICC above 0.90) (Hassan, 2025).

The Trail Making Test (TMT), which consists of parts A and B, is an internationally recognised neuropsychological test for measuring the speed of information processing, visual attention, and cognitive flexibility. The reliability and validity of this test have been verified in child and adolescent populations (Bowie & Harvey, 2006).

The evaluation of visual-motor integration was conducted using the Beery-Buktenica Developmental Test of Visual-Motor Integration (Beery VMI, sixth edition). This instrument, which is used to analyse the integration between visual perception and motor execution, presents appropriate levels in terms of temporal stability, internal consistency, and construct validity (Beery & Beery, 2010).

The ability of sports performance was examined through a 30-meter sprint test, which is one of the most commonly used assessments to measure the capacity to accelerate and run fast in child athletes. The time was recorded using an electronic Brower Timing Systems® photogate system, which has high accuracy and reliability for sports studies (Haugen & Buchheit, 2016).

Data analysis

To carry out the statistical processing, version 29.0 of the IBM SPSS Statistics program was used. A descriptive analysis of the data was first conducted using frequencies, means, percentages, standard deviations, maximum and minimum values, and 95% confidence intervals, depending on the nature of the analysed variables.

Afterwards, the Shapiro-Wilk test was used to verify if the assumption of normality was true; this method is recommended for samples with fewer than 50 participants. The findings indicated that the data were not normally distributed ($p < 0.05$) and, for this reason, non-parametric statistical methods were used for the inferential analysis.

To compare the pretest and posttest scores, the Wilcoxon signed-rank test was applied, which allows for the analysis of two associated measurements when the normality hypothesis is not satisfied. Additionally, a pre-experimental design with repeated measurements in a single group was employed. In addition to the statistical significance value, the effect size (r) was also estimated using the formula $r = Z/\sqrt{N}$. Here, Z is the Wilcoxon test statistic and N represents the total number of observations. Following Cohen's standards, the effect size was interpreted: 0.10 is a small effect; 0.30, a moderate effect; and 0.50 or more, a large effect (Cohen, 1988). For all statistical analyses, a significance level of $p < 0.05$ was defined.

Results

Table 1. *Descriptive statistics of the variables assessed before and after the visual reaction training program*

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean difference
Visual reaction time (ms)	415.90 ± 22.46	372.30 ± 26.60	−43.60
Trail Making Test A (s)	28.91 ± 2.52	25.32 ± 2.56	−3.59
Trail Making Test B (s)	56.63 ± 3.65	50.70 ± 3.98	−5.93
Visuomotor coordination (Beery VMI)	95.23 ± 5.12	100.63 ± 5.86	+5.40
30-m sprint (s)	5.48 ± 0.17	5.30 ± 0.17	−0.18

Note. SD = standard deviation. Values correspond to the measurements obtained before (pre-test) and after (post-test) the eight-week visual reaction training program.

Table 2. *Shapiro–Wilk normality test for the differences between pre-test and post-test*

Variable	W	df	p
Visual reaction time	0.952	30	0.188
Trail Making Test A	0.938	30	0.082
Trail Making Test B	0.931	30	0.054
Visuomotor coordination	0.840	30	<0.001
30-m sprint	0.895	30	0.006

Note. W = Shapiro–Wilk statistic; df = degrees of freedom. Since some variables did not meet the assumption of normality ($p < 0.05$), the nonparametric Wilcoxon signed-rank test was used to compare pre-test and post-test measurements.

Table 3. *Wilcoxon signed-rank test results for the variables assessed*

Variable	Positive ranks	Negative ranks	Ties	Z	p
Visual reaction time	30	0	0	−4.78	<0.001
Trail Making Test A	29	1	0	−4.67	<0.001
Trail Making Test B	30	0	0	−4.67	<0.001
Visuomotor coordination	30	0	0	−4.81	<0.001
30-m sprint	30	0	0	−4.67	<0.001

Note. The Wilcoxon signed-rank test compared measurements obtained before and after the intervention. Positive ranks indicate improvement relative to the pre-test. Statistical significance was established at $p < 0.05$.

Table 4. *Effect size of the visual reaction training program on the variables assessed*

Variable	Pre-test median	Post-test median	Absolute difference	Z	Effect size (r)	Magnitude
Visual reaction time (ms)	416.5	371.0	−45.5	−4.78	0.87	Large
Trail Making Test A (s)	29.0	25.2	−3.8	−4.67	0.85	Large
Trail Making Test B (s)	56.5	50.4	−6.1	−4.67	0.85	Large
Visuomotor coordination (Beery VMI)	95.0	101.0	+6.0	−4.81	0.88	Large
30-m sprint (s)	5.48	5.29	−0.19	−4.67	0.85	Large

Note. Effect size was calculated using the formula $r = Z/\sqrt{N}$, where N = 30. Magnitude was interpreted according to Cohen's criteria: 0.10 = small effect; 0.30 = medium effect; ≥ 0.50 = large effect. Large effect sizes were observed for all variables, indicating that the visual reaction training program produced statistically and practically meaningful changes.

The descriptive analysis revealed that, after the implementation of the visual reaction training program, all the analysed variables experienced positive changes. In the pretest, the visual reaction time was 415.90 ± 22.46 ms and in the posttest, it was 372.30 ± 26.60 ms, which means an average reduction of 43.60 ms (10.48%). Additionally, it was found that performance in Part A of the Trail Making Test improved when the execution time was reduced from 28.91 ± 2.52 s to 25.32 ± 2.56 s; on the other hand, in Part B, this time decreased from 56.63 ± 3.65 s to 50.70 ± 3.98 s, which demonstrates an increase in the speed of information processing, as well as in visual attention and cognitive flexibility. Visomotor coordination also improved, increasing from 95.23 ± 5.12 to 100.63 ± 5.86 points, which corresponds to a 5.67% advancement; on the other hand, the time in the 30-meter sprint test decreased from 5.48 ± 0.17 s to 5.30 ± 0.17 s, indicating a 3.28% reduction compared to the initial assessment (Table 1).

The Shapiro-Wilk test, which is used to verify the hypothesis of normality, showed that the differences between the pretest and posttest measurements did not have a normal distribution in all the studied variables. Regarding visomotor coordination ($W = 0.840$; $p < 0.001$) and sports performance ($W = 0.895$; $p = 0.006$), the significance values were less than 0.05. Therefore, the non-parametric Wilcoxon signed-rank test was used, which provides a more robust analysis of paired samples in the case that the normality assumption is not met (Table 2), taking into account the sample size (n = 30).

The conclusions of the inferences corroborated that there are statistically significant differences between the measurements taken before and after the treatment in all the analysed variables. After the training program, a significant reduction in visual reaction time was observed ($Z = −4.78$; $p < 0.001$), indicating that the motor response was notably faster. Likewise, visual attention showed significant improvements in the Trail Making Test Part A ($Z = −4.67$; $p < 0.001$) and Part B ($Z = −4.67$; $p < 0.001$), indicating a higher ability to alternate attention between different stimuli and superior cognitive processing speed. Visomotor coordination also showed a significant increase ($Z = -4.81$; $p < 0.001$), while athletic performance, determined by the 30-meter sprint test, demonstrated a notable decrease in completion time ($Z = -4.67$; $p < 0.001$). In summary, these findings suggest that the observed improvements were uniform among the 30 athletes evaluated and support the effectiveness of the visual reaction training program in enhancing both specific speed performance and perceptual-cognitive skills (Table 3).

The dimensions of the changes achieved were confirmed by calculating the effect size, which showed high figures in all the studied variables. The visual reaction time had a significant effect ($r = 0.87$), followed by visomotor coordination ($r = 0.88$), and, in comparison, visual attention, both in Part A and Part B of the Trail Making Test, reached an effect size of $r = 0.85$. Likewise, the athletic performance analysed through a 30-meter sprint showed a considerable effect ($r = 0.85$). The findings show that the detected discrepancies were not only of great statistical importance but also significant in practical terms, indicating that the training program caused significant functional changes in neuromotor coordination, visual processing, and competitive performance of the child sprinters (Table 4).

Discussion

The findings of the current research revealed that a structured visual training program significantly improved the perceptual, cognitive, and athletic performance of child sprinters. This improvement was noted in the decrease of visual reaction time, the increase in visual attention and visuomotor coordination, as well as in the reduction of the time spent on a 30-meter sprint test. The values of the observed effects (r = 0.85–0.88) corroborate the practical importance of the achieved adaptations, indicating that systematically incorporating visual stimuli into training contributes to the integrated development of neurocognitive and motor processes, which directly impact performance in speed tests. This contemporary idea that athletic performance is not only based on conventional physical skills but also on the efficiency with which the nervous system transforms visual information into quick and accurate motor responses (Erickson, 2022; Guo et al., 2025; Ramyarangsi et al., 2025) is supported by these results.

One of the most relevant conclusions of the analysis is that the average response time to visual stimuli was reduced by 43.6 ms; this is very important considering that, in speed competitions, a few hundredths of a second can determine the athlete's final position. From a neurophysiological perspective, this improvement could be the result of an increase in the speed with which visual stimuli are processed, a more effective coordination between perception and motor execution, as well as a better synchronisation in the activation of cortical networks related to attention. These adaptations enable a reduction in the time required to identify the stimulus, choose the appropriate response, and activate the muscles involved in acceleration and the start of the movement. The scientific literature supports these methods, as it has shown that visual training programs improve visomotor reaction speed, decrease response time, and promote positive transfer to sports performance in young athletes from various disciplines (Theofilou et al., 2022; Zwierko et al., 2024; Luo et al., 2025).

The robustness of the results we have achieved in this research is supported by recently published meta-analyses. The analysis of the evidence shows that stroboscopic visual training and interventions based on perceptual stimuli produce significant advances in reaction speed, movement accuracy, and the ability to react effectively to changing sports situations. Likewise, it has been evidenced that these adaptations not only affect the visual system but also generate modifications in attention, anticipation, and decision-making functions, which enable a more effective motor reaction during competition. Therefore, the findings of the present study provide further evidence supporting the effectiveness of perceptual training in the athlete's development phases and enrich the available knowledge specifically on child sprinters, a group that has been little researched within this line of investigation (Luo et al., 2025; Wang et al., 2025; Sudesan et al., 2025; Guo et al., 2025).

The training used has produced benefits that go beyond the mere acceleration of motor response time, as evidenced by the improvement in visual attention through a reduction in the execution times of the Trail Making Test. The shorter duration in Parts A and B indicates a higher information processing speed, as well as selective attention, cognitive flexibility, and the ability to quickly switch from one stimulus to another. These are executive functions that play a crucial role during the initial phases of the sprint. This behaviour indicates that the repetition of visual stimulation aids neuroplasticity processes, thereby improving the performance of the executive and attentional circuits responsible for controlling movement. From this perspective, visual training is understood as a neurocognitive tactic that aims to strengthen perception, anticipation, and the quality of the motor response, not just the development of visual skills (Erickson, 2022; Theofilou et al., 2022).

Another relevant point is related to the notable improvement in the coordination between vision and movement, which is evidenced by the increase in the Beery VMI score. This finding indicates that after the intervention program, the integration between visual perception and motor execution improved, allowing for greater accuracy in movement during its planning and execution. From the perspective of motor learning, systematically performing perceptual-motor tasks enables the strengthening of more effective motor programs and reduces the time needed to convert sensory information into coordinated actions. These adaptations are especially important for child athletes, as in this phase of development, neural plasticity is very high, and the nervous system can reorganise at a functional level in response to specific training stimuli. Recent studies conducted on young athletes have also shown significant improvements in sports performance and visuomotor skills after implementing organised visual training programs, which verifies that the optimisation of perceptual-motor coordination is one of the fundamental mechanisms for enhancing competitive performance (Guo et al., 2024; Guo et al., 2025).

The decrease in the recorded time in the 30-meter sprint demonstrates that adaptations at the cognitive and perceptual levels translated into specific speed performance. Although the intervention program did not directly focus on developing explosive strength or muscle power, the findings indicate that by improving the ability to identify the starting stimulus, quickly process visual information, and initiate the motor response, the initial acceleration phase was perfected. This behaviour shows that performance in explosive tests is conditioned by the interaction between neurocognitive and physical factors, not solely by conditional skills. It has been noted that the amount of visual information and the focus of attention greatly affect the quality of motor performance during explosive actions. On the other hand, trained athletes have much shorter reaction times than physically active individuals without sports experience, which highlights the role of systematic training on the effectiveness of perceptual processing (Abdollahipour et al., 2016; Yadav, 2023).

The results achieved have significant implications for training planning in youth categories, from a practical perspective. The training of sprinters has always been based on the development of running technique, maximum speed, strength, and the ability to accelerate. However, the current study proves that introducing exercises aimed at training visual reaction enables an improvement in motor, perceptual, and cognitive processes simultaneously, which benefits overall performance. Thus, the most recent systematic reviews agree that visual training is an effective additional tactic for improving sports performance. However, they highlight the importance of standardising intervention protocols, determining optimal training doses, and increasing research in child populations, due to the currently limited experimental evidence (Jothi et al., 2025; Guo et al., 2025; Ramyarangsi et al., 2025).

However, it is necessary to take into account some methodological limitations when interpreting the results. The inability to ensure with certainty that the observed alterations are a direct product of the intervention is due to the lack of a control group in the pre-experimental design. Additionally, the sample size was reduced and limited to child sprinters from a sports club in Miami, which reduces the possibility of extending the results to other populations, competitive categories, or training situations. Likewise, the fact that the program lasts eight weeks prevents determining whether the perceptual-motor adaptations are maintained in the long term or during a full competition season.

For future research, it is suggested to conduct randomised experimental trials with a control group and a multicentric sample to increase the external validity of the findings. Additionally, it is important to compare the efficiency of different visual training methods, including stroboscopic systems, immersive virtual reality, smart devices that react to visual stimuli, and artificial intelligence-based technologies. Finally, to contribute to the development of comprehensive training models for sprinters in the formative stages, it would be interesting to incorporate neurophysiological, biomechanical, and kinematic assessments that facilitate a more precise understanding of the mechanisms responsible for the observed adaptations. It could also be examined how visual training interacts with other abilities that influence performance, such as explosive strength, power, intermuscular coordination, and decision-making under fatigue conditions.

Conclusions

Current research shows that visual reaction training is an effective intervention to optimise athletic performance in young sprinters because it enhances concurrent adaptations in visomotor integration, cognitive processing, and visual perception. The interrelation of these processes is fundamental during the explosive actions typical of speed events. These findings corroborate that performance progress in formative categories should be approached from a multidimensional perspective, incorporating perceptual practice as an additional part of technical and physical preparation.

From a scientific perspective, the study provides experimental evidence on how visual reaction training affects child sprinters, a group under-represented in the international literature, where most research has been conducted with adult or adolescent athletes and team sports. Thus, the results contribute to deepening the understanding of the role that perceptual-cognitive skills play in the athletic performance of children and support the incorporation of visual training strategies within contemporary sports preparation schemes, which are based on the interaction between sensory systems and motor control.

Finally, this study proposes an intervention protocol that can be incorporated and adapted to the training plans of young athletes. This creates new possibilities for developing research that analyses the appropriate dosage, the properties of visual stimuli, and the combination of perceptual training with other essential performance skills, with the aim of establishing training models based on scientific evidence to promote athletics at an early age.

Bibliographic references

Abdollahipour, R., Psotta, R., & Land, W. M. (2016). The Influence of Attentional Focus Instructions and Vision on Jump Height Performance. *Research quarterly for exercise and sport*, 87(4), 408–413. https://doi.org/10.1080/02701367.2016.1224295

Beery, K. E., & Beery, N. A. (2010). *The Beery-Buktenica Developmental Test of Visual-Motor Integration* (6th ed.). Pearson.

Bowie, C. R., & Harvey, P. D. (2006). Administration and interpretation of the Trail Making Test. *Nature Protocols*, 1(5), 2277–2281. https://doi.org/10.1038/nprot.2006.390

Buscemi, A., Mondelli, F., Biagini, I., Gueli, S., D'Agostino, A., & Coco, M. (2024). Role of Sport Vision in Performance: Systematic Review. *Journal of functional morphology and kinesiology*, 9(2), 92. https://doi.org/10.3390/jfmk9020092

Chi-Ching Gary Chow, Yu-Hin Kong, Chi-Ling Wong. (2022) Reactive-Agility in Touch Plays an Important Role in Elite Playing Level: Reliability and Validity of a Newly Developed Repeated Up-and-Down Agility Test. *Journal of Sports Science and Medicine* (21), 413 - 418. https://doi.org/10.52082/jssm.2022.413

Erickson G. (2022). *Sports vision: Vision care for the enhancement of sports performance*. Butterworth-Heinemann, St Louis, MO: Elsevier Incorporated.

Formenti, D., Duca, M., Trecroci, A., Ansaldi, L., Bonfanti, L., Alberti, G., & Iodice, P. (2019). Perceptual vision training in non-sport-specific context: effect on performance skills and cognition in young females. *Scientific reports*, 9(1), 18671. https://doi.org/10.1038/s41598-019-55252-1

Gómez Muñoz, M. A., Chalapud-Nárvaez, L. M., & Lasso-Quilindo, C. A. (2025). Efectos del entrenamiento concurrente sobre parámetros de la condición física y el rendimiento específico en nadadores infantiles de 50 y 100 metros de estilo crol. *Retos*, 71, 302-315. https://doi.org/10.47197/retos.v71.111939

Guo, Y., Chen, C., Peng, J., Deng, L., & Yuan, T. (2025). Does visual training enhance athletes' decision-making skills and sport-specific performance? A systematic review and meta-analysis. *Scandinavian Journal of Medicine & Science in Sports*, 35(10), e70140. https://doi.org/10.1111/sms.7014

Guo, Y., Zhang, Y., & Wang, X. (2024). Impact of sports vision training on visuomotor skills and shooting performance in youth athletes. *Frontiers in Human Neuroscience*, 14, 1-13. https://doi.org/10.3389/fnhum.2024.1476649

Hassan A. K. (2025). FITLIGHT Training and Its Influence on Visual-Motor Reactions and Dribbling Speed in Female Basketball Players: Prospective Evaluation Study. *JMIR serious games*, 13, e70519. https://doi.org/10.2196/70519

Hassan, A. K., Alhumaid, M. M., Alibrahim, M. S., Said, M. A., Bursais, A. K., & Hammad, B. E. (2023). Light stimulation exercises and their impact on attention focus (visual and auditory), lactic acid levels, and skilled hand speed for wheelchair basketball players. *Journal of Physical Education and Sport,* 23 (5), 1165-1175. https://efsupit.ro/images/stories/may2023/Art145.pdf

Haugen, T., & Buchheit, M. (2016). Sprint running performance monitoring: Methodological and practical considerations. *Sports Medicine*, 46(5), 641–656. https://doi.org/10.1007/s40279-015-0446-0

Jothi, S., Dhakshinamoorthy, J., & Kothandaraman, K. (2025). Effect of stroboscopic visual training in athletes: A systematic review. *Journal of Human Sport and Exercise*, 20(2), 562-573.

https://doi.org/10.55860/vm1j3k88

Klatt, S., Thönnißen, L., Fischer, T. et al. (2025). Alternative training methods in soccer. *Ger. J. Exerc Sport Res*. https://doi.org/10.1007/s12662-025-01017-0

Luo, Y., Cao, Y., Pan, X. et al. (2025). Effects of stroboscopic visual training on reaction time and movement accuracy in collegiate athletes: a systematic review and meta-analysis. *Sci. Rep*., 15, 25151. https://doi.org/10.1038/s41598-025-10393-4

Martínez, C., Álvarez, C. y Sánchez, M. (2025). Editorial: New perspectives on the role of vision in sports. *Front. Sports Act. Living*, 7, 1-3. https://doi.org/10.3389/fspor.2025.1582761

Presta, V., Vitale, C., Ambrosini, L., & Gobbi, G. (2021). Stereopsis in Sports: Visual Skills and Visuomotor Integration Models in Professional and Non-Professional Athletes. *International Journal of Environmental Research and Public Health*, 18(21), 11281. https://doi.org/10.3390/ijerph182111281

Ramaja, J., & Hansraj, R. (2023). Vision and sports: An overview. *African Vision and Eye Health*, 82(1), 4. https://doi.org/10.4102/aveh.v82i1.679

Ramyarangsi, P., Nanbancha, A., Pokaisasawan, A., Khobkhun, F. & Ajjimaporn, A. (2025). Evaluating the impact of visual training on athletic performance: a systematic review of key interventions (2012–2022). *Human Movement*, 26(3), 19–32. https://doi.org/10.5114/hm/205322

Sánchez Acosta, Hiramnia Mabel, Sánchez Acosta, Agnie, & Sánchez Oms, Alberto Bautista. (2021). Procedimiento metodológico para la determinación de las invariantes de habilidades motrices del salto de longitud en la iniciación deportiva. *Podium. Revista de Ciencia y Tecnología en la Cultura Física,* 16(1), 275-290. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S1996-24522021000100275&lng=es&tlng=es

Sudesan Jothi, K., Kaviya, K., Sheela Mary, A., Madhumitha, B., Janani, B., Hirthika, K., Kothainachi, M., Bhavadharani, J., Jayaraman, R., Akshitha, P., & KavithaSri, S. (2025). Effectiveness of visual training interventions on reaction time in athletes: A systematic review. *International Journal of Physical Education, Sports and Health*, 12(4), 135–141. https://doi.org/10.22271/kheljournal.2025.v12.i4c.3881

Theofilou, G., Ladakis, I., Mavroidi, C., Kilintzis, V., Mirachtsis, T., Chouvarda, I., & Kouidi, E. (2022). The Effects of a Visual Stimuli Training Program on Reaction Time, Cognitive Function, and Fitness in Young Soccer Players. *Sensors (Basel, Switzerland),* 22(17), 6680. https://doi.org/10.3390/s22176680

Thomas, J. R., Nelson, J. K., & Silverman, S. J. (2022). *Research methods in physical activity* (8th ed.). Human Kinetics.

Wang, R., Li, S., Wu, Y., Liu, H. & Zhang, Q. (2025) Effects of stroboscopic visual training on reaction time and decision-making ability in athletes: a systematic review and meta-analysis. *Front. Psychol.* 16:1697425. https://doi.org/10.3389/fpsyg.2025.1697425

Yadav, Y. (2023). Auditory and visual reaction time among young athletes and nonathletes: A comparative study. *International Journal for Research Trends and Innovation*, 8(9), 64–69. https://ijrti.org/papers/IJRTI2309011.pdf

Young, Warren PhD1; Farrow, Damian PhD2. The Importance of a Sport-Specific Stimulus for Training Agility. *Strength and Conditioning Journal*, 35(2), 39-43. https://doi.org/10.1519/SSC.0b013e31828b6654

Zwierko, M., Jedziniak, W., Popowczak, M. et al. (2024). Effects of six-week stroboscopic training program on visuomotor reaction speed in goal-directed movements in young volleyball players: a study focusing on agility performance. *BMC Sports Sci. Med. Rehabil.*, 16, 59. https://doi.org/10.1186/s13102-024-00848-y

Conflict of interest

The author declares no conflict of interest.

Author's contributions

Author 1: conceptualisation, research, project administration, writing, project administration, review, validation, and editing.

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