Original Article

Effect of visual stimuli on the jumping ability of amateur soccer players

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ABSTRACT

In soccer, high levels of strength applied in short durations are crucial for various performance-related actions such as accelerations, decelerations, sprints, jumps, and changes of direction. These actions often occur in the presence of visual stimuli that require attention and rapid reaction. Recent training methodologies propose integrating visual stimuli to enhance sport-specific physical abilities. However, limited research has investigated the impact of visual stimuli on explosive force production abilities. Therefore, this study aimed to analyse the influence of reacting to non-specific visual stimuli on seated and counter-movement vertical jump performance. Seventeen senior amateur soccer players (age: 22.9 ± 2.8 years; height: 172.0 ± 8.5 cm; weight: 71.1 ± 7.3 kg) were recruited as participants for this study. Participants performed seated vertical jumps (SJsit-90º) and counter-movement vertical jumps (CMJ) under two conditions: with reaction to a visual stimulus (REAC) and without reaction (VOL). The order of the conditions was counterbalanced across participants. The statistical analysis revealed a significant decrease in the height of SJsit-90º in the REAC condition compared to the VOL condition (HeightVOL-REAC = 1.88 ± 2.16 cm; $p < .001$). Although a similar trend was observed, no significant differences were found in CMJ height between conditions (HeightVOL-REAC = 0.70 ± 0.63 cm; $p = .277$). It is concluded that the inclusion of non-specific visual stimuli to react to significantly and negatively affects the ability to apply force measured through seated vertical jumps. These findings emphasize the importance of considering the potential detrimental effects of external visual stimuli on explosive force production when designing training protocols for soccer players.

Keywords: Performance analysis of sport, Strength, Vertical jump, Reaction to visual stimuli, Team sports, CMJ, SJ.

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INTRODUCTION

Team sports, including soccer, are characterized by a dynamic and ever-changing environment that necessitates simultaneous perception, decision-making, and action by players during the game (Becerra, 2020, p. 31). The players' actions largely depend on their ability to identify relevant environmental cues (Coutinho et al., 2018), which requires considerable attention and the development of specific perceptual skills, alongside other motor functions (Meng et al., 2019).

Vision is recognized as the most important sensory ability in accurately perceiving key elements during a soccer game (Kung et al., 2020). Consequently, soccer performance relies not only on physical and technical-tactical skills but also on the player's perceptual-cognitive abilities (Williams & Jackson, 2019). While perceptual skills are indirectly trained during on-field practice, separate training to maximize player performance is necessary. Coaches should design training tasks that consider the factors that limit and enhance performance to ensure functional coupling between perception and action processes (Pinder et al., 2011).

Agility, a crucial skill in team sports, has been redefined to incorporate perceptual and decision-making components alongside change-of-direction speed (CODS). This revised definition emphasizes that agility involves rapid whole-body movements in response to a stimulus (Sheppard & Young, 2006; Serpell et al., 2011). Consequently, agility is influenced by perceptual-cognitive factors and physical attributes such as stride adjustments, sprinting speed, and leg muscle qualities, including strength, power, and reactive strength (Young et al., 2015). In light of this, new training methodologies have emerged that integrate visual stimuli to enhance physical skills like accelerations, decelerations, changes of direction, and sprinting (Turner et al., 2021; Spiteri et al., 2018).

While perceptual-cognitive skills have been extensively studied in team sports and linked to motor performance in sport-specific tasks (Meng et al., 2019; Koppelaar et al., 2019; Formenti et al., 2019; Vestberg et al., 2012; Serpell et al., 2011; Sheppard et al., 2006), few studies have directly examined their impact on force production or physical performance in specific actions.

For instance, Lee et al. (2019) investigated the effects of reacting to visual stimuli on the muscle activation of knee muscles during unplanned sidestepping. Their findings demonstrated lower muscle activation when reacting to non-specific visual stimuli compared to specific visual stimuli, indicating that muscle activation varies with changes to the visual environment. However, this study did not collect force or performance data.

Schroeder et al. (2020) compared the kinetics and joint kinematics of sidestepping in reaction to non-specific visual stimuli and defensive-opponent movements. They observed variations in biomechanics depending on the stimulus type, with greater ground reaction forces produced in response to sport-specific stimuli. However, force comparisons were not made when the movement was performed in a planned manner.

On the other hand, literature supports the notion that attending to external visual cues improves strength exertion in resistance training tasks (Coratella et al., 2020; Marchant et al., 2009; Wiseman et al., 2020; Neumann, 2019) as well as in jumping exercises (Makaruk et al., 2012; Marchant et al., 2018) and sprinting (Winkelman et al., 2017; Porter et al., 2015).

Jumping tests, such as the squat jump (SJ) and countermovement jump (CMJ), are commonly used to evaluate lower body neuromuscular function and explosive strength in athletes (Bishop et al., 2022; Bishop

& Turner et al., 2022; Turner et al., 2019). The height of these jumps serves as a reliable indicator of athletes' force application capacity and neuromuscular system state (Markovic et al., 2004; Bosco et al., 1983). Notably, the SJ assesses the ability to rapidly generate force during concentric movements, while the CMJ evaluates force production during stretch-shortening cycle movements (McGuigan et al., 2006).

Previous studies have shown differences in jumping performance between starting and non-starting Division I soccer players, with starters demonstrating superior jump height, mean velocity, and maximum velocity during SJ compared to non-starters (Magrini et al., 2018). Similarly, Edwards et al. (2022) found significant differences in SJ and CMJ height and peak power between youth Australian soccer players competing at different levels.

In real game situations, the ability to apply force effectively in technical actions is critical, and its execution is influenced by the nature of the visual stimulus to which the athlete must respond (e.g., trajectory of the ball, position of the goal, and movement of other players). Therefore, understanding how perceptual demands influence motor performance is of great importance in designing effective training programs for athletes.

Due to the lack of information on the reaction to visual stimuli in soccer and its effects on strength and motor performance, this study aims to explore the impact of visual stimuli on the jumping ability of soccer players as an indicator of their force production capacity.

MATERIALS AND METHODS

Sample

The sample size for this study was determined in advance using G*Power software (v.3.1.9.7), with $\alpha = 0.05$ and $\beta = 0.80$. Consequently, the sample consisted of a non-random selection of 17 senior amateur soccer players (mean age: 22.9 ± 2.8 years; mean height: 172.0 ± 8.5 cm; mean weight: 71.1 ± 7.3 kg) who had a mean experience of 17.7 ± 3.9 years playing soccer at the federated level. Inclusion criteria for participation in the study included being an active licensed soccer player, having a minimum of 5 years of soccer practice experience, and not reporting any significant injuries that would have prevented them from training or competing in the past 3 months.

Following a comprehensive explanation of the study's objectives, methodology, and potential risks, all players provided voluntary consent to participate in the data collection process by signing an informed consent form in accordance with the principles outlined in the Declaration of Helsinki (WMA, 2013; WMA, 1964). The protocol for the study was approved by the Ethics Committee of the Universidad Politécnica de Madrid (Code number: LEDRAUEVEL-MSQ-DATOS-20200307).

Material

The tests were conducted in a closed room equipped with an air conditioning system to control the ambient conditions of the room and with a BAR-908-HG® weather station (Oregon Scientific, Portland, OR, USA) to record the temperature and humidity of the room during data collection. The ambient conditions during the entire data collection were quite stable (room temperature: 20.6 ± 1.3 °C; humidity: 43.8 ± 6.5%). The four units of a Blaze Pod lighting device (Blazepod, UK) were programmed via the device mobile app to activate randomly one at a time with an interval between 2 and 5 seconds. When the subject was prepared in the starting position, the first light was not considered (Ready) and the second light was interpreted as the signal to perform the jump.. A 50 cm high box was used to standardize the starting knee flexion (from a seated position). Additional 3 cm plastic pieces were used to ensure a 90º seat position. To determine the height of the jumps, each jump was recorded in slow motion (240 fps) with a Redmi Note 10 smartphone (Xiaomi, Pekin, China) for subsequent analysis using the mobile app "*my Jump*" for Android, which is a valid and reliable method for calculating jump height (Balsalobre-Fernández et al., 2015).

Procedure

Each participant was randomly assigned to either Group A or Group B and took part in three experimental sessions with a one-week interval. The protocol and experimental design are illustrated in Figure 1.

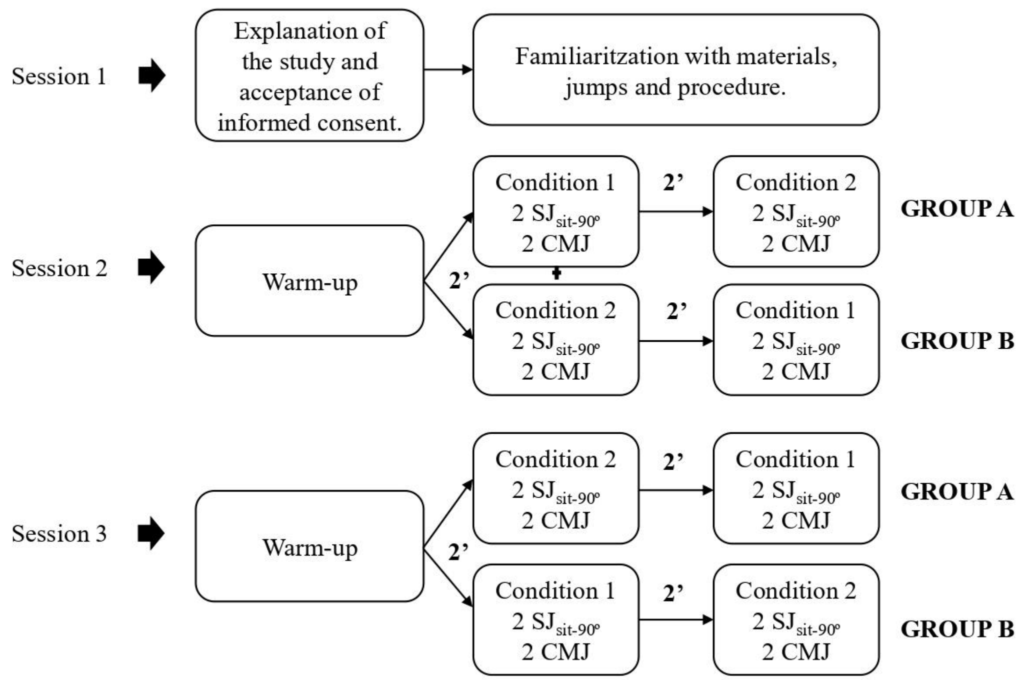


Figure 1. Schematic representation of the experimental design and sessions.

During the first session, participants received information about the study objectives and data collection procedures, and subsequently provided informed consent. They then familiarized themselves with the jumping tests (SJsit-90º and CMJ) and other data collection procedures.

Subjects performed several jumps in order to having instant feedback about the efficiency of each jump, being the average practice three or four jumps under each condition.

The second and third sessions included a warm-up and the testing of the $SJ_{sit\text{-}90º}$ and CMJ under two different conditions (with and without visual stimuli). The order of the conditions in the second and third sessions was reversed. Half of the subjects started with condition 1 (without visual stimulus) and the other half with condition 2 (with visual stimulus).

The test protocol started with a standardized warm-up, including 3-min of low-intensity running and 2-min of dynamic stretching on the arms and legs. Afterwards, they were required to complete 8 repetitions of squats with their own body weight, 5 squat jumps (SJ) and 5 CMJ without recording the results, after each warming-up set the subjects had a 1-min rest.

Procedure
The testing protocol is shown in Figure 2, in a view from above (A) and lateral view (B). After the warm-up, the participants performed two repetitions of the SJsit-90º and then performed two more CMJ under the experimental condition. In case of blocking or wrong execution of the jump, an additional jump was performed. A 2-min rest between sets of jumps was kept. The two experimental conditions were:

- Voluntary (VOL). The player was not subjected to any external stimulus; they could decide when to perform the jump.
- Jumping reacting to a light (REAC). The player reacted to a non-specific visual stimulus (light signal), programmed to appear suddenly and randomly in a maximum interval of 5 seconds. The reason for the random waiting time is that, as seen in Mattes & Ulrich (1997), the force exerted in response to a stimulus is related to the temporal predictability of the stimulus. The greater the predictability, the greater motor preparedness to respond. We want to represent the nature of the game in the test, so the stimulus should not be predictable.

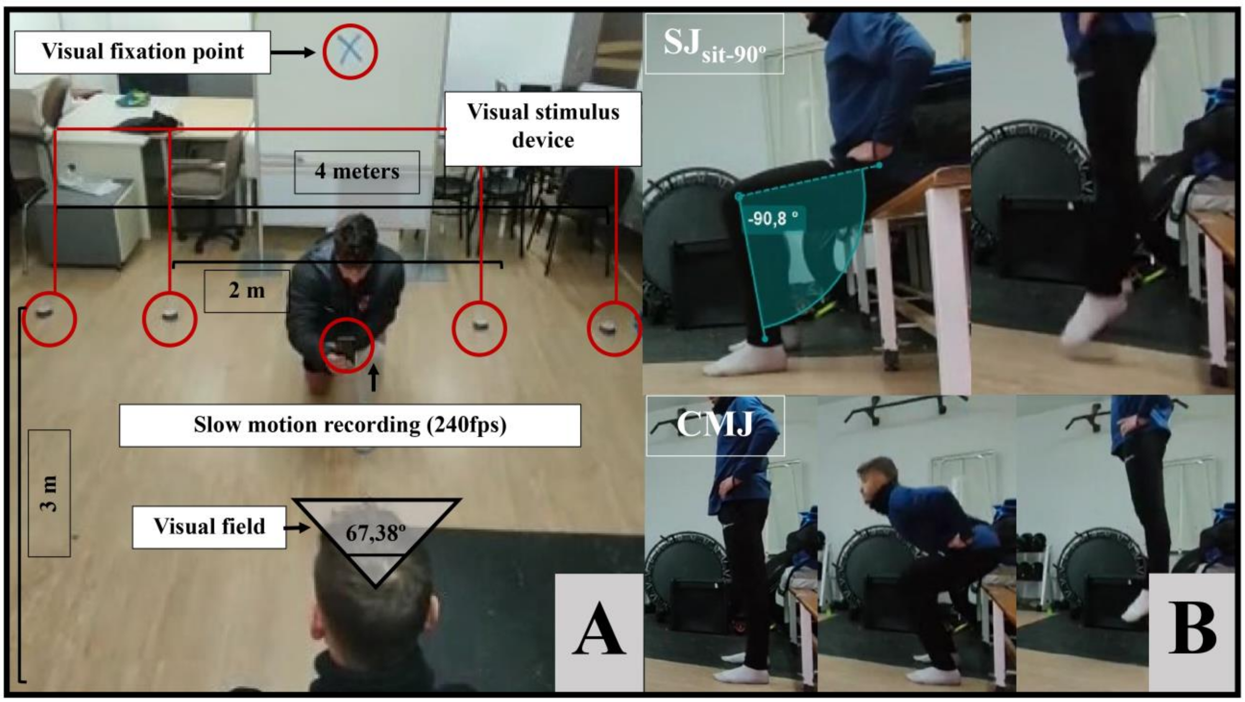


Figure 2. Schematic representation of the tests in the REAC experimental condition. A) View from above. B) Side view of the two types of jump (CMJ and SJsit-90º).

In the CMJ protocol, participants began in a tall standing position, with feet placed hip-width to shoulder-width apart. Then, participants dropped into countermovement position to a self-selected depth, followed by a maximal effort vertical jump. The hands remained on the hips throughout the movement to eliminate any influence of arm swing. If the hands were removed from the hips at any point, or excessive knee flexion was exhibited during countermovement, the trial was repeated. The participants reset to the starting position after each jump (França et al. 2022).

The SJsit-90º protocol was done from seated, maintaining a 90º knee-angle with a straight trunk. Starting in the sitting position was required to standardize the test for all subjects and to minimize the effect variables such as the preparation time for the jump (i.e. due to the waiting time until the appearance of the stimulus, a previous concentric contraction must be done if the subject is not sitting down) Therefore, each subject could be in a resting position while waiting for the light signal.

Each jump was recorded in "*slow motion*" setting (240 fps) to be analysed with the app "*MyJump2*" to determine the jump height. In addition, the technique of the jump and the contact with the ground on landing were checked to ensure that it was performed in plantar flexion; otherwise, the flight time would be increased and the height of the jump recorded by the app would be greater than the real height (Morin & Samozino, 2018, p. 88). Additionally, arm thrust was not allowed during the jump (hands resting on the hips during the whole jump).

Each subject performed a total of 8 jumps (2 CMJ and 2 SJsit-90º under both conditions: VOL and REAC) in each session. In the event of incorrect execution or blocking in any of the jumps, the test was repeated. From the two valid jumps for each condition, the highest was chosen for further analysis.

As shown in Figure 2, a device consisting of four independent lights was placed three metres from a bench where the jump was performed. The four lights were located equidistant from a central line where the participant stood. To require the subject to maintain a horizontal (external-wide) attentional focus representative of the soccer (Pesce et al., 2007), a cross was painted on a wall at the central line, positioned at a height of one meter. Participants were instructed to maintain visual fixation on this point. The two internal lights of the device were situated 1 meter away from the central line, while the two external lights were positioned 1 meter away from the internal lights, resulting in a 4-meter separation between the distal lights. Consequently, the total viewing angle required to observe all four lights simultaneously was 67.38°, corresponding to mid peripheral vision (Strasburger et al., 2011).

In this setting, the subject was required to use peripheral vision to perceive the stimuli, as occurs to a greater extent during soccer play, providing greater specificity to the test in terms of the player's perceptual function (Hadlow et al., 2018, Schumacher et al., 2019).

It should be noted that the verbal feedback provided before each set was the same for all participants: "*Jump as high as you can*".

Statistical analysis

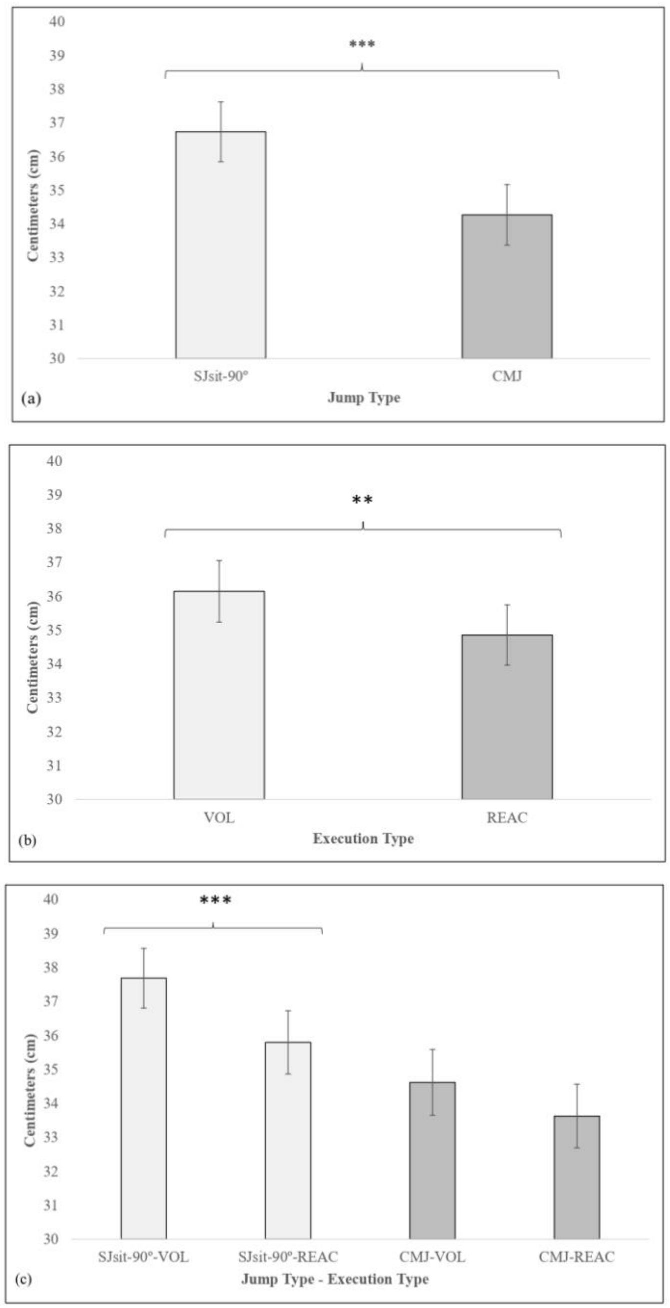
The statistical analysis was conducted using the SPSS 19.0 software. Prior to analysis, normality of the data distribution was assessed using the Shapiro-Wilk test, and homogeneity of variances was examined using the Levene's test. The results of both tests indicated a normal distribution of values and equal variance across the variables.

A repeated measures factorial analysis of variance (ANOVA) was performed to analyse the effect of execution type (VOL vs. REAC) and jump type (SJsit-90º and CMJ) on jumping performance. To determine significant differences between factors, a post hoc analysis using the Bonferroni correction was applied.

For estimating effect size (η^2), the following values were utilized: 0.01 for small effect size, 0.06 for medium effect size, and 0.14 for large effect size, based on the guidelines proposed by Castro and Martini (2014). A significance level of $p \leq .05$ was adopted to determine statistical significance in the results.

RESULTS

Figure 3 summarises the results of the data collections. An effect of jump type [$F(1,33) = 70.97$; $p \leq .0001$; $\eta^2 = 0.683$] was found on jump height, being the SJsit-90º higher than the CMJ (36.74 ± 0.89 cm vs 34.27 ± 0.90 cm, respectively).



*Note. **Statistical significance between conditions (p < .01).***Statistical significance between conditions (p < .001).*

Figure 3. (a) Mean number of sitting jumps (SJsit-90º) and countermovement jumps (CMJ).(b) Mean number of jumps in reaction to a visual stimulus (REAC) and voluntarily (VOL).(c) Mean number of sitting jumps in reaction to a visual stimulus (SJsit-90º REAC) and voluntarily (SJsit-90º VOL) and countermovement jumping in reaction (CMJ REAC) and voluntarily (CMJ VOL).

It was also found that the type of execution had an effect on the high of the jump height [$F(1,33) = 10.64$; $p = .003$; $\eta^2 = 0.244$;], with higher jumps performed under a VOL execution compared to the REAC execution (36.15 ± 0.91 cm vs 34.86 ± 0.89 cm, respectively).

No interaction was found for the type of jump and execution together [$F(1,33) = 3.03$; $p = .091$; $\eta^2 = 0.084$;]. However, post hoc analysis showed that only for SJsit-90º, the results with VOL execution were significantly higher [$F(1,33) = 25.8$; $p = \leq .0001$; $\eta^2 = 0.439$] than with REAC execution (37.69 ± 0.88 cm vs 35.80 ± 0.93 cm, respectively). Although CMJ did not show significant differences depending on execution type [$F(1,33) = 1.221$, $p = 0.277$, $\eta^2 = 0.36$], the mean was also slightly higher for the VOL condition compared to the REAC execution (34.62 ± 0.97 cm vs 33.91 ± 0.94 cm, respectively).

DISCUSSION

The athlete's capacity to generate force at high velocities in unloaded performance tasks is a crucial physical attribute in team sports due to its strong correlation with activities such as sprinting, change of direction, and jumping. Two commonly employed assessments to measure this quality are the Countermovement Jump (CMJ) and the Squat Jump (SJ) (Edwards et al., 2022). In our study, we specifically selected the SJsit-90º and the CMJ to evaluate isolated concentric and eccentric-concentric muscle actions, respectively, and investigate the impact of an external visual stimulus on neuromuscular performance. Our findings indicate that, regardless of the experimental conditions, athletes achieved greater jump heights in the SJsit-90º compared to the CMJ (36.74 ± 0.89 cm vs. 34.27 ± 0.90 cm, respectively, $p < .0001$) (Figure 3(a)). These results diverge from existing scientific literature comparing CMJ and SJ. Centeno-Prada et al. (2015) conducted a study on 323 elite athletes from various sports, including soccer, measuring CMJ and SJ heights to establish normative values. Their results demonstrated that the mean CMJ height was considerably higher than that of SJ. This differences can be attributed to two factors: firstly, in the CMJ, athletes are able to utilize the elastic energy generated during the eccentric phase, transferring it to the concentric phase of the movement, thereby facilitating rapid force production and enabling a higher take-off velocity. Conversely, the SJ necessitates the isometric maintenance of the squat position for a few seconds before the jump, which may impede movement efficiency due to the sustained muscle tension.

However, in our study, we employed a modified version of the Squat Jump (SJ) known as the SJsit-90º, where the athletes initiated the jump from a seated position. This modification was implemented to mitigate potential fatigue that could arise from maintaining the squat jump position until the stimulus appeared, particularly in situations where the waiting time was at its maximum (up to 5 seconds). Conversely, in cases where the waiting time was short, the preceding contraction could enhance jump performance (Blazevich & Babault, 2019). By allowing the athletes to start the jump in a relaxed seated position, they were able to assume an optimal and advantageous posture prior to executing the movement, thereby achieving greater jump heights.

Considering the impact of the visual stimulus regardless of the jump type, our findings demonstrate that directing attention to the stimulus has a significant and adverse effect on jump performance. Specifically, the jump height achieved in voluntary (VOL) executions was greater compared to reactive (REAC) executions (36.15 ± 0.91 cm vs. 34.86 ± 0.89 cm, $p = .003$) (Figure 3(b)).

However, when considering the specific type of jump, significant differences between conditions were only observed for the SJsit-90º. In this case, the voluntary (VOL) execution outperformed the reactive (REAC) execution (37.69 ± 0.88 cm vs. 35.80 ± 0.93 cm, $p \leq .0001$). These differences were meaningful, as a change of approximately 1.8 cm represents about a 5% alteration in performance, given an average jump height of around 37 cm. Figure 3(c) illustrates that although the CMJ displayed a similar trend to the SJsit-90º, the results did not reach statistical significance (34.62 ± 0.97 cm vs. 33.91 ± 0.94 cm, $p = .277$).

The negative impact of external visual stimuli on performance has also been observed in other studies examining the throwing speed of handball players and the padel smash. Rivilla-García et al. (2016) investigated the maximum speed of goal shooting in 94 handball players, both with and without a goalkeeper present. They found that the presence of opposition significantly reduced the speed of the shot compared to unopposed situations despite instructions to shoot at maximum speed. The authors suggested that this decrease in speed could be attributed to a shift in the technical action to prioritize accuracy rather than pure speed when attempting to score a goal in the presence of a goalkeeper. They further proposed that visual information processing may interfere with the muscular action involved in the throw (Rivilla-García et al., 2016; Rivilla-García & Martínez et al., 2011; Rivilla-García et al., 2011). Similar findings were reported in a study examining the speed padel smash with and without opposition (Rivilla-García et al., 2019).

In contrast to those works, in our study, the technical factors were practically null compared to a complex action like shooting. The observed differences between the CMJ and the SJsit-90º when reacting to the stimulus could be attributed to the duration of jump preparation actions and the involvement of motor control mechanisms. In CMJ jumps, the duration of preparatory actions is longer compared to SJ (500-1000 ms vs 300-430 ms, respectively, as reported by Van Hooren & Bosch, 2016). This extended duration may provide an advantage in planning the jump action, particularly during the eccentric phase. The movement during the eccentric phase is predominantly governed by the somatic nervous system through reflexes and sensorimotor spinal loops (Bobbert et al., 1996). As a result, the jump may be less susceptible to the effects of visual stimulus on the central nervous system (CNS), emphasizing the importance of applying maximum force in SJsit-90º. The role of the CNS in controlling high-intensity movements has been extensively studied and debated (Van Soest et al., 1994). In open actions, the afferent pathways involved in information gathering play a crucial role in movement execution. Vision in particular, influences the motor response (Ashton-Miller et al. 2001); this fact has been verified in muscle activation and the kinematics of changes of direction, where the performance of the movement depends on the conditional visual stimulus (Brown et al., 2014; Lee et al., 2019; Schroeder et al., 2021)... Similarly, in our study, the reaction to visual stimuli could impact the ability to produce force.

These results have significant implications for physical trainers and coaches in situational sports like soccer. In these sports, most actions are executed in response to visual stimuli such as teammates, opponents, and the ball. It is crucial to incorporate these stimuli into skill development tasks. However, when aiming for maximum physical outputs, such as achieving maximum jump heights, these findings suggest that incorporating visual stimuli may not be the most effective method, especially when the stimulus provided does not align with the characteristics typically associated with the sport (non-specific stimulus).

These findings are not only relevant for enhancing performance but also for injury prevention. The need for the player to attend to the different stimuli while executing high-intensity actions could be a key factor in the occurrence of an injury (Leventer et al, 2015).

A higher cognitive load can negatively influence the ability to generate force, which can pose an additional risk in explosive actions and contribute to the higher incidence of non-contact injuries. It has been extensively demonstrated that proper strength training is a key factor in injury prevention (Lauersen et al., 2014).

In soccer, one of the most significant injuries in terms of recurrence and time off work is the anterior cruciate ligament (ACL) rupture (Bisciotti, 2019). The risk factors for ACL injuries are multifactorial, and the mechanisms can be classified into contact and non-contact injuries, with non-contact injuries being the most common (85% of total) (Della Villa et al., 2020). This trend is also observed in other team sports like rugby (Della Villa et al., 2021). Furthermore, ACL injuries are more prevalent during competition than in training due to the higher intensity of gameplay. Brown et al. (2014), in their systematic review on the influence of visual stimuli on the biomechanics of change of direction, concluded that actions performed in reaction to visual stimuli closely resemble the positions assumed during competition when ACL injuries occur. Consequently, athletes are exposed to a greater risk of injury during unplanned changes of direction.

Considering these findings, recent approaches in injury rehabilitation suggest incorporating tasks that stimulate attentional and perceptual processes. The integration of motor, sensory, and insular activity may serve as the neurophysiological mechanism underlying improvements in motor performance, particularly in tasks involving precise timing, hand-eye coordination, and coordinated actions in response to external stimuli (Gokeler et al., 2019).

However, based on the data from this study, it is important to note that such activities should not be considered as a replacement for training focused on fundamental motor capacities, as strength, and specific sports skill development. These are crucial for enhancing neuromuscular capacity and optimizing athletic performance. Incorporating non-specific attentional and perceptual tasks should be seen as complementary to, rather than substituting, the core training methods.

Currently, there is limited research that examines the influence of attending and reacting to visual stimuli on strength and motor performance development. This initial study suggests that this aspect should be given particular consideration when preparing athletes. However, further research is necessary to gain a deeper understanding of this topic and provide comprehensive knowledge in this area.

Limitations

As for the experimental design, only one type of visual stimulus was evaluated, which consisted of a light that turned on spontaneously. While this stimulus may not directly replicate a real sporting scenario, it does correspond to the type of stimulus commonly employed in training conditions where athletes react to visual cues presented by coaches or teammates, and even various devices such as lights or mobile screens.

Regarding the characteristics of the visual stimulus, important factors such as the intensity and duration of the stimulus were not considered, which could influence the outcomes. Future studies should aim to investigate the effects of different types of stimuli with varying degrees of specificity and complexity to provide a more comprehensive understanding of the impact on motor performance. Furthermore, exploring the relationship between reaction time and jump performance would be of interest. For instance, in the case of CMJ, Bishop & Turner et al. (2022) suggest considering indicators such as the modified reactive strength index (RSI-mod), which relates jump height to take-off time. Including the effects of reacting to visual stimuli on RSI-mod could provide valuable insights. Moreover, while this study focused on the vertical jump due to its association with athletic performance and explosive force production, future research could specifically examine force application in response to visual stimuli. These suggestions highlight areas for further investigation to enhance our understanding of the relationship between visual stimuli, motor performance, and specific performance indicators.

CONCLUSIONS

The reaction to a non-specific visual stimulus significantly and negatively affects performance in the jump height of the SJsit-90º, potentially due to cognitive factors related to perception, decision-making, or reaction abilities. Interestingly, the same impact was not observed in the CMJ.

From a practical standpoint, these conclusions emphasize the importance of considering perceptual elements in strength training for team sports like soccer, where athletes face situations requiring high neuromuscular and cognitive demands. Further research is necessary to enhance our understanding of physical preparation in team sports, particularly soccer, to effectively meet the sport's physical demands and potentially improve specificity and transfer of training to performance on the field.

AUTHOR CONTRIBUTIONS

Study design: Carlos Balsalobre, and Guillermo Mateos. Data collection: Carlos Balsalobre, Manuel Sillero, and Guillermo Mateos. Data analysis: Manuel Sillero and Guillermo Mateos. Composition of the document: Manuel Sillero and Guillermo Mateos. Document review: Carlos Balsalobre, Manuel SIllero, and Guillermo Mateos.

SUPPORTING AGENCIES

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

DATA AVAILABILITY STATEMENT

Data associated with this paper can be found in XLS format and open access through the following link: https://doi.org/10.5281/zenodo.8028742

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