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ORIGINAL ARTICLE

Effects of intentional and light-stimulated conditions on squat jump performance in Japanese elite basketball players

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ABSTRACT

The purpose of this study was to compare squat jump (SJ) performance between an Intentional Jump Condition (IJC) and a Reactive Jump Condition (RJC) involving a response to a single light stimulus in elite basketball players. The study participants were 12 male elite basketball players belonging to Japan's professional basketball league (B3 League). The participants performed SJ under two conditions, IJC and RJC; Jump Height (JH), Peak Force (PF), Peak Rate of Force Development (PRFD), and Average RFD (ARFD) were then recorded. The differences among each variable between the IJC and RJC were evaluated using a paired t-test. The results showed no significant differences between the IJC and RJC for JH, PF, and ARFD. In contrast, PRFD was significantly higher in the RJC compared to that in the IJC ($p < .05$). These results suggest that elite basketball players may possess neuromuscular control strategies that allow them to generate greater force in a shorter time during RJC without compromising on SJ performance. Therefore, our results suggest that SJ using a single light stimulus during RJC may serve as a useful method for evaluating the neuromuscular function of elite basketball players; moreover, this method may be an effective training technique aimed at improving explosive force production.
Keywords: performance analysis; stretch-shortening cycle; intentional jump; reactive jump; rate of force development; kinetics.

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INTRODUCTION

Basketball is a high-intensity, intermittent sport characterized by constant changes of direction and specific skills such as jumping, sprinting, acceleration, deceleration, and contact (Abdelkrim et al., 2007; McInnes et al., 1995). Because these movements are frequently required during a game, they are critical to success on the court. In fact, male basketball players reportedly perform an average of 50 jumps (Ben Abdelkrim et al., 2007, 2010; McInnes et al., 1995; Scanlan et al., 2011) and an average of 18–105 sprints (Ben Abdelkrim et al., 2007, 2010; McInnes et al., 1995; Scanlan et al., 2011), and change direction every 1–3 seconds (Scanlan et al., 2015). Furthermore, Petway et al. (2020) reported that elite basketball players spend more time performing high-intensity movements, such as sprints and jumps, compared to that by sub-elite players. To perform these actions with high quality, explosive power generation in the lower limbs is essential (Erculj et al., 2010).

Jump tests are a primary method for assessing the ability to generate explosive power in the lower limbs (Bosco et al., 1983). Among these, the squat jump (SJ) is used as a standard method for assessing lower-body muscle strength and neuromuscular performance (Markovic et al., 2004), with its validity and reliability being demonstrated in the literature (Fernandez-Santos et al., 2015; Markovic et al., 2004). The SJ is characterized by the descent to a squatting position followed by a pause before the jump is executed, during which the accumulated elastic energy is dissipated as heat (Wilson et al., 1991). Since the SJ lacks an eccentric phase, it allows for the assessment of pure power output during the concentric phase (Markovic et al., 2004). Furthermore, SJ has less kinematic and dynamic variability compared to that of other jump tests (Bosco et al., 1983). In actual game situations, athletes are required to perform numerous jumping movements in a competitive and demanding environment while facing opposing players; they must not only jump high but also jump higher than their opponents in specific defensive or offensive situations. For these reasons, many strength and conditioning (S&C) coaches incorporate the SJ into their program evaluations.

Recent studies have reported that sport-specific movements involving visual cognitive tasks using light stimuli and reactive conditions result in a shorter overall time from movement initiation to completion compared to that of intentional conditions—a phenomenon known as the reactive advantage (Hughes et al., 2011; La Delfa et al., 2013; Welchman et al., 2010; Weller et al., 2018). Wakatsuki and Yamada (2020) demonstrated that in a sidestep task using a single light stimulus, the reactive condition resulted in earlier movement initiation compared to that by the intentional condition; however, they also suggested that this may impose limitations on speed control. Furthermore, regarding the countermovement jump (CMJ), while jump height (JH) decreases in reactive conditions using simple light stimuli compared to that in intentional conditions, the reactive strength index-modified (RSI-mod) increases due to a shorter time from movement initiation to take off, indicating a change in movement strategy (Vivar et al., 2025). Furthermore, Fujisawa et al. (2026) conducted SJ with track and field athletes and football players and reported that while JH and peak force (PF) were significantly higher under the intentional condition, peak rate of force development (PRFD) and average RFD (ARFD) were significantly higher under the reactive condition using a single light stimulus. In particular, the effects of light stimulation on force production are influenced by the characteristics of the sport; for example, ARFD was significantly higher in football players under reactive conditions. Furthermore, in single-leg CMJs and hop jumps, JH and hop distance decreased under reactive conditions compared to that in intentional conditions (Ohji and Aizawa, 2026). Based on these findings, when healthy adult males, track and field athletes, or football players are studied, light stimulation alters jump performance and movement strategies, and these changes may reflect sport-specific characteristics. However, the effects of light stimulation on jump performance in basketball players remain unclear.

Recently, a study of elite volleyball players reported that block jump height and the length of the first step after the ready-block position decrease under conditions involving sport-specific visual and cognitive loads, suggesting that cognitive-motor interference may occur even in elite volleyball players (Fleddermann and Zentgraf, 2018). Furthermore, elite athletes possess greater lower-body muscle strength and power output capacity compared to those of non-elite athletes (Suchomel et al., 2016); moreover, elite athletes demonstrate superior perceptual-cognitive abilities and decision-making skills in conditions involving still images, video, and actual field environments (Mann et al., 2007). Based on these findings, elite basketball players may exhibit characteristics different from those of non-elite ball sport athletes in jump performance under reactive conditions using light stimuli. However, most studies have been limited to measurements where athletes perform jump movements at arbitrary times from a resting state, and there is a lack of evaluations under conditions involving the loads and reactions required in actual competitive environments (Ziv and Lidor, 2010). Consequently, it is difficult to apply previous research directly to elite basketball players.

Specifically, basketball is an open-skill sport performed in a complex and unpredictable environment where the movements of opponents, teammates, and the ball constantly change. Players are required to continuously process visual information obtained from the environment while selecting and executing optimal movements according to the situation (Li et al., 2026; Shalom et al., 2025). Jumping actions during a game frequently occur in situations such as rebounding, shot blocking, and shooting against a defender; many of these are reactive actions executed immediately in response to external stimuli, such as the ball's trajectory and opponents' movements. Therefore, basketball players must possess not only explosive force production capabilities but also the perceptual-cognitive-motor skills to perceive environmental information within a limited time, make decisions, and seamlessly link them to appropriate jumping actions. In contrast, track-and-field athletes typically require explosive force production through the stretch-shortening cycle and on movement efficiency in predictable environments with low cognitive demands (Mero et al., 1992). Their movement initiation is therefore largely predetermined, and less dependent on external stimuli. Although football players require high-cognitive-load situational judgments in complex, dynamic environments (Roca et al., 2013) and immediate reactions to opponents and the ball, their jump frequency during a match is reported to be over 10 times (Nedelec et al., 2014), which is fewer than the number performed in basketball. In addition, reactive movements in football predominantly involve sprints and changes of direction (Bloomfield et al., 2007; Taylor et al., 2017), resulting in different perceptual-cognitive and motor demands. Therefore, basketball likely places greater demands on visual scanning, anticipation, and reactive jumping than track-and-field or football, which may lead to sport-specific adaptations in neuromuscular control during reactive jump tasks.

Rate of force development (RFD) is used to assess explosive force production (Aagaard et al., 2002) and is considered a key factor for success in many sports (Stone et al., 2002). RFD reflects the ability to generate large forces in an extremely short time (Aagaard et al., 2002; Suchomel et al., 2016; Thomas et al., 2015) and is a crucial indicator of jump performance. In fact, maximal RFD is reportedly a powerful predictor of jump performance (Marques et al., 2015), making it an important metric in basketball, which involves skills such as sprinting and jumping that require force generation over very short durations. Previous studies have reported that side steps (Wakatsuki and Yamada, 2020) and SJ (Fujisawa et al., 2026), RFD is higher under reactive conditions compared to that in intentional conditions. Based on these findings, RFD is one of the useful variables for evaluating jump movements involving reactive conditions.

The purpose of this study was to compare the effects of intentional conditions and light-stimulated reactive conditions on SJ performance in elite basketball players. Specifically, the impact of light stimulation on jump performance is expected to reflect the characteristics of the sport (Fujisawa et al., 2026). Given that elite athletes possess superior perceptual, cognitive, and decision-making abilities compared to non-elite athletes (Mann et al., 2007), and simultaneously excel in lower-body muscle strength and power output (Suchomel et al., 2016), we hypothesized that elite basketball players would exhibit different neuromuscular control strategies than non-elite athletes, and that the differences in SJ performance between intentional and reactive conditions would be reduced.

MATERIAL AND METHODS

Participants

The study included 12 male elite basketball players. All participants were members of teams in the B3 League, Japan's professional basketball league, and their teams finished in 5th place or higher in the league standings during the 2024–25 season. The teams consisted of 4-point guards, 1 shooting guard, 3 small forwards, 3 power forwards, and 1 centre. Based on screening evaluations conducted by the team's athletic trainer, participants were assessed for a history of severe musculoskeletal injuries; musculoskeletal injuries within the past 3 months; and the presence of any conditions that impair sensory input, musculoskeletal function, or motor function. No minors were included in this study; all participants were 18 years of age or older. All basketball players trained five times per week, were proficient in the SJ technique, and performed SJs regularly. Furthermore, the participants were accustomed to jumping under various unpredictable conditions during games and training and were familiar with these movements. Furthermore, all participants had normal or corrected vision. The informed consent form and all experimental methods were approved by the Gifu University Graduate School of Medicine Research Ethics Review Committee prior to the start of this study (Certificate Number: 2025-062) and were conducted in accordance with the Declaration of Helsinki. After receiving an explanation of the benefits and risks of this study, the participants provided written informed consent in accordance with institutional guidelines.

Design and procedures

The study protocol was conducted in accordance with Fujisawa et al. (2026). All participants were instructed to refrain from resistance training on the day before the experiment. This experiment was conducted during a week when no official B3 League matches were scheduled during the season in order to minimize the effects of neuromuscular fatigue on the jump test. On the day of the experiment, the participants gathered again on the basketball court and performed 15 minutes of low-intensity jogging and dynamic stretching, as determined in advance by the team's athletic trainer. Subsequently, they performed five SJ. After the warm-up, all participants were given a 2-minute rest, and each participant performed a total of four SJs under two different conditions. All SJ trials were conducted in accordance with the experimental protocol of Bosquet et al. (2009). Participants started in an upright stance with their feet shoulder-width apart; upon the start signal, they transitioned to a squatting position, held that position for 2 seconds, and then jumped vertically with maximum effort (Bosquet et al., 2009). Upon landing, lateral and anterior-posterior movement was restricted to ensure landing at the same position as before the SJ was initiated (Yamauchi and Ishii, 2007). Additionally, for all trials, participants began the test with their hands on their hips to eliminate arm swing. This is based on a report indicating that, when testing basketball players, trials without arm swing show less variation in indicators such as jump height compared to that in trials with arm swing, and thus demonstrate higher reliability (Heishman et al., 2020). Starting from a static initial posture—defined as the average hip angle of 66° (0° being full extension) and average knee angle of 77° (0° being the neutral position)—at which individuals can reportedly jump smoothly and comfortably (Bobbert et al., 2006), our study participants were instructed to jump as high as possible with maximum effort using the extension of the three lower-limb joints, without using a counter-movement. To ensure that all participants jumped from the same initial posture for every trial, the initial posture was controlled by having participants visually track a marker placed at eye level in front of them and by positioning a photoelectric sensor (TC Timing Systems, Brower Timing System Inc., Draper, UT, USA) under the participant's buttocks to emit a sound when the predetermined hip and knee joint angles were reached. Participants wore their own basketball shoes during the test session.

In this experiment, two conditions were established: the Intentional Jump Condition (IJC) and the Reactive Jump Condition (RJC) (Fujisawa et al., 2026). In the IJC, each participant initiated the SJ at their own timing. In the RJC, participants were instructed to look at a light-emitting diode (LED) omnidirectional light presenter (PH-145, DKH, Tokyo, Japan) placed 1 m in front of them and were instructed to jump in response to the LED lights turning on (Figure 1). Participants performed the SJ in response to light stimuli presented at random intervals of 2–5 seconds. To account for the effects of post-activation potentiation (Blazevich and Babault, 2019), a maximum waiting time of 5 seconds was set. Additionally, since the force and power exerted are influenced by the temporal predictability of the stimulus (Mattes and Ulrich, 1997), random wait times were employed.

Participants performed the SJ twice under each condition (for a total of four trials). To avoid habituation resulting from repeated trials under the same condition, the two conditions were presented in a randomized order. Prior to each trial, participants were verbally instructed on the specific SJ condition they were about to perform. To eliminate the effects of fatigue, participants were given a rest period of at least 2 minutes between trials (Markovic et al., 2004). Furthermore, participants were verbally instructed to jump as high as possible with maximum effort; specifically, for the RJC only, they were instructed to react quickly to the light stimulus and perform a maximal jump. Participants were not provided with feedback regarding their SJ performance. The examiner monitored the vertical component of ground reaction force from the force plate and judged trials in which no counter-movement was observed as successful attempts. Furthermore, trials were deemed failures if the landing of the SJ occurred outside the force plate, if the hands were removed from the hips during the SJ, or if counter-movement was observed; in such cases, the reason for the failure was communicated to the participant, and the trial was repeated.

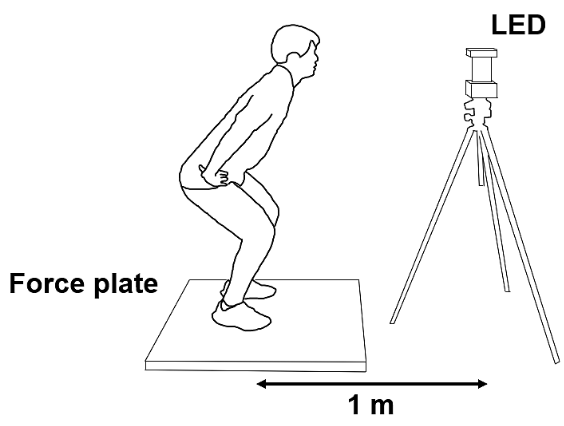


Figure 1. Schematic representation of the experimental design.

Measures
JH, PF, PRFD, and ARFD were adopted as evaluation variables for SJ performance. Vertical ground reaction force (vGRF) was collected at 1,000 Hz using a force plate (PH-6210A, 0.9 m × 0.9 m; DKH, Tokyo, Japan). The flight time (t) obtained from the force plate data was used to estimate the height of the rise in the centre of mass (h) during the SJ. JH was defined as the flight time component and calculated using the equation JH = (9.81 × flight time^2) / 8, adopted from the study by Bosco et al. (1983).

The data obtained from the force plate were smoothed using a five-point moving average to create a force-time curve. Then, based on the force-time curve, the maximum value of vGRF was calculated as PF, and the derivative-time curve was calculated by taking the time derivative of this curve at 0.001-second intervals. Additionally, based on the ground reaction force-time curve, the point at which the vertical vGRF on the force plate increased by 10% or more of body weight was defined as the onset of force generation. ARFD (= ΔvGRF / Δtime) was calculated by dividing PF during the jump by the time of arrival, with the maximum value of the derivative defined as PRFD (Figure 2), following previous studies (Haff et al., 2015; Khamoui et al., 2011). PF, PRFD, and ARFD were normalized by dividing them by body weight.

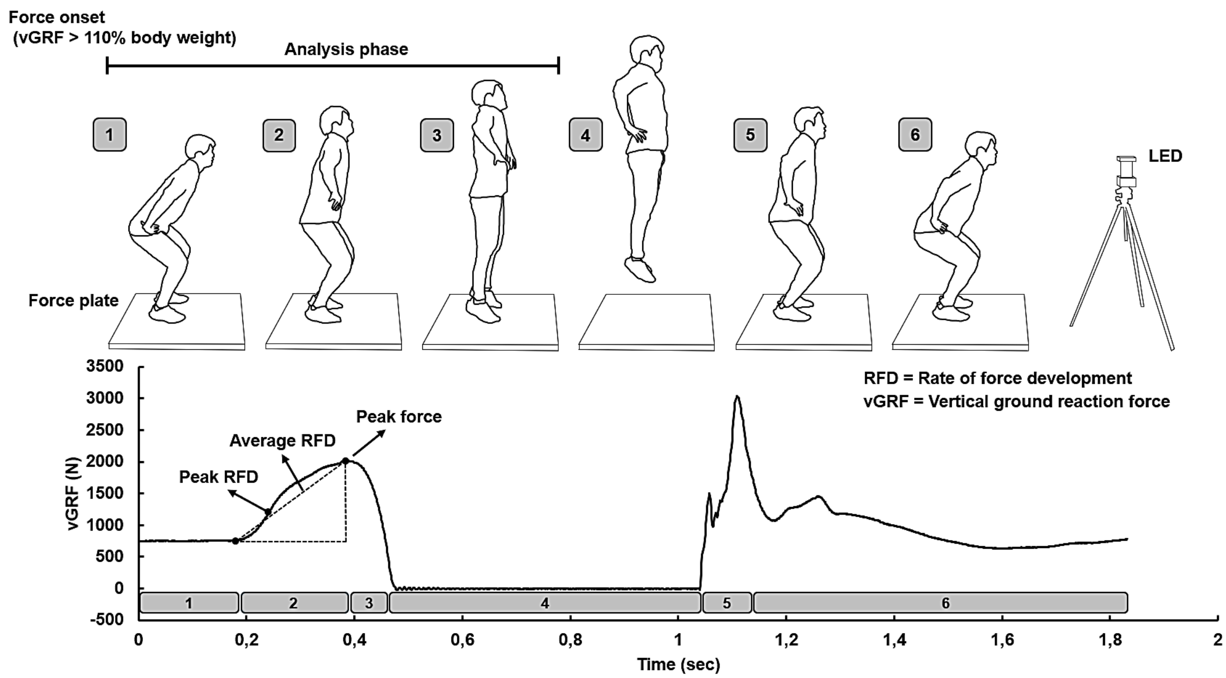


Figure 2. Typical movement and kinetic characteristics of a squat jump.

Statistical analysis

All statistical analyses were performed using IBM SPSS Version 25.0 (IBM, Armonk, New York, USA). The Shapiro–Wilk test was conducted to verify normality. Since the Shapiro–Wilk test results indicated that all data were normally distributed, parametric tests were used in this study. The intraclass correlation coefficient (ICC) and coefficient of variation (CV) were calculated to evaluate the test-retest reliability of the measured variables. A paired t-test was used to examine the differences in each SJ performance variable between the IJC and RJC among basketball players. Furthermore, to compare the magnitude of the differences between the two data sets, Hedges' *g* was calculated and used as the effect size. Effect sizes were defined as follows: less than 0.2 (trivial), 0.2–0.5 (small), 0.5–0.8 (medium), 0.8–1.3 (large), and 1.3 or greater (very large) (Cohen, 1988). The significance level was set at less than 5% for all analyses. All data were presented as mean ± standard deviation.

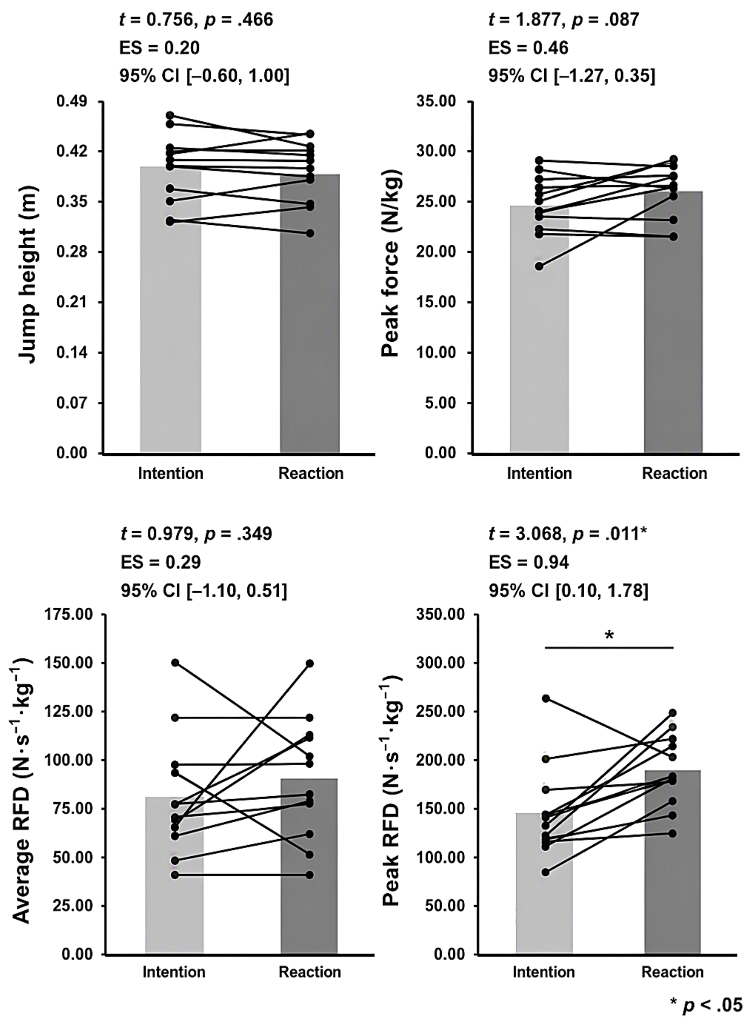
RESULTS

Descriptive statistics for squat jump performance variables categorized by playing position are presented in Table 1.

Table 1. Intentional and reactive squat jump performances across playing positions (mean ± SD).

	Jump height (m)	Peak force (N/kg)	Average RFD (Ns^{-1}/kg)	Peak RFD (Ns^{-1}/kg)
Intention				
Point guard (n = 4)	0.42 ± 0.03	26.43 ± 1.32	92.47 ± 38.72	170.41 ± 62.72
Shooting guard (n = 1)	0.47	24.08	48.49	117.18
Small forward (n = 3)	0.36 ± 0.04	26.26 ± 3.5	104.23 ± 15.36	172.14 ± 28.95
Power forward (n = 3)	0.37 ± 0.05	21.32 ± 2.51	57.54 ± 15.12	106.02 ± 18.2
Center (n = 1)	0.42	24.08	68.33	123.11
Reaction				
	Jump height (m)	Peak force (N/kg)	Average RFD (Ns^{-1}/kg)	Peak RFD (Ns^{-1}/kg)
Point guard (n = 4)	0.42 ± 0.02	27.84 ± 1.51	111.35 ± 27.99	204.42 ± 31.10
Shooting guard (n = 1)	0.43	26.49	62.05	125.67
Small forward (n = 3)	0.36 ± 0.02	25.96 ± 3.77	90.85 ± 35.85	205.64 ± 23.53
Power forward (n = 3)	0.37 ± 0.06	23.46 ± 2.07	66.03 ± 21.45	161.51 ± 19.14
Center (n = 1)	0.45	27.51	113.54	235.17

Note. RFD = rate of force development, SD = standard deviation. For the shooting guard and center positions (n = 1 each), raw values are presented without SD.



Note. RFD = rate of force development; ES = effect size; CI = confidence interval.

Figure 3. Comparison of squat jump performance variables between intentional and reactive conditions.

To evaluate the test-retest reliability of the measured variables, the ICC and CV were calculated. In the IJC, the values were as follows: JH (ICC = 0.866, CV = 2.70%), PF (ICC = 0.287, CV = 6.39%), PRFD (ICC = 0.242, CV = 20.74%), and ARFD (ICC = 0.340, CV = 27.35%). Similarly, in the RJC, the reliability values were: JH (ICC = 0.813, CV = 3.88%), PF (ICC = 0.226, CV = 6.84%), PRFD (ICC = 0.248, CV = 15.66%), and ARFD (ICC = 0.303, CV = 23.81%).

Figure 3 presents the results for each variable of SJ performance for all participants. Results from the paired t-test showed no significant differences between the IJC and RJC for JH (g = 0.20, small), PF (g = 0.46, small), and ARFD (g = 0.29, small). However, for PRFD, the RJC was found to be significantly higher than the IJC (p = .011; g = 0.94, large).

DISCUSSION

The purpose of this study was to investigate the effects of an IJC and a RJC, with the latter requiring participants to respond to a single light stimulus before jumping, on SJ performance in elite basketball players. Our analysis revealed that, compared to those with IJC, elite basketball players exhibited similar JH, PF, and ARFD values with RJC, but higher PRFD values (Table 1). These results support our hypothesis that elite basketball players experience only a minor decline in jump performance during RJC and demonstrate performance equivalent to that of IJC.

In this study, no significant differences were observed in JH and PF between IJC and RJC (Table 1). JH reportedly decreases with RJC using light stimulation in football players (Fujisawa et al., 2026; Vivar et al., 2025), track and field athletes (Fujisawa et al., 2026), and healthy college students (Ohji and Aizawa, 2026). Furthermore, while PF decreases in track and field athletes following RJC using light stimulation, it does not decrease in football players (Fujisawa et al., 2026). The results of this study are consistent with previous reports on football players. Vivar et al. (2025) reported that performing high-intensity exercises, such as jumps at maximum output, involves extremely high neurological demands and that, in principle, full attention must be directed toward the exercise itself to achieve that maximum output. Therefore, even if the cognitive and motor tasks utilize different resources, the slightest diversion of attention toward responding to light stimuli could potentially impair maximum output (e.g., JH). Nevertheless, in the present study, no decline in SJ performance, such as JH or PF, was observed. On the other hand, Vivar et al. (2025) also pointed out that when athletes can utilize long-term procedural memory without relying on mental effort (i.e., when the task is highly automated), cognitive resource consumption is suppressed, making it less likely for performance to decline due to additional cognitive load. The participants in this study were athletes from a professional league in Japan (B3 League), possessing a highly competitive level, who frequently incorporated reactive jumping movements into their regular training, based on advanced situational awareness. Consequently, vertical jumping movements such as the SJ were highly automated owing to the nature of their sport, which may explain why no significant differences were observed in JH and PF between the IJC and RJC. However, to avoid overinterpretation, the absence of differences in JH and PF cannot be exclusively attributed to the athletes' expertise, and alternative explanations must be considered. Specifically, the cognitive challenge posed by the single visual stimulus used in this study may have been too limited to meaningfully interfere with jump performance. According to Wickens (2008) model, as long as the task demand for resources does not exceed the limit, residual capacity is maintained, and performance breakdown does not occur. Since the light stimuli in this study did not involve judgment or selection, the demand for cognitive resources was extremely low, and the load on the entire system may have remained well within the range of residual capacity. Consequently, maximum output indicators (such as JH and PF) that depend on physiological and physical limits may have been maintained at their original levels.

Furthermore, although no significant differences were observed between the IJC and RJC in terms of JH, PF, and ARFD in this study, a significant difference was observed only in PRFD (Table 1). Previous studies involving football players have reported that transitioning from the IJC to the RJC allows for an increase in PRFD without changing PF (Fujisawa et al., 2026), and the results of this study support these prior findings.

Wakatsuki and Yamada (2020) reported that in a sidestep task, the time from movement onset to completion is shorter for reactive movements compared to that for intentional movements (reactive advantage); they noted that this is influenced by the two distinct motor preparation processes and force generation patterns associated with reactive and intentional movements. Specifically, since movement in the RJC is initiated by an external stimulus (light), the motor preparation process may have been simplified compared to that in the IJC. Consequently, the overall temporal structure of the movement may have changed, and with the time allocated for force production constrained, a force production pattern that enhances the initial rise in force during the early phase may have been adopted. The results of this study also suggest that such changes in temporal structure and force production patterns likely influenced the reduction in movement time (reactive advantage) observed in reactive movements.

RFD is an indicator that varies independently of maximum muscle strength and is strongly influenced by neurological factors, such as motor unit recruitment patterns and firing frequency, particularly during short-duration force production (Haff and Nimphius, 2012; Markovic et al., 2004). Although JH and PF were comparable in the RJC and IJC, a significant difference in PRFD was observed between the two conditions (Table 1). This suggests that elite basketball players may possess the ability to modify their force production patterns in response to external conditions. However, because no electromyographic or direct neuromuscular measurements were collected in this study, changes in neural drive, motor unit recruitment strategies, or firing frequency were not directly assessed. Therefore, the attribution of the observed differences in PRFD specifically to these neural factors remains speculative. Consequently, the results of this study suggest that elite basketball players may be optimizing the timing of their force production by enhancing their ability to generate force over shorter durations while maintaining maximum muscle strength.

From a practical perspective, S&C coaches working with elite basketball players should actively consider incorporating a single light stimulus into existing SJ tasks. The results of this study indicate that the addition of a single light stimulus can be an extremely effective training strategy for specifically enhancing short-duration explosive force production—which is directly linked to athletic performance—without sacrificing the athletes' maximum force output (JH or PF) in any way. Although a single light stimulus is non-specific to basketball and involves relatively low cognitive load, these characteristics may serve as significant advantages when applied in training settings. Because the protocol is simple and generic, there is little risk of disrupting athletes' jumping movements or maximum output, and it can be safely and easily integrated into existing training as an initial step toward introducing cognitive approaches. Therefore, it is recommended to use this simple light stimulus to establish a solid foundation for sensitizing the neural drive from the central nervous system to the muscles (RFD). To maximize translational value, coaches should implement a structured progression model. Once athletes adapt to simple stimuli, training should progress by increasing stimulus complexity (e.g., using multiple lights of different colours) and introducing decision-making demands (e.g., go/no-go tasks). As proficiency improves, practitioners can integrate opponent-specific cues (e.g., video projections of a defender's movements) and combine reactive jumps with change-of-direction tasks or basketball-specific actions, thereby bridging the gap between general physical preparation and on-court ecological demands.

This study has some limitations. First, since the study focused on elite basketball players from a single team, it included athletes from different positions. Reportedly, physical characteristics, exercise load, and technical roles vary significantly by position in basketball (Ben Abdelkrim et al., 2010; Garcia et al., 2020; Zhang et al., 2026). Therefore, participants specializing in different positions may exhibit diverse responses to light stimulation due to differences in physical characteristics, load characteristics during competition, and the technical skills required. Future research should integrate the participants' specialized positions and examine in greater detail the effects of RJC using light stimuli on jump performance among basketball players of each position. Second, the operationalization of the reactive condition in this study involved only a single visual stimulus requiring a simple reaction. While this design allows for direct comparison with previous studies, it does not replicate the perceptual and decision-making complexity encountered during actual basketball competition. Therefore, a clear distinction must be made between the "*reactive*" performance measured in this study and true "*game-representative*" performance. The observed neuromuscular adaptations are specific to simple reaction demands and may not necessarily generalize to more complex game situations involving stimulus discrimination, opponent behaviour, tactical information, or multiple response options. Given that performance can decline when cognitive load exceeds working memory capacity (Strobach, 2024; Wickens, 2008), future studies should investigate reactive jumps under increasingly representative basketball conditions, such as defensive cues, video-based opponent movements, or decision-making paradigms requiring selection among multiple actions. Third, the current study identifies an interesting acute phenomenon where PRFD increases under reactive conditions. However, longitudinal intervention studies are needed to determine whether these acute increases in PRFD translate into chronic performance adaptations. Finally, a priori power analysis was not conducted. A post hoc power analysis (G*Power: paired t-test, two-tailed, $d = 0.8$, $\alpha = 0.05$, $1-\beta = 0.80$) indicated a required sample size of 15. However, targeting a single professional team limited our final sample size to 12. This relatively small sample size may constrain statistical power and generalizability; therefore, future studies should recruit across multiple teams. Despite these limitations, the strength of this study lies in its evaluation of SJ performance under an IJC and a RJC requiring a response to a light stimulus, which revealed previously unrecognized characteristics of reactive jumping movements in elite basketball players and provides valuable information for S&C coaches.

CONCLUSIONS

This study examined the effects of an IJC and a RJC, with the latter involving a response to a single light stimulus, on SJ performance in elite basketball players. Our results showed that, compared to that with IJC, RJC did not yield significant differences in JH, PF, or ARFD; however, PRFD was significantly higher. These findings indicate that even when elite basketball players perform jumps while reacting to simple visual stimuli, they can increase the rate of force development while maintaining maximum muscle strength and jump performance. From a broader perspective, our findings align with emerging neurocognitive approaches to athletic performance assessment. Recent studies emphasize the importance of integrating cognitive and physical testing, such as neurocognitive jump tasks, to more sensitively detect performance characteristics in dynamic environments (Ohji and Aizawa, 2026). Within this context, reactive jump protocols utilizing visual stimuli may serve as valuable screening tools for identifying sport-specific neuromuscular adaptations and evaluating the complex interaction between perceptual-cognitive demands and motor execution (Vivar et al., 2025). Therefore, the SJ performed under reactive conditions using light stimuli may serve as a useful method for evaluating neuromuscular function and advancing athlete monitoring applications in elite basketball players. Moreover, this study suggests that it may be an effective training method for improving explosive force production in training settings, outlining a clearer pathway toward chronic performance enhancement.

AUTHOR CONTRIBUTIONS

All authors meet the criteria for authorship in accordance with established ethical guidelines. Contributions are specified according to the CRediT (Contributor Roles Taxonomy) as follows: Conceptualization, Y.F. and R.H.; methodology, Y.F. and R.H.; formal analysis, Y.F., K.K., and R.H.; investigation, Y.F., K.K., T.Y., and R.H.; data curation, Y.F., K.K., and R.H.; writing—original draft preparation, Y.F. and R.H.; writing—review and editing, Y.F., K.K., T.Y., and R.H.

All authors have critically reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

AI USE DISCLOSURE

In accordance with current publishing ethics and transparency recommendations, artificial intelligence (AI) tools were used solely to assist with translation and language editing, with the aim of improving clarity and readability. No AI tools were used in the generation of scientific content, including the study design, data collection, analysis, interpretation of results, or the formulation of conclusions. The authors retain full responsibility for the content of the manuscript and confirm its originality, integrity, and accuracy.

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