ORIGINAL SCIENTIFIC PAPER

Effects of a 5-Week Boxing Training Program on Visual Motor Reaction Time and Functional Laterality in Novice Female University Students

Francesca Martusciello[1,2], **Alfredo Brancucci**[1], **Arben Kaçurri**[3], **Sead Bushati**[3], **Aldo Muçalliu**[3], **Andrea Perazzetti**[4], **Antonio Tessitore**[1]

AFFILIATIONS
[1]University of Rome "Foro Italico", Department of Movement, Human and Health Sciences, Rome, Italy
[2]University of Verona, Department of Neurosciences, Biomedicine and Movement, National PhD Programme in Kinesiology and Sport Sciences, Verona, Italy
[3]Sports University of Tirana, Sports Research Institute, Tirana, Albania
[4]Telematic University Giustino Fortunato, Faculty of Law, Degree Course in Sciences of Motor Activities, Sports and Psychomotor Education, Benevento, Italy

CORRESPONDENCE
F. Martusciello, University of Rome Foro Italico, Department of Movement, Human and Health Sciences, Piazza Lauro de Bosis 6, 00135, Rome, Italy, *francesca.martusciello@uniroma4.it*

Abstract
This study examined the effects of a 5-week boxing training program on visual motor reaction time, functional laterality, and psychological variables in female university students with no prior boxing experience. Thirty-one participants were assigned to either an experimental group, which completed 10 boxing sessions over 5 weeks, or a control group. Visual-motor reaction time (VMRT) was assessed using the FitLight Trainer™ system under simple (SRT) and complex reaction time (CRT) conditions, performed from both left- and right-sided stances. The lateralization index (LI) was calculated; self-esteem, self-efficacy, and self-defence confidence were assessed; and exertion and enjoyment were recorded in the experimental group. No significant changes in SRT or psychological variables. Significant interactions emerged for CRT (mean difference =32.85ms, p=0.007), indicating side-specific adaptations. In addition, LI increased significantly over time (p=0.034) and indicated greater lateral asymmetry in the experimental group (p=0.015). Participants in the training group also reported moderate exertion (4.34±2.57) and high enjoyment (6.45±0.95). These findings suggest that short-term boxing training in female students' novice to boxing may not be sufficient to improve basic reaction speed or psychological outcomes, but it may influence perceptual–decision processes and functional laterality in a task-specific manner.

Keywords: *university student, female boxing, visual motor reaction time, functional laterality, perceptual-motor performance*

Introduction

In a combat sport match, the two athletes engage in a dyadic relationship across time-limited scenarios, which require constantly making decisions under time constraints (Milazzo et al., 2016) about which stimuli to prioritise and which to disregard in their responsive actions. Additionally, the type and magnitude of stimuli, along with the athletes' arousal states and levels of fatigue, influence their responses, requiring a perceptual profile tailored to the specific demands of the sport (Abernethy, 1996). Athletes' quick and accurate reactions depend heavily on their ability to process visual and tactile stimuli while synchronizing their movements (Zhang et al., 2022).

The duration of a responsive action comprises: a) Reaction Time (RT), which reflects mental processes prior to movement (Schmidt & Wrisberg, 2008); b) Movement Time (MT), which encompasses both kinetic and cognitive functions (Schmidt et al., 2018). In turn, RT is categorized into simple reaction time (SRT) and complex reaction time (CRT), with the latter involving longer processing by central nervous system. Therefore, as rapid and coordinated movements are driven by cognitive processes linked to visual stimuli, visual motor reaction time (VMRT) is recognised as one of the key factors influencing performance superiority (Hülsdünker et al., 2018). VMRT can be objectively evaluated using various methods developed over the years for both training and testing. Among these, Light Sport Training Systems (LSTS) assess the speed and accuracy of responses to visual stimuli through rapid motor reactions by using sensitive wireless lights connected to a mobile control device that can light up randomly or in a specific sequence (Polechoński et al., 2025).

Boxing is a fast-paced combat sport characterized by dynamic situations, where boxers engage at close distances, and the impact of their actions is influenced by their distance to the target (Hristovski et al., 2006). The ability of boxers to accurately read their opponents' visual cues and respond quickly is crucial for blocking and evading punches, set up counterattacks, as well as anticipating opponents' attacks by exploiting openings in their change in defences (Ottoboni et al., 2015). Menzel and Potthast (2021) examining the duration from the initial fist movement from a defensive position to the target and back, found differences for punch actions (Jab, Cross, Hook and Uppercut) between experienced (faster) and non-experienced amateur (slower) boxers.

Research indicates that visual abilities correlate with punching accuracy, suggesting as enhanced visual skills and training programs targeted on RT, eye-hand coordination and depth perception improve punching accuracy in male and female boxers (Wu et al., 2024; Xiao et al., 2025), while also highlighting the role of training experience. Solovey et al. (2021) demonstrated that young male boxers with 5-7 years of experience possess significantly faster SRT compared to non-athlete peers, indicating better central nervous system stability and attentional performance. The study also implemented a 3-month non-contact boxing program for non-athlete students, showing positive effects on cognitive functions, sensorimotor reactions, and nervous system efficiency, thus justifying its inclusion in physical education.

Additionally, how boxers organise and execute offensive and defensive actions is also influenced by their functional laterality (Shtanagey et al., 2021), which refers to the preferential use of the right or left arm and leg, as well as its impact on how approaches, attacks and defences are directed to achieve an optimal performance (Grouios, 2004; Guilherme et al., 2015). In this regard, previous studies indicate that RT can vary between the left and right sides due to laterality, stimulus type, sport practice, and stress, with lateral specialization further modulated by the specific type of training (Badau et al., 2018; Iglesias-Soler et al., 2018).

Finally, participation in combat sports like boxing can enhance individuals' psychological well-being. Research on undergraduate students indicates that engagement in boxing activity is associated with higher subjective well-being, with psychological factors such as emotional intelligence and self-esteem mediating this relationship (Ying & Yang, 2025). Specifically, boxing activity may improve well-being directly by fostering emotional competencies and boosting self-esteem.

Based on the above premise, this study aimed to investigate functional laterality in female university students with no prior boxing experience by assessing SRT and CRT under various lateralized conditions before and after a short-term non-contact boxing training program. Additionally, the study investigated the effects of this boxing program on the well-being of the female students, exploring changes in psychological variables, specifically self-esteem, self-efficacy, and perceived self-defence, through questionnaire-based assessments.

Materials and methods

Participants and design

This study employed a PRE-POST experimental design, with an experimental group (EG) participating in a 5-week boxing training program while a control group (CG) maintained their usual activities. All participants completed the same assessments at PRE and POST time points, including VMRT tests under various lateralized conditions for both SRT and CRT responses, as well as questionnaires assessing selected psychological variables. RPE and ENJ were also recorded for all EG training sessions.

Thirty-one female university students from the Sports University of Tirana (age: 19.4±1.1 years) were recruited and divided in EG (N=20) and CG (N=11), of whom 27 were right-handed and 4 were left-handed. Inclusion criteria included: (a) no prior boxing experience, (b) absence of musculoskeletal injuries that could affect performance during testing. A schematic overview of the study design and assessment timeline is presented in Figure 1.

Participation was voluntary and subjects' informed consents were obtained before data collection. The research was approved by the Ethics Committee of the Sport University of Tirana ([2025]1514/2) and complied with ethical standards outlined in the Declaration of Helsinki.

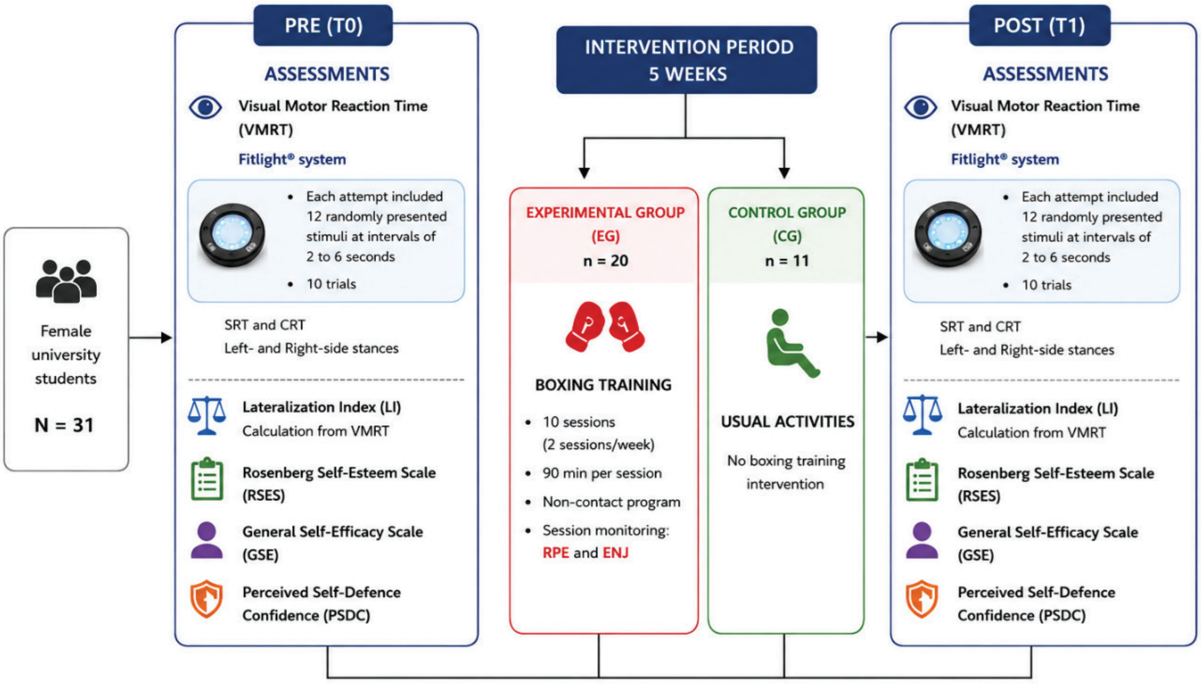

Figure 1. Experimental design and assessment timeline

Boxing training program

The EG completed a structured five-week non-contact boxing program with two 90-minute sessions per week, totaling 10 sessions, supervised by a certified national boxing coach from the Albanian Boxing Federation. The program, mirroring previous short-term non-contact boxing interventions with novice female university students (Martusciello et al., 2026), included a warm-up, technical drills on fundamental boxing techniques (Jab, Cross, Hook, Uppercut), punching combinations and footwork exercises. Specific reaction-based drills to stimulate perceptual-motor responses were intentionally avoided.

Visual motor reaction time assessment

VMRT was assessed using the FitLight Trainer™ system (FitLight Corp., Ontario, Canada). Tests were conducted under different lateralized conditions, requiring participants to respond from both Left (L) Stance (orthodox) and Right (R) (southpaw) while executing a lead straight punch (with trunk rotation) toward a light positioned at chin level. Participants were assessed for both SRT and CRT with two Stance-Side conditions (L and R). In SRT tests, they quickly responded to a single visual stimulus with a straight punch (Jab) using the lead hand. In CRT tests, the color-coded stimuli required to choose between two colors with a Jab (yellow = left punch) or a Cross (blue = right punch). Each attempt included 12 randomly presented stimuli at intervals of 2 to 6 seconds. After excluding the smallest and largest values, the mean reaction time of the remaining trials (N=10) was calculated for further analysis (Polechoński et al., 2025).

To explore functional laterality, a lateralization index (LI) was calculated as the difference between R and L Stance-Side reaction times (ms) (LI = R - L), quantifying the magnitude and direction of asymmetry. Positive values indicated longer reaction times on R, while negative values indicated longer times on L. Values close to zero indicated more symmetrical performance. Such calculation was provided for both PRE and POST time points.

Psychological questionnaires

Psychological variables were assessed using two validated questionnaires administered at PRE and POST under standardised conditions to ensure their reliability. Self-esteem was evaluated with the 10-item Rosenberg Self-Esteem Scale (RSES) (Rosenberg, 1965) using a 4-point Likert scale from 1 (“strongly disagree”) to 4 (“strongly agree”), with higher total scores (including the five requiring reverse scoring) expressing higher self-esteem. The Cronbach’s α coefficient for this scale was 0.91.

General self-efficacy, measuring individuals' perceived ability to cope with difficult situation, was evaluated with the 10-item General Self-Efficacy Scale (GSE) (Schwarzer & Jerusalem, 1995). Responses were recorded on a 4-point Likert scale ranging from 1 (“not at all true”) to 4 (“exactly true”), with higher total scores expressing greater perceived self-efficacy. The Cronbach’s α coefficient for this scale was 0.96.

Additionally, both EG and CG completed a customized 6-item questionnaire to assess their perceived self-defence confidence (PSDC) and ability to cope with potentially challenging situations. Statements included self-confidence in daily situations, belief in self-change in defence ability, body control, calmness in difficulties, capability to face challenges, and strength to handle moments of stress or tension. Responses were recorded on a 4-point Likert scale, with higher scores indicating greater PSDC. The questionnaire's internal consistency showed good reliability (Cronbach's α=0.80).

Perceptual responses to training

In the EG, RPE (Borg, 1998) and ENJ scores were recorded after each training session using a 1-7 scale (Perazzetti et al., 2025). These measures evaluated participants' perceived training intensity and engagement during the boxing training program. For the analysis, a mean score across the 10 training sessions was calculated for each participant.

Statistics

Descriptive statistics were calculated as mean ± standard deviation (SD). The normality was further assessed using the Shapiro–Wilk test, which indicated that most variables were normally distributed.

For reaction time variables (SRT, CRT), a 2 (time: PRE, POST) × 2 (Stance-Side: L, R) repeated-measures ANOVA was conducted with group (EG, CG) as a between-subject factor. To analyse LI, a 2 (time: PRE, POST) repeated-measures ANOVA with group (EG, CG) as a between-subject factor was conducted.

Psychological questionnaire scores were analysed using repeated-measures ANOVA with Time (PRE, POST) as the within-subject factor and Group (EG, CG) as the between-subject factor.

When significant main effects or interactions were observed, post hoc pairwise comparisons were performed using the Bonferroni correction. Statistical significance was set at $p<0.05$. All statistical analyses were performed using Jamovi version 2.7.23.

Results

Descriptive values for SRT and CRT are presented in Table 1. From PRE to POST, the EG showed reductions in SRT and CRT, especially on the L Stance-Side, while the CG remained stable.

Table 1. Descriptive statistics (mean ± SD) of SRT and CRT for the L and R Stance-Side in the experimental and control groups at Pre and Post test

	Time	SRT (L) (Mean ± SD)	SRT (R) (Mean ± SD)	CRT (L) (Mean ± SD)	CRT (R) (Mean ± SD)
Experimental	Pre	419.8±86.9	412.3±50.6	568.8±114.16	588.7±119.9
	Post	401.5±67.4	406.7±73.4	535.9±61.7	581.6±85.9
Control	Pre	432.9±39.2	421.2±50.6	551.5±64.4	531.2±67.9
	Post	419.6±33.2	421.6±73.4	561.3±56.5	567.1±60.6

Note. Reaction time values are expressed in milliseconds (ms); SRT: Simple Reaction Time (only jab punches); CRT: Complex Reaction Time (jab and cross punches); L: Left; R: Right.

The results of the repeated-measures ANOVA, which are summarised in Table 4, show no significant main effects or interactions for SRT, as well as no significant main effects for Time or Stance-Side were found for CRT. However, a significant Stance-Side x Group interaction emerged ($p=0.015$) with a post hoc test confirming differences between the R and L Stance-Side in the EG (mean difference=32.85ms, $p=0.007$).

A significant Time × Stance-Side interaction was also found ($p=0.034$). Post hoc comparisons did not maintain the differences, although a trend toward a difference between the L and R Stance-Side at Post test was observed ($p=0.052$). The Time × Group interaction approached statistical significance ($p=0.068$).

The results of ANOVA for LI revealed a significant main effect of Time ($F(1,29)=4.94$, $p=0.034$, mean difference=25.93 ms), indicating greater lateralization at POST compared with PRE (Table 2).

A significant main effect of Group was also observed ($F(1,29)=6.70$, $p=0.015$) with greater lateral asymmetry in the EG compared with the CG. The time × group interaction was not significant ($p=0.994$).

Table 2. Descriptive statistics (mean ± SD) of LI (Left, Right) for SRT and CRT in the experimental and control groups at Pre and Post test

Variable	Group	Pre (Mean ± SD)	Post (Mean ± SD)
SRT LI (ms)	Control	−11.71±42.24	1.95±25.37
	Experimental	−7.54±37.45	5.17±45.43
CRT LI (ms)	Control	−20.31±65.38	5.71±25.84
	Experimental	19.93±44.64	45.78±59.71

Note. Positive values indicate faster responses on the left, whereas negative values indicate faster responses on the right. LI = Lateralization Index; SRT = Simple Reaction Time; CRT = Complex Reaction Time.

Minimal changes were observed between the PRE and POST test scores for RSES, GSE, and PSDC across both groups (Table 3). The EG showed a slight increase in GSE, while RSES and PSDC remained relatively stable.

Table 3. Descriptive statistics (mean ± SD) of psychological questionnaire scores for the experimental and control groups at Pre and Post test

Group	Time	RSES	GSE	PSDC
Experimental	Pre	32.3±3.5	33.8±5.6	21±2.4
	Post	31.7±3.3	35.5±4.1	20.6±2.8
Control	Pre	30.6±3	27.2±10.2	20.9±2.6
	Post	30.3±2.8	27.2±9.1	19.9±2.9

Note. RSES = Rosenberg Self-Esteem Scale; GSE = General Self-Efficacy Scale; PSDC = Perceived Self-Defence Confidence.

A repeated-measures ANOVA revealed no significant main effects or interactions for the RSES and PSDC questionnaires. For GSE, no significant effect for Time and for Time x Group interaction was found, while a significant main effect of Group was observed ($p=0.002$), indicating higher GSE scores in the EG compared to CG (mean difference =7.49).

Table 4. Summary of repeated-measures ANOVA results for reaction time, laterality index, and psychological variables

Variable	Effect	F (df1, df2)	p-value	η^2p
SRT	No significant effects	–	all p>0.05	
	Stance-Side × Group	6.70 (1,29)	0.015	0.19
CRT	Time × Stance-Side	4.94 (1,29)	0.034	0.15
	Time × Group	3.59 (1,29)	0.068	0.11
LI	Time	4.94 (1,29)	0.034	0.15
	Group	6.70 (1,29)	0.015	0.19
RSES	No significant effects	–	all p >0.05	
PSDC	No significant effects	–	all p>0.05	
GSE	Group	11.92 (1,29)	0.002	0.29

Note. η^2p = partial eta squared; SRT = Simple Reaction Time; CRT = Complex Reaction Time; LI = Lateralization Index; RSES = Rosenberg Self-Esteem Scale; GSE = General Self-Efficacy Scale; PSDC = Perceived Self-Defence Confidence. No significant main effects or interactions were observed for SRT, RSES, and PSDC (all $p>0.05$).

Session monitoring in the EG indicated mean RPE and ENJ of 4.34±2.57 and 6.45±0.95, respectively.

Discussion

This study aimed to investigate the interventions' effects on reaction time performance and psychological variables, focusing on lateralization patterns. The main findings showed that although SRT did not change significantly, the intervention led to side-specific adaptations in CRT performance. In contrast, psychological variables remained largely unchanged.

Simple reaction time

Regarding SRT, no significant effects were found, indicating that simple stimulus detection and motor initiation processes were not substantially affected by the intervention, which might be less sensitive to short-term training adaptations in novices. However, descriptive data showed a slight reduction in SRT values in the EG, suggesting an improvement trend reflecting early-stage adaptations not yet pronounced in novices. This aligns with literature indicating limited SRT improvements after training, such as Çakmakçı et al. (2019) who noted significant changes only in the dominant hand after a longer training period.

Complex reaction time and laterality

In contrast, CRT data revealed an asymmetrical adaptation pattern over time. The EG showed greater asymmetry at POST, with faster reaction times on the L Stance-Side compared to R (≈45.8 ms), whereas the CG showed nearly symmetrical values (≈5.8 ms), suggesting that training may have affected higher-level perceptual–decision processes rather than basic motor responses. Previous research indicates that reaction time in boxing is influenced by task specificity and movement characteristics, with faster responses registered in jab-like actions compared to more complex movements like crosses (Loturco et al., 2015; Yordanova et al., 2023). This aligns with our findings, showing higher reaction times in CRT, reflecting the cognitive load associated with decision-making tasks and suggesting a side-specific modulation. Although our tests were conducted in both L (orthodox) and R (southpaw) stances, most students were right-handed, potentially contributing to their higher scores on the front hand, which is more frequently used in quick, exploratory actions. This interpretation is further supported by the LI, which showed a significant increase over time, with higher overall values in EG compared to CG. Descriptive data revealed a marked shift in CRT asymmetry, with EG values rising to 45.8 ms at POST, indicating faster responses on the L Stance-Side. In contrast, the CG showed minimal changes (+5.7 ms), reflecting nearly symmetrical performances. Consistent with Yordanova et al. (2023), training experience amplifies differences between movement patterns, suggesting that short-term boxing training may induce task-specific and stance-dependent adaptations rather than uniform bilateral improvements.

Psychological variables

Regarding psychological variables, no significant changes in RSES or PSDC were observed at POST in either group, suggesting that the short-term boxing training program for EG may not induce measurable changes, which are typically influenced by longer-term experience. Similarly, no significant PRE-POST effects were observed for GSE, although EG exhibited higher overall values, indicating pre-existing differences between groups rather than training-induced adaptations. However, descriptive data showed a slight increase in self-efficacy in the EG, potentially reflecting early positive perceptions of skill acquisition and engagement in a new activity. Research indicates that participation in combat sports can enhance psychological well-being, including self-esteem and self-efficacy (Ying & Yang, 2025), especially with structured training interventions (Ciaccioni et al., 2024). Thus, the limited psychological adaptations observed in this study may be attributed to the short intervention duration and participants' novice status.

The moderate RPE and high ENJ levels reported by the EG during the training sessions indicate that the program was well tolerated and positively received by participants. This is crucial for adherence, as research on modified boxing programs shows that enjoyment, perceived safety, and a supportive environment are key factors for long-term participation (Perkins & Hahn, 2019). Although our intervention lasted only 5 weeks, the positive perceptual responses may represent an important prerequisite for sustained engagement and the potential development of long-term psychological benefits.

Strengths and limitations

The focus on female university students who are novices to boxing represents an important contribution to the current boxing literature, which has predominantly examined trained athletes and male participants. Moreover, the use of a structured non-contact boxing program enhances the practical applicability of the findings, as such interventions can be safely implemented in educational and recreational settings. In addition, the assessment of functional laterality through stance-specific reaction-time testing and the calculation of the lateralization index enabled a more detailed understanding of early perceptual–motor adaptations to boxing training. Finally, the simultaneous assessment of perceptual–motor performance and psychological variables provided a comprehensive perspective on the effects of short-term boxing training in novice participants.

Despite these strengths, the findings of this study are subject to the following limitations: a) the short five-week intervention may not suffice for stable adaptations, particularly in RT and psychological variables; b) the sample was limited to female university students, which restricts generalizability to other populations; c) the small number of left-handed participants limited analysis of lateral dominance.

Future research should prioritise longer interventions, larger and more diverse samples, increased representation of left-handed participants, and a broader multidimensional approach. Additionally, studies should explore lateral dominance and investigate ecological-dynamic training approaches incorporating digital environments and eSports-based tasks to enhance perceptual-cognitive responsiveness and decision-making (Ceruso et al., 2025).

Conclusions

This study evaluated the effects of a 5-week boxing training program on visual-motor reaction time, functional laterality, and psychological variables in female students novice to boxing. The findings suggest that short-term training does not significantly affect SRT but may selectively affect perceptual-decision processes, as evidenced by lateralized adaptations in CRT performance. Moreover, functional laterality increased following the intervention, indicating the emergence of side-specific adaptations during the early stages of boxing practice. In contrast, psychological variables largely remained unchanged, with only a marginal increase in self-efficacy, indicating that longer interventions may be needed to elicit meaningful psychological adaptations.

Practical implications

Coaches and physical education instructors should incorporate training activities requiring stimulus discrimination, rapid decision-making, and sport-specific responses, rather than focusing exclusively on simple reaction drills. The observed changes in side-specific adaptations highlight the importance of monitoring these adaptations during the early stages of boxing practice and implementing bilateral training strategies to promote balanced motor development. Furthermore, the high enjoyment levels reported by participants suggest that non-contact boxing may be an engaging and accessible activity for promoting participation in physical activity in educational and recreational settings.

Acknowledgements
There are no acknowledgments.

Conflicts of Interest
The authors declare no conflict of interest.

Received: 27 April 2026 | **Accepted:** 17 July 2026 | **Published:** 01 October 2026

References

Abernethy, B. (1996). Training the visual-perceptual skills of athletes: Insights from the study of motor expertise. *The American Journal of Sports Medicine, 24*(6), S89-S92. PMID: 8947438

Badau, D., Baydil, B., & Badau, A. (2018). Differences among three measures of reaction time based on hand laterality in individual sports. *Sports, 6*(2), 45. https://doi.org/10.3390/sports6020045

Borg, G. (1998). *Borg's Perceived Exertion and Pain Scales;* Human Kinetics: Champaign, IL, USA, ISBN 978-0880116237.

Çakmakçı, E., Tatlıcı, A., Kahraman, S., Yılmaz, S., Ünsal, B., & Özkaymakoğlu, C. (2019). Does once-a-week boxing training improve strength and reaction time? *International Journal of Sport Exercise and Training Sciences, 5*(2), 88-92. https://doi.org/10.18826/useeabd.552086

Ceruso, R., D'elia, F., Sannicandro, I., Manzi, V., & Esposito, G. (2025). Effects of an Ecological-Dynamic Training Protocol Integrating Football eSports on Reactivity in Young Footballers: A comparative study. *International Journal of Kinesiology & Sports Science, 13*(3), 12. https://doi.org/10.7575/aiac.ijkss.v.13n.3p.12

Ciaccioni, S., Castro, O., Bahrami, F., Tomporowski, P. D., Capranica, L., Biddle, S. J., ... Pesce, C. (2024). Martial arts, combat sports, and mental health in adults: A systematic review. *Psychology of Sport and Exercise, 70,* 102556. https://doi.org/10.1016/j.psychsport.2023.102556

Grouios, G. (2004). Motoric dominance and sporting excellence: Training versus heredity. *Perceptual and Motor Skills, 98*(1), 53-66. https://doi.org/10.2466/PMS.98.1.53-66

Guilherme, J., Garganta, J., Graca, A., & Seabra, A. (2015). Influence of nonpreferred foot technical training in reducing lower limbs functional asymmetry among young football players. *Journal of Sports Sciences, 33,* 1790–1798. https://doi.org/10.1080/02640414.2015.1012100

Hristovski, R., Davids, K., Araújo, D., & Button, C. (2006). How boxers decide to punch a target: emergent behaviour in nonlinear dynamical movement systems. *Journal of Sports Science & Medicine, 5,* 60-73. PMID: 24357978

Hülsdünker, T., Strüder, H. K., & Mierau, A. (2018). The athletes' visuomotor system–Cortical processes contributing to faster visuomotor reactions. *European Journal of Sport Science, 18*(7), 955-964. https://doi.org/10.1080/17461391.2018.1468484

Iglesias-Soler, E., Mayo, X., Dopico, X., Fernández-Del-Olmo, M., Carballeira, E., Fariñas, J., & Fernández-Uribe, S. (2018). Effects of bilateral and non-dominant practices on the lateral preference in judo matches. *Journal of Sports Sciences, 36*(1), 111-115. https://doi.org/10.1080/02640414.2017.1283431

Loturco, I., Franchini, E., Abad, C. C. C., Kobal, R., Gil, S., Romano, F., ... Libardi, C. A. (2015). A comparative study of specific reaction time in elite boxers: differences between jabs and crosses. *Journal of Athletic Enhancement, 4*(3). https://doi.org/10.4172/2324-9080.1000199

Martusciello, F., Perazzetti, A., Kaçurri, A., Bushati, S., Muçalliu, A., & Tessitore, A. (2026). Short-Term Effects of a Structured Boxing Program on Technical Skill Acquisition in Novice Female Students. *Journal of Functional Morphology and Kinesiology, 11*(1), 26. https://doi.org/10.3390/jfmk11010026

Menzel, T., & Potthast, W. (2021). Application of a validated innovative smart wearable for performance analysis by experienced and non-experienced athletes in boxing. *Sensors, 21*(23), 7882. https://doi.org/10.3390/s21237882

Milazzo, N., Farrow, D., & Fournier, J. F. (2016). Effect of implicit perceptual-motor training on decision-making skills and underpinning gaze behavior in combat athletes. *Perceptual and Motor Skills, 123*(1), 300-323. https://doi.org/10.1177/0031512516656816

Ottoboni, G., Russo, G., & Tessari, A. (2015). What boxing-related stimuli reveal about response behaviour. *Journal of Sports Sciences, 33*(10), 1019-1027. https://doi.org/10.1080/02640414.2014.977939

Perazzetti, A., Kaçurri, A., Gjaka, M., Pernigoni, M., Lupo, C., & Tessitore, A. (2025). Impact of a Congested Match Schedule on Internal Load, Recovery, Well-Being, and Enjoyment in U16 Youth Water Polo Players. *Sports, 13*(9), 286. https://doi.org/10.3390/sports13090286

Perkins, P., & Hahn, A. (2019). Factors underpinning at least three years of participant adherence to a community-focused modified boxing program. *Open Journal of Social Sciences, 7,* 298-331. https://doi.org/10.4236/jss.2019.72023

Polechoński, J., Pilch, J., Langer, A., Prończuk, M., Markowski, J., & Maszczyk, A. (2025). Assessment of the reliability and validity of simple and complex reaction speed tests in mixed martial arts athletes using the BlazePod system. *Baltic Journal of Health and Physical Activity, 17*(1), 2. https://doi.org/10.29359/BJHPA.17.1.02

Rosenberg, M. (1965). Rosenberg self-esteem scale. *Journal of Religion and Health.* https://doi.org/10.1037/t01038-000

Schmidt, R. A., & Wrisberg, C. A. (2008). *Motor Learning and Performance. A Situation-Based Learning Approach.* 4th ed. Human Kinetics.

Schmidt, R. A., Lee, T. D., Winstein, C., Wulf, G., & Zelaznik, H. N. (2018). *Motor control and learning: A behavioral emphasis.* Human kinetics.

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinman, S. Wright, & M. Johnston, Measures in health psychology: A user's portfolio. *Causal and control beliefs, 35*(37), 82-003.

Shtanagey, D., Korobeynikov, G., Kolumbet, A., & Dudorova, L. (2021). The study of the dynamic characteristics of hand movements of female boxers with different types of functional asymmetry. Scientific Journal of NPDU. *Physical Culture and Sports, 7*(138), 16-21. https://doi.org/10.31392/NPU-nc.series15.2021.7(138).03

Solovey, A., Vovkanych, L., Sorokolit, N., Rymar, O., Yaroshyk, M., & Novokshonov, I. (2021). The influence of boxing exercises on the cognitive processes and speed of sensorimotor reactions of 15-17 years old boys. In Society. Integration. Education. *Proceedings of the International Scientific Conference, 4* (pp. 468-479). https://doi.org/10.17770/sie2021vol4.6232

Wu, R., Yang, Q., Cui, W., Gao, D., Luo, Y., & Wang, D. (2024). Relationship between visual ability assessment and punch performance in competition in male amateur boxers. *Frontiers in Physiology, 15*, 1429554. https://doi.org/10.3389/fphys.2024.1429554

Xiao, Y., Zhong, H., Gao, D., Zhuang, M., Long, Y., Wei, Q., ... Chen, C. (2025). The relationship between visual ability assessment and competitive boxing performance in female amateur boxers. *Frontiers in Physiology, 16,* 1639227. https://doi.org/10.3389/fphys.2025.1639227

Ying, L., & Yang, Q. (2025). The impact of combat sports on undergraduate students' subjective well-being: Chain mediation effects of emotional intelligence and self-esteem. *Frontiers in Psychology, 16,* 1659084. https://doi.org/10.3389/fpsyg.2025.1659084

Yordanova, Y., Pulev, T., Kirilova, K., Ruteva, M., & Stambolieva, K. (2023). Sport experience and visual motor reaction time of boxers. *Journal of Physical Education and Sport, 23*(5), 1176-1181. https://doi.org/10.7752/jpes.2023.05146

Zhang, Z., Piras, A., Chen, C., Kong, B., & Wang, D. (2022). A comparison of perceptual anticipation in combat sports between experts and non-experts: A systematic review and meta-analysis. *Frontiers in Psychology, 13,* 961960. https://doi.org/10.3389/fpsyg.2022.961960