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The Effects of Different Types of Training on Cognitive Performance in Professional Esports Players

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Over the past decade, the number of studies on cognitive performance in esports has increased in line with its popularity. Cognitive functions like task switching, information processing, attention, and memory have been identified as an integral part of cognitive performance. In parallel, different types of training, ranging from physical to a combination of cognitive and motor tasks, have emerged as promising strategies to improve cognitive function and thus performance of esports players. However, only acute high-intensity interval training was studied in esports players and exclusively in recreational players. Due to the lack of specialized training programs for esports coaches, the small number of professional esports players and the relative youth of professional esports practice, there is a large gap in the literature regarding cognitive performance training methods to improve the cognitive performance of professional esports players. Based on these results, the present invited commentary encourages further studies to be conducted among professional esports players. Indeed, research perspectives are necessary to develop training protocols and optimal training schedules to improve professional esports players' performance. In addition, this commentary supports the collaboration between academic and professional esports organizations. Finally, we provide recommendations to allow a win-win condition for both researchers and professional esports players in the future.

Keywords: professional players, physical performance, high-intensity interval training, cognitive-motor

In recent years, video games have evolved from a recreational activity to a competitive practice, often referred to as esports, in which players compete in local or international tournaments (Besombes, 2016). In this context, studies have compared either the cognitive performance of expert video games players to novice nongamers or the change in cognitive performance following video games training (for a review, see Toth et al., 2020). Studies have also shown that video gamers demonstrated superior cognitive capacity compared to nonplayer populations (Green & Bavelier, 2012; Kowal et al., 2018). In addition, there is a positive correlation between improved cognition and esports performance (Nagorsky & Wiemeyer, 2020; Toth et al., 2020) and it is possible to improve these same abilities through specific physical (Toth et al., 2020), cognitive or cognitive-motor training (Demirakca et al., 2016; Lauenroth et al., 2016). However, no studies have investigated the impact of such training on professional esports players' cognitive, physical, or motor performance. The difficulty of reaching and including professional players in studies is explained by the intense competitiveness inherent in the esports landscape. Indeed, winning titles and championships is a particularly arduous task. As a result, organizations tend to conceal the factors that influence their performance. Moreover, the balance of performance remains fragile, and during periods of success, teams are wary of potential disruptions that could be caused by researchers. The latter are likely to introduce invasive methodological protocols, which could break this winning dynamic.

However, professional esports players, whose main professional activity is the competitive practice of video games, requires special

attention concerning their health (Wattanapit et al., 2020; Yin et al., 2020) and their postcareer. First, physical and cognitive training could be extended throughout the entire career, reducing the risk of cognitive decline. Last, results from dedicated research may also allow individuals to transition into in-game coaching roles with notions of life balance, performance, and work ethic (Salo, 2017). Based on this observation, the literature review by McNulty and collaborators on the subject published in the *Journal of Electronic Gaming and Esports* indicated that the majority of players perceive benefits from exercise on performance (McNulty et al., 2023). However, in their review, the authors revealed that of the six included studies (a) none were devoted to professional players; (b) only two were interventional; and (c) in five of them, the data collected on physical activity levels were self-reported. On this last point, other researchers argue for collecting objective data with measurement tools which have greater validity, greater reliability, and less variability, such as triaxial accelerometers combined with heart rate monitors or submaximal effort tests to avoid overreporting bias in questionnaires and to obtain more accurate results (Voisin et al., 2022).

To review studies pertaining to cognitive performance of esports players after physical, cognitive, or cognitive-motor training, we proceeded to an exhaustive bibliographic search on several databases (*Google Scholar*, *PubMed*, *Web of Science*) and esports-specific databases (*International Journal of Esports*, *Journal of Electronic Gaming and Esports*, *Esports Research Network*) with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard model and selected with the PICOS (Population, Intervention, Comparison, Outcomes, and Study Design) criteria (See Table 1).

After identifying, screening, and assessing the eligibility of articles (See Figure 1), we found that there was only one study that met the criteria (De Las Heras et al., 2020). The finding of our bibliographical search highlights the lack of studies in this area that

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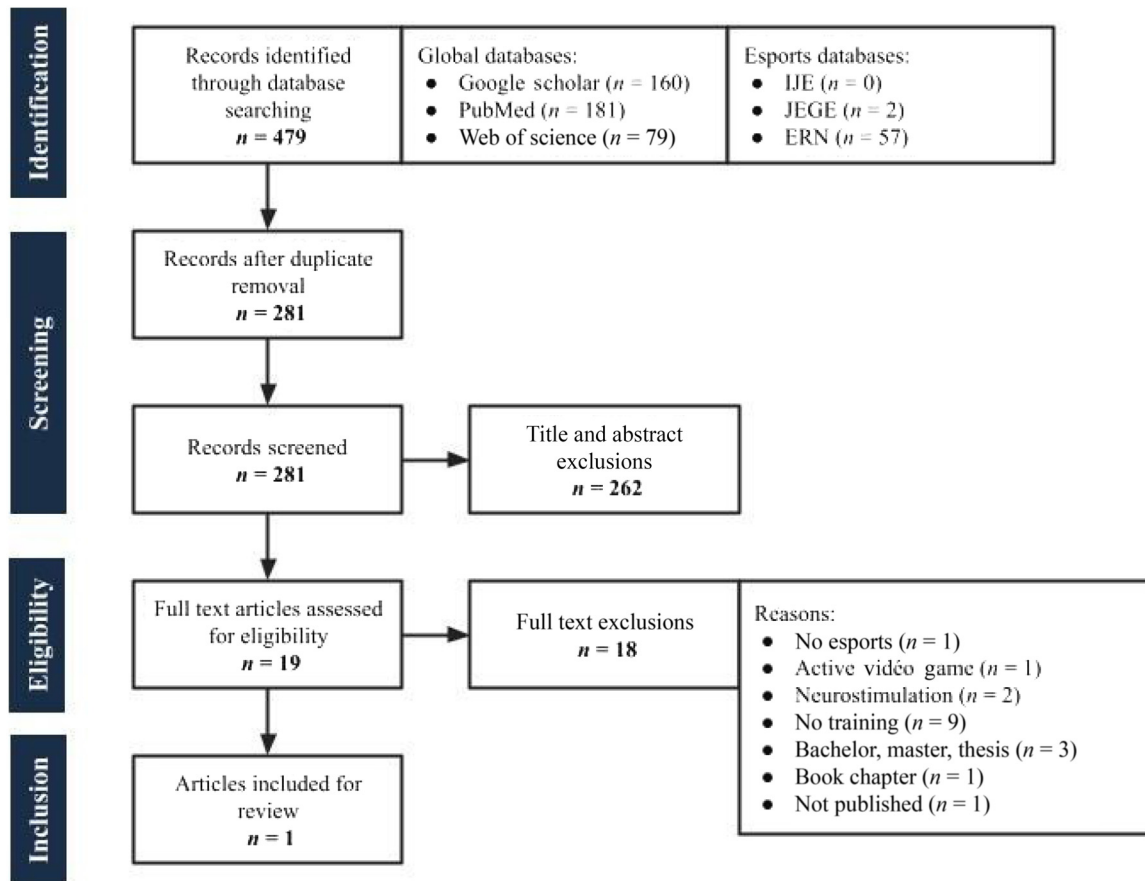
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Table 1 PICOS Model of the Systematic Review

PICOS elements	Description
Population	Young esports players (age ≥ 16 and ≤ 26 years) regularly playing action video games (as they have improved cognitive and motor skills).
Intervention	All physical, motor, cognitive, or combined interventions conducted using a pre–post design.
Comparison	All studies with pre–post baseline measurements or compared with no intervention group.
Outcome	To be included, the studies had to assess the performance of the esports players. Studies must include, but not be limited to, at least one of the following variables. Physical performance: heart rate, HRV, grip strength; self-reported performance: perceptual effort (RPE), enjoyment, anticipation of sessions; motor performance: visuo-haptic coordination, fine motor skills; cognitive performance: cognitive flexibility, decision making, task switching, memory (long term and visual), information processing, planning, sustained and divided attention, task switching, inhibition, spatial orientation, reaction time, accuracy; or finally in-game performance: Kill-Death-Assists, target accuracy, minions killed, victory/defeat.
Study design	Studies published in peer-reviewed journals, and we applied a language restriction, limiting ourselves to articles written in French, English, or certified with an English translation.

Note. PICOS = Population, Intervention, Comparison, Outcomes, and Study Design; HRV = heart rate variability; RPE = rating of perceived effort.

**Figure 1** — Chart flow of the selection process.

would help to identify the optimal strategy for improving the performance of esports players in general, but also of professional players. This lack of sufficient data can be attributed to several factors. First, esports is still an emerging discipline and its industry is relatively new. Consequently, there is a scarcity of specialized trained esports coaches. The lack of expertise has hindered the ability to conduct extensive research and design effective training programs tailored to these specific players. Second, the number of professional esports players is currently small, and research within

esports organizations is still in its nascent stages, but this is expected to change as the industry matures over time. Third, the relative youth of professional esports practice explains the slow progress in optimizing player performance. In the past, success in the game was often associated with extensive game time. However, as the industry has evolved, it has become obvious that focusing on the finer details is crucial for making a difference in performance. As a result, factors such as sleep (Bonnar et al., 2019), nutrition (Goulart et al., 2023), physical and mental preparation (Pedraza-Ramirez et al., 2020), and

lifestyle management (Trotter et al., 2020) are now recognized as essential elements in enhancing player capabilities. Thus, the purpose of this invited commentary is to highlight the need to perform studies on professional esports players, and more particularly, the need to develop cognitive, physical, or cognitive-motor training program fitted to this specific population.

Esports, Training, and Cognitive Performance

While there is a body of evidence regarding the effects of physical (Ludyga et al., 2020) and cognitive-motor training (Demirakca et al., 2016) on cognition in nongamers, studies in professional esports players are still lacking. Initially implemented for health reasons (Penedo & Dahn, 2005), due to the sedentary nature of video games (Bayrakdar et al., 2020; Rudolf et al., 2020; Yin et al., 2020) favorably linked to the onset of musculoskeletal disorders (DiFrancisco-Donoghue et al., 2019; Donoghue et al., 2020), or even obesity issues (Trotter et al., 2020), the physical training has been first studied for its neurocognitive effects for nonprofessional esports players (Dykstra et al., 2021). Indeed, a recent dual systematic review showed that four main cognitive areas (attention, task-switching, information processing, and memory abilities) were involved in esports and that physical training (aerobic exercise) improved cognitive abilities (Toth et al., 2020). The same authors of this review also pointed out the lack of studies concerning other types of training such as coordinative, resistance, and high-intensity interval training (HIIT; Toth et al., 2020).

Three years after the publication of this dual systematic review, the result of our literature research (see Figure 1) showed that there is still a need to perform such studies. Indeed, we found that only the study of De Las Heras and collaborators was able to test the effect of a HIIT program on esports players especially among the *League of Legends* players (De Las Heras et al., 2020). After 15 min of HIIT performed on a cycle ergometer, the authors showed that short bouts of HIIT improved participants' capacity to eliminate targets by 9% and increased the accuracy of the attacks by 75%. This result suggested that a HIIT session could improve game performance, as well as the physical and cognitive well-being of young (22 ± 3 years) recreational video gamers.

Although original, the study of De Las Heras and colleagues only highlighted the acute effect of a HIIT session but not the chronic effect of HIIT training. In addition, the HIIT session was not carried out on professional esports players (but on the 85th percentile of European players). Finally, this study only dealt with unimodal physical training (HIIT). However, as previously reported, many other types, frequencies, and modalities of training could be relevant to cognitive performance (Toth et al., 2020). Based on these shortcomings in the literature, new research needs to be conducted with professional esports players.

New Avenues of Research in Professional Esports Players

After a brief review of previous studies on esports, this section will suggest new avenues of research related to our current work.

First, we believe that future research should more clearly distinguish professional esports players from recreational video game players. A player attains professional status when he possesses a contractual arrangement overseen by an esports organization. This contract involves compensation for their gameplay at an

elevated proficiency level, reaching a point where the income sustains their livelihood, typically around €2,000 per month in Europe. This monetary remuneration is tied to the player's participation in representing the organization in both national and international video game tournaments, distinct from activities like streaming and content creation. Following these benchmarks, a professional player engages in approximately 80 gaming sessions weekly and stands within the upper echelon of European players, belonging to the top 0.01% (League of Graphs, n.d.).

Thus, sampling them from professional organizations participating in national and international competitions will have two major effects. First, it will be possible to eliminate the threshold effect that top esports players may be subject to, a crucial factor seems that both components, physical and cognitive, need to be simultaneously present to get the best output (Fissler et al., 2013). Second, it will allow to customize the training program in a real high-performance context, depending on the feasibility (i.e., time, logistical or organizational constraints) of the training.

However, accessing this population as well as setting up an experimental research protocol is currently a real challenge for researchers, who face a variety of obstacles. Currently, the scarcity of subjects, their lack of availability, and the data collection protocols and tools deemed too intrusive for professional esports organizations are major obstacles to the production of knowledge on professional esports performance. As a consequence, necessary methodological concessions (e.g., remote control groups, single-case experimental design, change in the duration and intensity of training sessions) impact the scientific rigor of protocols and finally their results. Furthermore, despite a more lenient scientific approach, professional teams are still reluctant to allow external studies that may jeopardize the privacy of their personal data, which poses a challenge in obtaining access to professional players.

In this particular framework, we emphasize the importance of professional players and organizations being more proactive and open to working with researchers to address this issue.

With this aim, several recommendations for the field would bolster future research to overcome these obstacles.

1. Involve professional staff and players in drawing up the protocols, and in interpreting and concluding the research project jointly with the researchers.
2. Integrate knowledge translation models (Boland et al., 2020), which would engage practitioners within a research process, through shared concepts and coproduced knowledge, to strengthen the ability to link, exchange, and cocreate knowledge.
3. Propose a collaboration based on exchange, communication, and dialogue between the various parties (academic and esports players) involved in the project to identify areas of overlap and ultimately lead to more effective collaboration and improved esports performance. Also, emphasize researchers' esports experience, for smoother interactions with practitioners, maintaining regular communication with staff and players, as well as postgraduate scientific background, to address inquiries effectively while enabling the recognition and adoption of evidence-based practices for impactful decision making in surrounding esports performance (Brocherie & Beard, 2021).
4. Promote constant communication between researchers and esports stakeholders to develop research issues that are valid according to scientific evaluation criteria adopted by scientific institutions for publication (i.e., control groups, randomization, statistical tests, sample sizes) but also directly useful for professional esports organizations and their staff.

5. Explain that the primary objective of the research is to improve performance, rather than to use the results solely for publication purposes. Indeed, there is skepticism or wariness among teams about the potential contributions from academic entities, stemming from concerns about their detachment from practical realities. This is about academics and researchers helping and working with professionals and practitioners.
6. Make compromises between research and performance, as in academic settings, constraints arise from scientific demands and peer evaluation, while practical constraints relate to intervention, customer satisfaction, and problem-solving, and where the collaboration between parties with diverse constraints leads to tensions (Delalandre, 2009).
7. Conduct qualitative research, such as case studies, to bridge the research practice gap by fostering relationships between practitioners and coaches, which may result in mutual interests and more demanding research such as laboratory-based experiments (Fullagar et al., 2019).
8. Foster the recruitment of staff with a scientific background (BSc, MSc, PhD) within esports professional organizations to facilitate dialogue with the academic world and roll out evidence-based training programs.

Finally, the neurophysiological effects are different depending on the frequency and the type of training, for instance, high-intensity aerobic training shows a more significant increase in brain-derived neurotrophic factor than low-intensity aerobic training. In addition, the change in working memory was significantly greater in the high-intensity exercise group, compared with both the low- and even the moderate-intensity aerobic exercise groups (Jeon & Ha, 2017).

Consequently, future research should better define and frame the respective different frequencies and types of training, in particular, whether they are performed chronically or acutely, and whether they are more physical (HIIT, resistance training), or cognitive and cognitive-motor. The aim is to establish the ideal training schedule for professional esports players to improve their performance.

In this context, we are currently conducting a Single-Case Experimental Design project which aims at extending current knowledge with longitudinal and acute experimental research on exercise interventions and their relationships to esports performance. More precisely, the current study will compare the effects of a chronic and acute HIIT training and a chronic and acute cognitive-motor training (motor exercise combined with cognitive perturbation) on the cognitive and physical performance (e.g., cardiac function [heart rate variability], skeletal muscle function) of professional elite esports players. This will allow us to highlight the cognitive and physical capacities improved according to the frequency of training (chronic or acute) and the type of training (HIIT or cognitive-motor), to determine the optimal schedule of cognitive, physical, and cognitive-motor training for professional esports athletes. Finally, we will also investigate the link between improvements in cognitive, physical, motor, and physiological abilities and the performance of professional esports players during training and competition periods.

Conclusion

Research investigating the enhancement of specific esports cognitive abilities of professional esports players will allow the development of training programs and optimal training schedules to

improve professional esports players' performance. In doing so, scholars and researchers will have to collaborate with industry and professional organizations to disseminate research, and training will be carried out in a more evidence-based approach, and less empirical way, stabilizing and accentuating the professionalization of the ecosystem, in a context where the esports players' careers and health become a major stake for the industry sustainability.

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