COMENIUS UNIVERSITY IN BRATISLAVA FACULTY OF PHYSICAL EDUCATION AND SPORT

Development of cognitive skills of AS Trenčín football players in the U15 category in football

Diploma Thesis

2025 **Bc. Milan Šavol**

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Diploma Thesis

Study programme: Coaching and Teaching of Physical Education
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Thesis supervisor: Mgr. Martin Mikulič, PhD.

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I honestly declare that I have prepared the entire diploma thesis on the topic "Cognitive abilities in football in the category under 15 years of age in AS Trenčín", including all its appendices and pictures, independently, using the literature listed in the attached list and artificial intelligence tools. I declare that I have used the AI tools in accordance with the relevant legislation, academic rights and freedoms, ethical and moral principles, while respecting academic integrity, and that their use is appropriately indicated in the work.

Thanks

In this way, I would like to thank my friends, family, girlfriend and especially my supervisor Mgr. Martin Mikulič, PhD for providing valuable advice, willingness, comments and professional guidance duringthe writing of the diploma thesis.

ABSTRACT

ŠAVOL, Milan: *Cognitive Abilities in Football in the Up to 15 Years Category in AS Trenčín* [Diploma Thesis]. Comenius University in Bratislava. Faculty of Physical Education and Sport; Department of Sports Games. Supervisor: Mgr. Martin Mikulič, PhD. Degree of professional qualification: Master's. Bratislava: FTVŠ UK, 2025. 71 p.

The aim of the diploma thesis is to evaluate the effectiveness of the experimental program Simust, focused on the development of cognitive abilities in youth football players of the AS Trenčín club in the U15 category. The Simust program represents an innovative approach that uses simulation and training tools to stimulate mental processes important for football performance, such as perception, decision-making, concentration and reaction time. The research sample consists of players of the AS Trenčín U15 team who were systematically exposed to cognitive training using the Sibit program over a period of time. The level of cognitive ability was measured before and after the intervention using standardized tests and evaluated using statistical methods. We used the Shapiro-Wilk test, paired t-test, descriptive statistics, and indirect observation. The results of the research showed that the application of the Simust cognitive training program had a statistically significant effect on improving the performance of players in the U15 category. At the level of significance of $\alpha = 0.05$, an improvement in perception, decision-making and orientation in space was confirmed, both in the controlled conditions of the SIMUST - "Scan preference" test, as well as in real match situations.

Key words: football, cognitive abilities, age category U15, Simust

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ŠAVOL, Milan: Cognitive abilities in football in the under-15 category at AS Trenčín. [Master´s thesis]. Comenius University in Bratislava. Faculty of Physical Education and Sport; Department of Sports Games. Thesis Supervisor: Mgr. Martin Mikulič, PhD. Degree of Professional qualification: Master´s. Bratislava: FTVŠ UK, 2025. 71 pages.

The aim of our master´s thesis is to evaluate the effectiveness of the experimental program Simust in developing the cognitive abilities in youth football players of AS Trenčín in the U15 category. The Simust program represents an innovative approach that employs simulation and training tools to stimulate mental processes essential for football performance, such as perception, decision-making, concentration, and reaction time. The research sample consisted of AS Trenčín U15 players who were systematically exposed to cognitive training using the Simust program over a specific period. The level of cognitive abilities was assessed both before and after the intervention using standardized testing methods and evaluated through statistical analysis. Specifically, the Shapiro-Wilk test, paired t-test, descriptive statistics, and indirect observation were applied. The research results demonstrated that the implementation of the Simust cognitive training program had a statistically significant effect on improving player performance in the U15 category. At a significance level of $\alpha = 0.05$, improvements were confirmed in areas such as perception, decision-making, and spatial orientation, both under controlled testing conditions in the SIMUST "Scan Preference" test and in real match situations.

Key words: football, cognitive abilities, age category U15, Simust

Preface

With this diploma thesis, I would like to express my interest in connecting the modern football training process with the development of players' cognitive abilities. The topic of visual perception (scanning), game decision-making and their connection with training stimuli has proven to be extremely topical and practically usable in the conditions of professional sports. During the development of the thesis, I had the opportunity to analyze in detail the performance of players not only from a game point of view, but also from the point of view of their mental readiness and cognitive flexibility. An important part of this process was the implementation of the specialized SIBIT program, as well as the continuous analysis of match variables before and after the intervention.

Content

1 THE CURRENT STATE OF THE ADDRESSED ISSUE AT HOME AND ABROAD

1.1 Characteristics of football in terms of load

Football is a complex sport that places high demands on players in terms of physical fitness, technical skills, tactical thinking and mental resilience (Haugen et al. 2020). The workload in football is multifactorial and its nature changes depending on the age, playing position, level of competition and playing style of the team (Šimonek 2019). In the context of 15-year-old football players who are in the stage of basic sports training, it is important to understand the specifics of the load and adapt the training process to it.

1.1.1 Load

During a football match, players alternate between different physical activities of varying intensity, such as walking, running at different speeds, sprints, jumps, duels, and changes of direction (Paul et al. 2015). This alternation of activities represents a combination of aerobic and anaerobic load for the body. Aerobic endurance is key to managing the total volume of match load and for rapid recovery between high-intensity stretches (Aurélien et al. 2020). Anaerobic loading, characterized by short, explosive movements, is important for speed and strength displays such as sprints, jumps, and personal duels (Hammami et al. 2018). For 15-year-old footballers, attention should be paid to the development of both types of load, with an emphasis on building a solid aerobic foundation, which will also support the development of anaerobic capacities.

1.1.2 Cognitive load

Football is not only about physical fitness, but also about making quick and correct decisions in dynamically changing game situations (Zwierko et al. 2022). Players must constantly perceive and analyze the playing field, or the immediate space around them, anticipate the movements of teammates and opponents, and choose optimal solutions (Klimek & Lisinski 2023). These cognitive processes, including perception, attention, anticipation, decision-making, and reaction time, are crucial for successful game performance (Ryu et al. 2020). In young footballers in adolescence, it is important to develop not only physical, but also cognitive abilities, since it is at this age that significant development of the brain and cognitive functions occurs (Ludyga et al. 2022).

1.2 Characteristics of cognitive abilities

Cognitive abilities, often referred to as cognitive functions, are a set of mental processes that allow us to perceive, process, store and use information from the world around us (D'Esposito & Grossman 2018). These abilities are fundamental for learning, problem-solving, decision-making, and adaptation to changing conditions (Diamond 2016). Basic cognitive functions include perception, thinking, memory, speech, and attention, and these processes are interconnected and interact with each other (Goldstein 2019). The development of cognitive abilities takes place throughout life, but is especially intense in childhood and adolescence (Blakemore & Choudhury 2016). Understanding how cognitive abilities work and the factors that influence them is important in many areas, including education, psychology, and sports.

1.2.1 Perception

Perception is a complex process through which we organize and interpret sensory information from the surrounding world, thus creating an internal representation of reality (Wolfe et al. 2018). This process involves not only the passive reception of stimuli from the environment, but also their active processing and selection, in which previous experiences, expectations and cognitive schemes participate (Gregory 2015). In the context of sports, and football in particular, visual and auditory perception plays a key role, which allows players to orient themselves on the field, follow the movement of the ball and teammates, and anticipate the actions of the opponent (Vater, et al. 2020). Effective perception is therefore a basic prerequisite for fast and accurate decision-making in dynamically changing game situations (Broadbent et al. 2015). Therefore, the development of perception in young footballers is an important part of the training process, in order to improve their game overview and ability to respond to relevant stimuli (Fadde 2022).

1.2.2 Mind

Thinking is a highly complex cognitive process that represents a person's basic ability to process information, solve problems, and adapt to changing environmental conditions. It encompasses a wide range of mental operations, such as reasoning, judgment-making, planning, hypothesis formation and verification, abstraction, and creativity (Holyoak & Morrison 2018). Thinking is not just a passive reflection of reality, but an active process of constructing and reconstructing internal representations of the world, using both logical and analytical, as well as intuitive and creative procedures (Ward, et al. 2018).

According to Sternberg & Sternberg (2017), different types of thinking are distinguished in psychology, such as:

- Deductive thinking: Drawing conclusions from general principles and premises.
- Inductive thinking: Making generalizations based on specific observations and experiences.
- Analytical thinking: Breaking down a problem into smaller parts and systematically examining the relationships between them.
- Critical thinking: Evaluating information, arguments, and evidence in terms of its validity and reliability.
- Creative thinking: Generating new and original thoughts, solutions and ideas.
- Tactical thinking: Focused on achieving short-term goals in dynamic and uncertain situations
- Strategic thinking: Focused on formulating and achieving long-term goals and visions.

In the context of football, thinking plays a key role in tactical preparation, strategic planning and in the game performance itself. Tactical thinking allows players to analyze game situations, recognize patterns in the opponent's play, and predict the development of the game based on the principles of game strategy (Memmert, et al. 2017). During the match, football players must constantly make quick and correct decisions under time pressure and in conditions of high uncertainty. These decisions are based on a comprehensive evaluation of the game situation, which includes the perception of the position and movement of teammates and opponents, the path of the ball, one's own technical capabilities and tactical instructions (Matos et al. 2023).

The ability to think creatively is important in football for finding non-standard and surprising solutions to game situations, whether offensively or defensively (Fadde & Zaichkowsky 2018). Creativity can manifest itself in unexpected passes, dribbles, shooting solutions, but also in an original positional position, whether in an individual or team context.

The development of thinking in young football players, specifically in 15-year-old football players who are in the stage of basic sports training, is one of the main goals of the training process. Emphasis should be placed on understanding basic game principles,

developing game intelligence and the ability to adapt to different game situations (Roca, et al. 2018). Training methods aimed at developing thinking include, for example, modeled situations, game exercises with different rules and restrictions, video analysis of matches and tactical meetings (Machado, et al. 2020). It is also important to support the creativity and independent decision-making of players, with the aim of educating not only technically proficient, but also intelligent and game-creative football players (Jonker, et al. 2015).

Other aspects of thinking relevant to football:

- Anticipation (anticipation) is the ability to predict where the ball, teammates and opponents will move, allowing players to be in the right place at the right time and react effectively to game situations (Moesch, et al. 2019).

- Solving problems in a football match is very important. A football match is full of unexpected situations that require quick and effective solutions. The ability to analyze a problem, consider different options, and choose the optimal solution is crucial for success in the game (Aksum, et al. 2021).

Thinking is a complex and multifaceted process that is irreplaceable for success in football, and sport in general. The development of different types of thinking, with an emphasis on tactical thinking, creativity and foresight, should be an integral part of the training process from a young age.

1.2.3 Memory

Memory is a key cognitive skill that allows us to encode, store, and recall information and experiences (Squire & Wixted 2015). It is essential for learning, adapting to the environment and for creating a personal identity. Memory is not a single system, but consists of several interconnected systems that differ in the type of information stored and the length of time it is stored (Baddeley 2017). We distinguish between sensory memory (short-term retention of sensory perceptions), short-term/working memory (temporary retention and manipulation of information) and long-term memory, which is further divided into explicit (conscious recall of facts and events) and implicit (unconscious, automatic skills and habits) (Squire 2015).

In the context of football, memory plays an important role in various aspects of the game. Working memory is important for keeping game instructions up-to-date, keeping track of the position of teammates and opponents, and for planning subsequent actions (Furley &

Memmert 2015). Long-term explicit memory allows players to remember tactical instructions, game systems, and strategies, while long-term implicit memory is the basis for acquired motor skills such as passing, shooting, and ball handling, which become automatic and are performed without conscious control (Gucciardi, et al. 2017). In the match, we also remember important information about the opponent, his strengths and weaknesses, favorite game variants, which can later be used to improve our game.

Memory development in young footballers, especially the development of various memory systems in 15-year-old footballers, is important for improving their playing performance. Training methods should include exercises aimed at improving working memory, for example through complex game exercises with changing rules and tasks, but attention should also be paid to long-term memory, for example, focused repetition and consolidation of what has been learned, whether we are talking about technical skills or tactical principles (Verburgh, et al. 2016). It is also important to create the conditions for effective encoding of information into long-term memory, for example through clear and understandable instructions, visual aids, and sufficient repetition (Ryu, et al. 2020).

Memory is a complex and multifaceted system that is essential for successful game performance in football. The training process should therefore systematically develop all relevant memory systems in order to improve the ability of players to learn, adapt to game situations and use their experience effectively.

1.2.4 Speech

Speech is a unique communication system that distinguishes humans from other animals and plays a key role in cognitive development, social interaction, and cultural transmission (Tomasello 2019). It allows us to express thoughts, feelings, intentions, and experiences through articulated sounds that are organized into words and sentences according to grammatical rules (Chomsky 2017). Speech is not only a tool of communication, but also a tool of thinking that allows us to construct our internal mental processes in a complex way, make generalizations, and reflect on abstract concepts (Clark 2018). The ability to produce and understand speech is closely linked to other cognitive functions such as memory, attention, and executive functions, and these interconnections are particularly important for complex cognitive tasks (Harley 2017).

Although football may appear to be primarily a physical activity, verbal communication plays an important role both on and off the field. During a match, players

use speech to coordinate their actions, pass on information about the position of opponents, guide teammates, and express tactical instructions (Goral et al. 2017). Effective verbal communication can improve team chemistry, speed up reaction time, and contribute to better game performance. Off the pitch, speech is important for tactical preparation, match analysis and team spirit building. Coaches use speech to give instructions, motivate players, and provide feedback, while players communicate with each other about game situations, share insights, and build relationships with each other.

Speech development in young footballers, specifically in 15-year-old footballers, it is important to develop not only their football skills, but also the ability to communicate effectively in the context of the game. The training process should include exercises aimed at improving verbal communication on the field, such as practicing clear and concise instructions, using standardized football terms, and encouraging each other (Blaser & Seiler 2019). It is also important to support open communication between players and the coach, in order to create an environment in which players are not afraid to express their opinion, share their observations and actively participate in tactical preparation.

Speech is an important tool for communication and thinking, which also plays a significant role in the football environment. The development of communication skills in young footballers should be an integral part of the training process, with the aim of improving their game performance, teamwork and overall development as athletes and personalities.

1.2.5 Attention

Attention is a cognitive function that plays a key role in selecting relevant information from the environment and processing it efficiently (Friesen et al. 2018). It allows us to focus on the essential stimuli and ignore the irrelevant ones, thus optimizing the use of cognitive resources (Allport 2020). We distinguish between several types of attention, including selective (selection of one piece of information), divided (simultaneous processing of multiple pieces of information) and sustained (maintaining attention over time), which are dynamically interconnected and complementary in football (Vestberg et al. 2017).

In the context of athletic performance, and football in particular, the ability to manage attention and resist distractions is critically important for successfully managing game situations (Furley et al. 2023). During a match, footballers have to process a lot of visual and auditory information, quickly evaluate game situations and react adequately (Schumacher et al. 2020). Selective attention is essential for focusing on key game aspects such as ball

position, movement of teammates and opponents, and for filtering out irrelevant distractions, such as noise from the audience (Noël et al. 2021). Divided attention allows players to simultaneously observe multiple important objects and events, which is crucial, for example, when dribbling with the ball and simultaneously perceiving the space and position of surrounding players (Jin et al. 2023). Sustained attention ensures that concentration is maintained throughout the match, even with increasing physical and mental fatigue, which is especially important in its final phases (Ryu et al. 2020).

Systematic attention development in young football players should be an integral part of the training process for 15-year-old football players. Trainers should use methods and exercises that stimulate various aspects of attention. For the development of selective attention, exercises aimed at following specific game stimuli in a disturbing environment, for example in the form of small games with different rules and tasks (Woods et al. 2021), are suitable. Divided attention can be effectively trained through complex exercises that combine technical and tactical elements, such as guiding the ball in a confined space with the need to respond to the coach's signals (Fadde & Zaichkowsky 2018). For the development of sustained attention, longer-lasting exercises with increasing cognitive difficulty, which simulate fatigue and pressure at the end of a match (Zwierko et al. 2022), are suitable. An important aspect is also the development of the ability to manage stress and regulate emotions that can negatively affect concentration (Larkin et al. 2015).

Attention is a multifaceted cognitive function that is absolutely crucial for football performance. Targeted and systematic development of different types of attention in young football players, using adequate training methods, can lead to a significant improvement in their game success and cognitive readiness for difficult game situations.

1.2.6 Scanning

Football is a highly dynamic, variable and complex sport in which the ability of players to obtain and use visual information about teammates and opponents can logically be the key to successful performance. Indeed, research has revealed the perceptual and cognitive mechanisms that distinguish skilled players from less skilled ones, as well as quality performances from less successful ones (Williams & Jackson, 2019). However, much of this research has focused on visual search strategy. These studies are typically conducted using eye tracking technology, with players responding to photos or videos presented in front of them in a laboratory environment.

Some studies have found that skilled soccer players fix their vision less frequently but for longer periods of time, which may indicate that they are able to extract more information from each visual fixation (Cañal-Bruland et al., 2011). Other research, on the other hand, shows that skilled gamers fix their vision more often, but for a shorter period of time (Vaeyens et al., 2007a,b; Roca et al., 2011). For example, a study conducted on a sample of 44 professional and semi-professional gamers in England (Roca et al., 2018) showed that the most creative gamers used a wider range of attention, performing more visual fixations with a shorter duration compared to less creative gamers. This frequent shift of fixation between objects makes sense, as in team ball sports, players are constantly forced to shift their attention between different objects – especially between the ball and other players (Jordet, 2005a,b; Mann et al., 2019).

The problem is that few studies focus on the perceptual processes of truly elite, professional gamers – probably because of the difficulty of recruiting this population for research. Therefore, a new research direction has emerged, which is based on the opposite approach to laboratory studies – it systematically observes and analyzes the behavior of elite football players during real matches. This approach is based on the ecological theories of Gibson (1966, 1979), according to which perception is an active process of obtaining information from the environment – it is a psychosomatic act that involves motor activity. Exploratory activity is an effort to reveal information through the movements of the head and sensory organs towards stimuli in the environment (Reed, 1996). In football, this phenomenon is often referred to as "pre-orientation" (in German "Vororientierung") or in English as "checking your shoulder" or "scanning".

Jordet (2005a) was the first to film professional footballers using high-zoom cameras to analyse their scanning behaviour in detail before receiving the ball. He found that for midfielders, constantly scanning the space behind their backs is the basis for successfully perceiving and then processing this information. The most extensive study so far is the research of Jordet et al. (2013), who analyzed 1,279 game situations from Sky Sport's PlayerCam in the English Premier League. Players who have won prestigious individual awards in the past (e.g. FIFA World Player of the Year) scanned more often than others before receiving the ball, with more frequent scans positively correlated with passing success.

Some studies have tried to analyze head movements using wearable sensors (inertial measurement units) placed in headbands. The results showed that a higher frequency of

turning the head before getting the ball was associated with a faster reaction when passing and a higher probability of passing forward (McGuckian et al., 2018).

Scanning as part of cognitive processes in football

One of the key components of effective decision-making as a player in football is the ability to perceive the situation on the pitch in a timely and accurate manner. In this context, the term **"scanning" is increasingly coming to the fore,** referring to the active movement of the player's head, during which he consciously turns his gaze away from the ball in order to obtain visual information about the spatial arrangement of teammates, opponents and the game situation (Jordet et al., 2020).

A study from the English Premier League, which involved 27 elite professional footballers, analyzed the behavior of players during 21 competitive matches, which represented as many as 9,574 individual ball game activities. The results showed that the scanning frequency varies depending on the player's position. Central midfielders and central defenders scan the most, while forwards have the lowest scanning frequency. At the same time, **contextual differences have also been noted** – the scanning frequency decreases in situations with intense pressure from the opponent, on the edges of the field and near the opponent's goal (Jordet et al., 2020).

In terms of game activities, it has been shown that players perform scans more often **before passing** than before driving the ball, shooting or just receiving the ball. Interestingly, scanning was more common before longer and forward-directed passes than before short or backward-directed passes, although the differences were only slight (Jordet et al., 2020).

The use **of the Bayesian hierarchical model**, which took into account the individual differences of players and the difficulty of individual passes, confirmed a positive relationship between the frequency of scans and the success of passes. In other words, the more often a player scans, the higher the likelihood that their pass will be successful (Jordet et al., 2020).

It should also be said that the demands of the match are likely to affect the degree to which even the best elite players can scan, and scanning appears to be a small but positive factor in the performance of elite football players (Jordet et al., 2020).

Visual Exploratory Behavior and Decision-Making in Football

One of the most important cognitive skills that affect the performance of football players is the ability to quickly orient themselves in the playing space through the so-called Visual Exploratory Behaviour (VEB), also known as scanning.

According to Jordet (2018), who is considered a world expert in this field, the cognitive components of decision-making in football can be divided into three basic segments:

- Visual perception – the ability to receive and interpret visual stimuli,
- Visual Exploratory Behavior (VEB) – the ability to actively search for and scan relevant information from the environment,
- Anticipation – the ability to anticipate the development of the game situation.

Jordet analysed the behaviour of more than 250 professional players to find out how often players look around (i.e. perform "scans") before receiving the ball. He found that players with a frequency above 0.5 scans per second are considered to be so-called high scanners, and this ability is closely related to the quality of game decision-making (Jordet, 2018).

Concrete data shows that, for example:

- Xavi achieved a frequency of 0.83 scans/s,
- Cesc Fabregas 0.75 scanov/s,
- Frank Lampard 0,62 scanov/s,
- Steven Gerrard 0,61 scanov/s,

while Messi, Iniesta, Pirlo and Ibrahimovic achieved around 0.5 scans/s.

Frank Lampard was the player with the highest frequency of VEB in the Premier League during the period under review. Also interesting is the statement of Tony Carr, the coach of the West Ham academy, who recalls that Lampard's father often shouted from the stands: "Pictures! Pictures!", which encouraged him from an early age to create a mental image of the situation on the pitch in his head before touching the ball. These findings thus point to the fact that a high scan frequency is not only an innate trait, but can be systematically trained at an early age (Jordet, 2018).

The results of the "Scanning Study 1", which Jordet conducted in the Premier League environment, showed significant differences in the success of game actions between players with high and low VEB frequency. Players who looked around more often before receiving

the ball achieved a success rate of up to 77% on forward passes, while those who scanned less often achieved only a 39% success rate (Jordet, et al. 2020).

These results point to the fact that scanning is not only a natural ability of selected players, but it is a skill that can be purposefully developed through training. Players with a high level of VEB have a greater amount of relevant information at their disposal, which they can then process more efficiently, thus increasing the quality of their decisions in match situations. As reported by Jordet (2018), the best players scanned almost twice as often as the least active and thus achieved significantly higher game success rates.

1.3 Cognitive abilities in football

Cognitive abilities play a key role not only in everyday life, but also in sports, especially in dynamic and complex sports games such as football. Success in these games requires not only physical fitness and technical skills, but also a high level of cognitive functioning. Skills such as perception, thinking, memory, speech, and attention, which we discussed in detail in the previous chapter, are constantly involved in football, and their effective use is critical to achieving optimal game performance (Vestberg, et al. 2017).

1.3.1 Linking Cognitive Function and Gaming Performance

In football and other sports games, cognitive functions are closely linked to game activities and tactical decision-making. Perception allows players to quickly and accurately capture relevant information from the game environment, such as the position of the ball, the movement of teammates and opponents, and to anticipate the development of the game situation (Broadbent, et al. 2015). Thinking, especially tactical and strategic, is essential for analyzing game situations, choosing optimal solutions, and adapting to changing conditions on the pitch (Zwierko, et al. 2022). Memory allows players to retain and use tactical instructions, game systems, as well as experience from previous matches, which contributes to better anticipation and more effective decision-making (Ryu, et al. 2020). Speech serves as an important tool for communication between players, allowing them to coordinate their actions, exchange information, and guide each other during the game (Goral, et al. 2017). Finally, attention is key to selectively focusing on relevant game stimuli, filtering out distractions, and maintaining concentration throughout the match, even under pressure and under fatigue conditions (Noël et al. 2021).

1.3.2 Specifics of cognitive demands in football

Football, like other team sports games, places specific demands on the cognitive functions of players. An open game environment, the constant change of game situations, and the need for fast and accurate decision-making under time pressure require high levels of cognitive flexibility, adaptability, and resilience to stress (Furley, et al. 2023). Players must be able to quickly switch between different types of attention, process large amounts of information efficiently, and make the right decisions in fractions of a second (Schumacher, et al. 2020). In addition, success in football also depends on the ability to "read the game", i.e. to anticipate the opponent's intentions and react to them adequately (Fadde & Zaichkowsky 2018). This ability is closely linked to the development of game intelligence, which is formed through experience, learning, and systematic training aimed at developing cognitive functions (Roca, et al. 2018).

1.3.3 The importance of cognitive training

Given the importance of cognitive skills for game performance, it is clear that their development should be an integral part of the training process, not only for professionals, but also for young, developing football players. Cognitive training in soccer can focus on improving various aspects of cognitive functioning, such as information processing speed, reaction time, peripheral perception, anticipation, decision-making under pressure, and creativity in dealing with game situations (Heilmann, et al. 2024). Modern training approaches use a variety of methods and technologies, such as video simulations, virtual reality, cognitive training programs, and specialized game exercises, to develop players' cognitive abilities in the context of soccer situations (Woods, et al. 2021).

Cognitive abilities are just as important for success in football and other sports games as physical fitness and technical skills. The systematic development of these skills, through targeted training and game practice, can lead to a significant improvement in game performance and the achievement of maximum sports potential in players of all ages.

1.4 Stages of sports training

Sports training is a long-term, systematically managed process aimed at achieving maximum sports performance in the chosen sport (Peráček 2019). Its structure is based on the laws of ontogenetic development of the player, taking into account biological, psychological and social aspects. The results of research and practical experience confirm that the division of the training process into successive stages enables more effective achievement of the set goals and better adaptation of players to the training load (Kačáni 2005).

Currently, according to M. Mikulič and P. Peráček (2019), the following division of sports training is recommended:

Sports preparation: 8 – 11 year old children

Basic sports training: 12-15-year-old pupils

Special sports training: 16-19-year-old youth

Top sports training: 19-21-year-old juniors and seniors

Within the framework of basic and special sports training, two phases are defined. In basic training, the first phase takes place for players aged 12-13, while the second phase covers the period of 14-15 years. This system can also be applied to special sports training (Kačáni 2005).

Basic sports training (pupils) (12 – 15 years):

Phase 1: 12 – 13-year-old younger pupils

Phase 2: 14 – 15-year-old older pupils

Special sports training (juniors) (16 – 19 years):

Phase 1: 16 – 17-year-old younger youths

Phase 2: 18 – 19-year-old older juniors

It is obvious that the mentioned stages of sports training cannot be taken in isolation, they form a coherent whole, they follow each other and smoothly transition into each other. For practical reasons, they cannot be omitted or shortened (participation in youth competitions), because their shortening or omission may have a negative impact on the player's performance growth (Kačáni 2005).

1.4.1 Sports preparation

Organized sports training begins at the age of 8-11, when optimal conditions are created for the development of motor skills and the acquisition of basic game skills. During this period, general physical training supplemented by various movement games, relays or competitions is preferred. The main methodological approach is the "game method", which ensures the playful and natural development of children's motor skills (Kačáni 2005).

The main tasks of the stage of sports preparation according to Kačáni (2005):

- Versatile game movement preparation
- Mastering the basics of football technique
- Acquiring specific habits and activities for collective play
- Educating the relationship to the rules of football and physical training

1.4.2 Basic sports training

This period is characterized by a uniform physical development of the pupil, while his functional capacity is at a high level. Suitable conditions are created for the development of coordination skills and the acquisition of game skills, from the simplest to the most complex, with the process of imitation playing an important role. In the psychic area, there is an improvement in observation skills, perception, movement memory and the development of the basics of logical thinking (Kačáni 2005).

Special preparation within game training is focused on understanding the plot of the game and mastering it as a whole. Training units are focused on improving the technical aspects of game activities through systematic and repeated practice of individual elements of football technique. Carefully planned game training in combination with group form contributes to the development of motor skills and improvement of players' fitness readiness (Kačáni 2005).

The training process of 15-year-old footballers should be dominated by game forms of training that are attractive for this age category and at the same time allow for the comprehensive development of all necessary skills and abilities (Ryu et al. 2020). It is also important to include exercises aimed at preventing injuries and compensating for unilateral load (Le Gall et al. 2019).

The stages of sports training represent an important framework for long-term planning and management of the training process. At the stage of basic sports training, which includes 15-year-old football players, it is crucial to focus on all-round development with a gradual

transition to specialization, with an emphasis on improving game skills, developing fitness and cognitive prerequisites and building solid psychological foundations.

The main tasks of the stage of basic sports training according to Kačáni (2005):

- further development of all-round motor readiness with an emphasis on the development of speed and coordination skills
- improvement of the technical side of the individual's game activities, mastering the basics of individual tactics through the illustrative method
- acquiring and expanding special tactical knowledge necessary to perform in competitive matches
- mastering the basic rules of football
- systematically educate and shape the pupil's personality in the specific environment of the playing team, develop the ability to compete

1.4.3 Special sports training

During the first phase of this period, significant changes occur in the player's body associated with the typical signs of puberty. Rapid physical growth can lead to impaired balance and coordination of movements. Gamers often exhibit instability in behavior and decision-making, tending to be critical of authority figures. At this developmental stage, it is therefore essential that they are supported by understanding and patient pedagogical-psychological guidance (Kačáni 2005).

The second phase of this period is characterized by the gradual end of puberty and the completion of the player's physical and personal development. The nervous system stabilizes, which leads to more balanced regulatory activity. Players at this stage show greater stability not only in game aspects, but also in behavior and decision-making, which increases their ability to react effectively to training and competition situations (Kačáni 2005).

As part of the game preparation, there is a gradual increase in the training load, while the players improve their game expression through the comprehensive development of game skills. Special attention is also paid to functional training to achieve optimal speed. Systematic and thoughtful strengthening in youth competitions carries elements of the training process of professional players. In all areas of game preparation, the volume and

intensity of the training load are consistently controlled in order to maximize performance (Kačáni 2005).

The main tasks of the stage of special sports training according to Kačáni (2005):

- development of special motor skills and game fitness in the conditions of game training (bioenergetic systems)
- further improvement of defensive and offensive game activities in specific game conditions with an emphasis on their dynamics
- development of fitness and tactics of the game of individuals, formations and the whole team in individual phases and sections of the game
- formation of positive personality traits of the player and a conscious attitude to training and competitive activities, development of competitive skills

1.4.4 Top sports training

In this age category, the training process is systematically focused on the comprehensive improvement of the players' playing abilities and skills. The main motivation is their participation in competitions. A key factor in achieving quality game performance is targeted training load, which includes various forms of interaction, including group and individual two-phase training in precisely defined periods (Kačáni 2005).

The main tasks of the stage of top sports training according to Kačáni (2005):

- comprehensive development of game skills within game training
- development of tactical knowledge of players, improvement of universal expressions
- shaping the profile of a top player – professional, increasing mental resistance to intense training and match load and deformation factors

1.5 SIMUST

PLAY SMART - The basis of sports success

In elite sports, the speed of decision-making is often the difference between success and failure. At the heart of this is motor logic – the ability to quickly and efficiently apply decisions to physical actions. The faster and more accurate this process is, the higher the performance (Azadi 2025).

"It's no longer just about physical talent – it's about how quickly and intelligently a player can perform an action under pressure" (Azadi 2025)

Siamak Azadi, founder of SIMUST (Sina Multisensory Soccer Testing), is a sports physiotherapist with expertise in neuromuscular and cognitive neuroscience. Azadi is originally from Iran and moved to the Netherlands in 1988. In 2015, driven by a vision to improve football performance, he founded SINA Voetballab in Beverwijk (Azadi 2025).

Image No. 1 Siamak Azadi, founder of SIMUST

Over the course of a decade, Azadi collaborated with specialists from several disciplines – cognitive science, neuromuscular training and exercise physiology – to develop SIMUST. This innovative system uses advanced technology to comprehensively assess and train the minds and bodies of footballers (Azadi 2025).

Azadi (2025) claims that his goal was to create a tool capable of detecting both physical and cognitive strengths and limitations and provide a pathway for adapted development. His vision positioned SIMUST as a game-changing solution in elite sports performance.

"I didn't want a system that just tells you how fast you run, but one that shows how fast you think, make decisions and act. Because at the highest level, football is a brain sport." (Azadi 2025)

SIMUST was developed with the aim of revolutionizing football training by combining cognitive demands with physical preparation. Modern football requires more than just skill – it requires mental acuity, quick decision-making and the ability to perform under pressure. SIMUST makes these invisible mental processes visible, measurable, and trainable (Azadi 2025).

"What the eyes can't see, the game still requires." (Azadi 2025)

SIMUST's main question was: How do cognitive abilities affect performance and how can we optimize them? Success in football stems from the harmony between mind and body. SIMUST focuses on evaluating and training both at the same time. It focuses on building brain-muscle coordination and developing individualized learning pathways, recognizing that no two players learn or perceive the game in the same way (Azadi 2025).

In team sports, performance relies on a seamless mix of physical, physiological, psychological, and cognitive elements. SIMUST trains the brain like a muscle, allowing players to create faster and more efficient neural pathways for action. SIMUST is designed to improve, not replace, conventional training. It integrates cognitive tasks into physical workouts and challenges players to make better decisions even under fatigue, pressure, or time constraints (Azadi 2025).

To truly simulate the requirements of a modern game, a state-of-the-art facility was set up in Beverwijk, the Netherlands, in 2015. Equipped with state-of-the-art monitoring and testing technology, this centre has become the birthplace of football's most comprehensive, multi-dimensional and multi-layered performance testing system. Experts in human movement science, neuromuscular research, and cognitive neuroscience have joined forces to realize this groundbreaking vision (Azadi 2025).

According to Azadi (2025), Smart Interactive Multi-Sensory Training (SIMUST) is an advanced football simulation system that enhances the cognitive and physical performance of players using real-world interactive scenarios. Includes:

- Real interaction with the ball
- High-resolution screens and immersive visuals
- Motion tracking and video analysis from multiple angles
- Ball Launching Machines and Dynamic Response Systems

Azadi (2025) reports that this semi-realistic setup allows players to train under match-like pressure, focusing on:

- Perception
- Decision-making
- Reaction time
- Technical design

By simulating a live game environment in a controlled space, SIMUST effectively bridges traditional training with the integration of cognitive technologies (Azadi 2025).

According to Azadi (2025), the neuromuscular process in sports involves several steps, from perceiving a stimulus to performing an action:

1. Perception and sensory processing: The eyes detect the ball and its movement and send signals to the visual cortex. Other senses, such as proprioception and auditory stimuli, contribute to situational awareness.

2. Cognitive processing and decision-making: The brain analyzes a situation and selects an appropriate action, such as passing, guiding the ball, or shooting.

3. Motor planning: The motor cortex, basal ganglia, and cerebellum plan movement and send signals to the muscles through the spinal cord.

4. Motor Execution and Muscle Activation: Motor neurons transmit signals to specific muscles, causing muscle fibers to contract and perform the chosen movement.

5. Feedback and adjustment: Sensory receptors in muscles and joints send feedback to the cerebellum to fine-tune balance and coordination and make real-time adjustments to movement.

The entire neuromuscular process, from perception to execution, proceeds quickly (150 to 500 milliseconds), depending on the complexity of the task and skill level (Azadi 2025).

Azadi (2025) further argues that we perceive repetition as a key factor. Repetition accelerates the cognitive-motor loop, improves pattern recognition, decision-making, and action execution by optimizing neural pathways and reducing cognitive load. Elite athletes train repeatedly, which allows them to react immediately under pressure.

- Faster pattern recognition: The brain becomes more efficient at detecting familiar patterns.
- Faster decision-making: Decisions become more intuitive and automatic with repetition.
- More efficient motor performance: Repetition strengthens neuromuscular connections and improves movement efficiency.
- Reduced cognitive load: When skills become automatic, the brain processes less, freeing up resources for foresight and creativity.

2 AIM, HYPOTHESES AND TASKS OF THE THESIS

2.1 AIM OF THE THESIS

The aim of our work is to determine the effectiveness of the SIMUST experimental program for the development of cognitive skills of AS Trenčín football players in the U15 category.

2.2 THESIS HYPOTHESES

H1: We assume that through the SIMUST experimental program, the monitored players will significantly increase the frequency of Environment Scanning during the match.

H2: We assume that through the SIMUST experimental program, the monitored players will significantly improve their performance in the Scan preference test.

2.3 JOB TASKS

Task 1: Perform input testing of monitored players

Task 2: Perform an initial observation of the scans of the monitored players in the match.

Task 3: Apply the experimental program

Task 6: Perform output testing of monitored players

Task 7: Perform an output observation of the scans of the monitored players in the match.

3 METHODOLOGY OF THE THESIS

3.1 DETERMINING THE RESEARCH SITUATION

$V_{(n-4)}$ (S1,S2)t0 ←→ $V_{(n-4)}$ (S1,S2)t1

S1- Performance in the SIMUST test

S2 – Performance in the match

T0 – 7.10.2024

T1 – 20.3.2025

Specific match(DAC-AS): 13.10.2024

Specific match(DAC-AS): 22.3.2025

3.2 CHARACTERISTICS OF THE ENSEMBLE

Table No. 1 Information on monitored players from AS Trenčín from the U15 category.

	Body weight	Body height	Lateralita	Player Feature	National team
Player No. 1	63kg	173cm	Lefty	DSSH	Yes
Player No. 2	61kg	169cm	Right-hander	OSSH	Not
Player No. 3	58kg	173cm	Right-hander	OSSH	Yes
Player No. 4	82kg	188cm	Lefty	HOWL	Not

During the period of initial testing, AS Trenčín, category U15, was 2nd in the table in the 1st Student League, group west. In the period of exit testing, AS Trenčín, category U15, was 1st in the extension table in the 1st student league, group west.

3.3 DESCRIPTION OF THE EXPERIMENTAL AGENT

Table 2 Information on the interaction of monitored players from AS Trenčín from the U15 category with SIMUST

	Number of TJ SIMUST	TJ time	total TJ time
Player No. 1	58	15-25min	1280min
Player No. 2	52	15-25min	1120min
Player No. 3	46	15-25min	1040min
Player No. 4	52	15-25min	1140min

3.4 METHODS OF DATA ACQUISITION

The first basic method of data acquisition is measurement - testing. The players had 2 measurements:

- Admission - 7.10.2024
- Exit fee - 20.3.2025

Between entry and exit, we did various other exercises with the players, to support scanning, anticipation, quick decision-making, passing, first touch and correct body rotation. Measurement-testing took place during the SIMUST - "Scan Preference" test, when we recorded the necessary data in a record sheet.

Table No. 3 Record sheet for the evaluation of players in the SIMUST test - "Scan preference"

	1		2		...		10		Sum of points
Player No. 1	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
Player No. 2	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
Player No. 3	Ľ	P	Ľ	P	Ľ	P	Ľ	P	

Player No. 4	L	P	L	P	L	P	L	P	

The SIMUST test - "Scan preference" lasts 1 minute and 37 seconds for one player. Player number 1 stands in the middle of the field between 12 displays that create an imaginary circle with a diameter of 18 meters. At the bottom of each display there is a "passing board" with dimensions of 0.95m x 0.45m, on which the player passes the ball. The displays are spaced evenly, with a greater distance between every third, which divides the displays into 4 parts (in the front part, which player number 1 has in front of him – to the left of player number 1 there are three displays, to the right of player number 1 there are three displays, in the back, which player number 1 has behind him – to the left of player number 1 – there are three displays, to the right of player number 1 are three displays). The displays show players in different positions. The front part shows red players in a position where they want the ball at their feet and player number 1 has to pass for the passing board. On the back, red players are shown in a position where they want the ball to run and player number 1 has to hit a small goal that is just (30 centimeters) next to specific displays. Player number 2 stands in the front between two trios of displays, from where he passes the ball to player number 1 when he misses the board or passes the ball into a small goal. The task of player number 1 is to pass the ball 10 times into the small goal at the back of the field. The test takes place in such a way that at the beginning player number 2 passes the ball to player number 1 and he looks for the red player. The priority is the players in the back of the field, the players who are in a position to want the ball to run and therefore it is the red players behind his back. However, if no player appears at the back of the field, the task of player number 1 is to pass the ball to the red player in front. Always before the ball comes to the number 1 player, he should turn his head, analyze the entire field and adapt the first touch to it based on what he has seen. The first touch should be directed to the area where player number 1 wants to play. That is, when he passes the ball against the screen in the front on the left side, the number 1 player must analyze the remaining 3 three-pointers of displays to know where he will receive the ball. For example, he sees a red player on the display in the front on the right side and at the same time he does not see anyone on the back, so the first touch is directed to the front to the right side. However, if he sees a red player in the front on the right side, but he also sees a red player behind him in the back, he decides according to the above-mentioned

priority and player number 1 turns towards the back with the first touch and tries to hit a small goal with the second or third touch.

The displays, passing boards and even the goals do not have sensors in them whether the number 1 player hit the target or not. Changes in the displays are time-dependent. In our exercise, we work with a time of 3.5 seconds. Which means that every 3.5 seconds the players on the displays change. That is why we emphasize turning the head, perceiving space, the first touch and using 2 maximum 3 touches, because after 3.5 seconds the red player will disappear. Just like in a match, in some parts of the game our teammate can only relax for a very short time and if we don't pass him at the right moment, the opponents will retake him. Also transferring the performance of the player in the test to the match, when our priority is to play upwards, to the opponent's goal (to the back of the field), if we see a free player, it is the same in our test.

Player number 1 was rated as follows:

- 2nd point: He saw the red player and passed into the (right) small goal
- 1 point: He saw the red player, but he didn't pass or didn't have time to pass into the (right) small goal
- 0 points: Didn't see the red player

Figure 2 The entire SIMUST playground

Figure 3 Individual parts of the SIMUST playground

The second basic method of obtaining data is indirect observation. We observed the players in 2 matches:

- Dunajská Streda – AS Trenčín 13.10.2024
- Dunajská Streda – AS Trenčín 22.3.2025

Table No. 4 Record sheet from the matches Dunajská Streda – AS Trenčín

					Ked oscenoval kam hral	
					Dopredu	Dozadu
		Celkový počet Scannou	Celkový počet prihrávok ktoré dostal	počet prihrávok pred ktorými oskenoval	Úspešný / Neúspešný	Úspešný / Neúspešný
Hráč č. 1	**1. polčas**					
	2. polčas					
	Spolu					
Hráč č. 2	**1. polčas**					
	2. polčas					
	Spolu					
Hráč č. 3	**1. polčas**					
	2. polčas					
	Spolu					
Hráč č. 4	**1. polčas**					
	2. polčas					
	Spolu					

We watched individual players in two matches. Both matches took place at the academy in Dunajská Streda. We monitored the frequency of head turns of the players above 45 degrees. We also watched how many times individual players were passed by their teammates. If the player turned his head above 45 degrees before the pass, we watched what happened afterwards. Whether he played forward or backward and whether he was successful or unsuccessful. We rated it as successful when a player made a good pass to a teammate, finished a shot with a goal, was fouled by an opponent, or the opponent took the ball away from him so that the ball left the playing area and his team had the ball. We assessed as unsuccessful when a player made a bad pass to a teammate, did not finish the shot with a goal, the opponent took the ball away from him without breaking the rules, or the ball left the playing area and the other team had the ball.

3.5 METHODS OF PROCESSING AND EVALUATION OF THE DATA OBTAINED

Quantitative statistical methods were used to process and analyze the data obtained during the research in order to objectively evaluate changes in player performance between two time periods (t_0 and t_1). All calculations and visualizations were carried out using tools suitable for research data processing.

Descriptive statistics were used as the basic form of analysis to summarize the data. For each player, as well as for each variable, the means, medians, and standard deviations for the

values recorded at time t_0 and t_1 were calculated. This approach allowed for a simple comparison of pre- and post-intervention performances.

The difference between t_0 and t_1 was calculated for each player and each variable, which provided information about the direction and extent of the change. Subsequently, this difference was also expressed as **a percentage**, which increased the clarity of interpretation of the practical significance of changes in the data.

To verify the statistical significance of the differences between t_0 and t_1, we first used **the Shapiro-Wilk test**, which aimed to verify that the differences between the values of t_1 and t_0 are normally distributed. This step was necessary to select the appropriate follow-up test. If the normality assumption was met ($p > 0.05$), the parametric **pair t-test was continued**. It was used to compare the average performance values before (t_0) and after (t_1) training intervention with repeatedly measured data from the same players.

To better understand the practical significance of the differences between the periods t_0 and t_1, **the Cohen d calculation was also used**, which is a measure of the magnitude of the effect independent of statistical significance. This indicator quantifies how significant the change in performance was after the intervention, taking into account the dispersion of the data. This makes it possible to assess whether the observed changes are also of real significance in the context of sports performance, even in cases where the sample size is smaller.

The visual side of the analysis was complemented by **box fences** and bar graphs, which clearly illustrated the development of the performance of individual players and the differences between t_0 and t_1.

4 OUTCOMES

In this part of the diploma thesis, we focus on the analytical evaluation of the performance of four football players who participated in testing in a simulated training environment (SIMUST) and were also monitored in two competitive matches. The aim of the analysis is to assess whether there was an improvement in spatial perception (scanning), post-scan decision-making and overall game performance between the two time periods marked as t_0 and t_1.

4.1 SIMUST

The SIMUST- "Scan preference" test was focused on the player's ability to identify relevant visual stimuli and react correctly in time-limited situations. The player was tasked with passing 10 times to the back of the field in a small goal next to the red player on the display in a position asking for the ball to run, while the evaluation took place on a scale from 0 to 2 points. In total, the player could get 20 points. By comparing the results in t_0 and t_1, the effect of cognitive training can be evaluated. The players took the test at two time points, allowing a comparison of performance before and after the SIMUST intervention.

Table 5 Results of the SIMUST- "Scan preference" test at time t_0

t_0	1		2		3		4		5		6		7		8		9		10		Súčet bodov
Hráč č. 1	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	1	X	X	1	2	X	X	0	1	X	X	0	X	1	1	X	X	0	2	X	9
Hráč č. 2	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	1	X	X	2	1	X	X	1	0	X	X	2	X	1	1	X	X	2	1	X	12
Hráč č. 3	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	1	X	X	0	0	X	X	0	1	X	X	1	X	0	2	X	X	0	0	X	5
Hráč č. 4	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	0	X	X	1	1	X	X	0	0	X	X	0	X	1	2	X	X	1	2	X	8

The SIMUST- "Scan preference" test result table at time t_0 indicates the baseline level of players' ability to effectively perceive space before receiving the ball and make the right decisions. The results are highly variable between individual players, whereby:

- Player 2 scored the highest number of points (12), which indicates the ability to identify players in space in time and orient themselves in the game situation.

- Player 3 scored only 5 points, which may indicate a lower level of anticipation and a problem with orientation in space before receiving the ball.

In general, the results indicate room for improvement, especially in the area of quick visual perception and decision-making – players often reacted late or chose a less optimal option.

Table 6 Results of the SIMUST- "Scan preference" test at time t_1

t_1	1		2		3		4		5		6		7		8		9		10		Súčet bodov
Hráč č. 1	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	1			2	2			2	2			2		1	1			2	1		16
Hráč č. 2	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	2			1	2			2	2			2		2	1			1	2		17
Hráč č. 3	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	2			0	1			2	1			1		0	2			2	2		13
Hráč č. 4	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	Ľ	P	
	1			0	1			2	2			1		1	2			2	1		13

The results of the SIMUST- "Scan preference" test at time t_1 clearly indicate the progress in the performance of all evaluated players. Compared to the initial t_0 status, the number of points for each player has increased, which confirms the positive impact of systematic cognitive training. Concretely:

- Player 2 once again achieved the highest score (17 points), confirming his stable performance and ability to make effective decisions in simulated game situations.
- Players 3 and 4, who had a weaker score in t_0 (5 and 8 points), improved significantly (both 13 points), which is a sign of improvement in space scanning and choosing the appropriate solution.

The results from t_1 are proof of the effectiveness of the SIMUST training program and its potential to support the development of player thinking, anticipation and perception of free space.

4.1.1 Verification of the normality of differences – Shapiro-Wilk test

To verify whether it is possible to use a parametric test to compare the results of the SIMUST-„ Scan preference test between two time periods t_0 and t_1, the Shapiro-Wilk normality test was used. We applied this test to the differences between the t_1 and t_0 values for each player. The test results showed that the differences were normally distributed ($p > 0.05$) and therefore we were able to proceed with the paired t-test.

4.1.2 Paired t-test – comparison of SIMUST results (t_0 vs t_1)

Table 7 Comparison of results – paired t-test

Statistics	Value
Number of players	4
Degree of freedom (df)	3
Test statistics (t)	8,33
p-value	≈ 0.007
Decision	The difference is statistically significant ($p < 0.05$)

Based on the results of the Shapiro-Wilk normality test, the assumption of a normal distribution of differences was confirmed. For this reason, a paired t-test was used to evaluate the difference between t_0 and t_1. The results showed a statistically significant difference ($t = 8.33$, $df = 3$, $p \approx 0.007$), which confirms the positive effect of training.

From the point of view of player performance, a systematic improvement in the number of correct reactions within the test can be observed. This result suggests that systematic cognitive training in the SIMUST environment positively influenced the perception of space.

4.1.3 SIMUST Test Results – Descriptive Statistics

Table 8 Descriptive statistics of the SIMUST test - "Scan preference"

Variable	Diameter	Median	Standard deviation
SIMUST t_0 test result	8.50	8.50	2.87
SIMUST t_1 test result	14.75	14.50	1.71

The table shows us a comparison of the results of the SIMUST- "Scan preference" test between times t_0 and t_1. The average result increased from 8.5 to 14.75 points. Not only has there been an improvement in performance, but also a reduction in the variability of results, which can be seen in the standard deviation, which has dropped from 2.87 to 1.71.

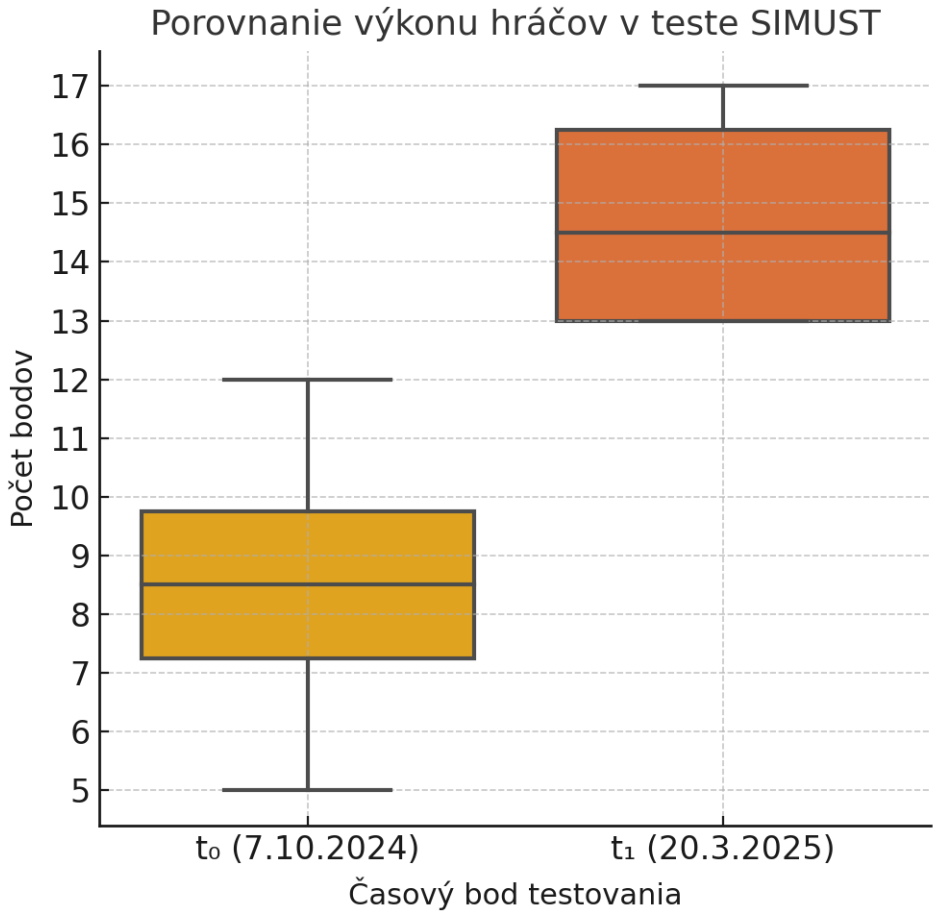

Figure 4 – Boxplot of SIMUST- "Scan preference" test results for four players at time t_0 and t_1.

The results of the SIMUST – "Scan preference" test at time t_0 and t_1 show a significant improvement in the ability of players to effectively scan space and make decisions under time pressure. The average number of points increased from 8.5 to 14.75, while the box fence also shows the shift in the median and the overall range of results. In addition, the variance of results has been narrowed, signaling a higher consistency of performance between individual players at time t_1. Cohen's d is 2.74, which confirms a very strong effect and clearly testifies to the positive impact of purposeful cognitive training through the SIMUST program on players' game decision-making.

4.1.4 Comparison of the results of individual players in the SIMUST test - "Scan preference"

Table 9 Comparison of SIMUST test results – Scan preference

Player	t0	t1	Difference	Percentage increase (%)
Player 1	9	16	7	77.78
Player 2	12	17	5	41.67
Player 3	5	13	8	160.0
Player 4	8	13	5	62.5

Comparison of SIMUST test results - "Scan preference"

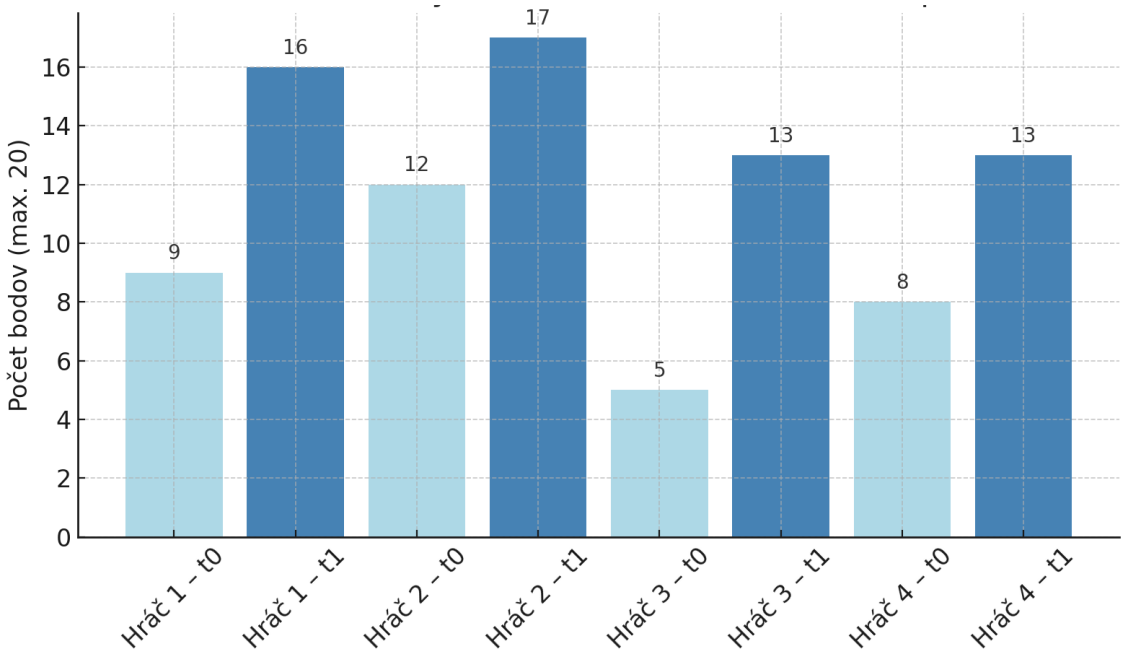

Figure 5 Comparison of SIMUST test results - "Scan preference"

The "Scan preference" test shows the clear progress of all four players between times t_0 and t_1, which is the result of regular cognitive training with SIMUST. All players completed more than 1000 minutes of specialized training units, which was reflected in the increase in their point score in the test.

The most significant percentage improvement was achieved by player 3 (from 5 to 13 points, +160%). Player 1 – the representative and the most experienced participant – confirmed a steadily growing performance (from 9 to 16 points, +77.78%). These results confirm the effectiveness of training in the SIMUST program in the development of decision-making and visual perception.

4.2 DAC – AS matches

Table 10 Results of the match at time t_0

t_0		Celkový počet Scannov	Celkový počet prihrávok ktoré dostal	počet prihrávok pred ktorými oskenoval	Ked oscenoval kam hral	
					Dopredu	Dozadu
					Úspešný / Neúspešný	Úspešný / Neúspešný
Hráč č. 1	**1. polčas**	224	8	4	1/1	2/0
	2. polčas	184	8	2	1/1	0/0
	Spolu	408	16	6	2/2	2/0
Hráč č. 2	**1. polčas**	157	11	3	2/1	2/1
	2. polčas	160	7	4	1/1	2/1
	Spolu	317	18	7	3/2	4/2
Hráč č. 3	**1. polčas**	168	9	5	1/2	2/0
	2. polčas	150	5	1	0/1	0/0
	Spolu	318	14	6	1/3	2/0
Hráč č. 4	**1. polčas**	159	10	3	0/1	2/0
	2. polčas	155	8	1	0/1	0/0
	Spolu	314	18	4	0/2	2/0

The match played at t_0 (13.10.2024) was the starting point for evaluating the level of visual scanning and decision-making of players before receiving a pass. The total number of scans for players ranged from 314 to 408, with player No. 1 recording the highest visual activity. The number of passes received by the players ranged between 14 and 18.

Scanning before receiving the ball has been used rather sporadically so far – players have scanned the space before 4 to 6 passes. Most of the solutions after the scan were either backwards or less efficient forwards. Player No. 2 was the most active in terms of scanning and progressive solutions (7 scanned passes, of which 3 were successful forwards), while player No. 4 solved exclusively backwards after the scan (2× successfully).

The t_0 data show that while players had a basic ability to scan and read the game, their solutions were often conservative, with low progressivity rates and variability in success. At the same time, it is the baseline before the introduction of targeted cognitive and perceptual preparation.

Table 11 Results of the match at time t_1

					Ked oscenoval kam hral	
					Dopredu	Dozadu
t_1		Celkový počet Scannov	Celkový počet prihrávok ktoré dostal	počet prihrávok pred ktorými oskenoval	Úspešný / Neúspešný	Úspešný / Neúspešný
Hráč č. 1	**1. polčas**	323	17	13	7/4	2/0
	2. polčas	331	7	6	4/1	1/0
	Spolu	654	24	19	11/5	3/0
Hráč č. 2	**1. polčas**	284	14	12	8/2	2/0
	2. polčas	244	8	6	1/1	2/2
	Spolu	528	22	18	9/3	4/2
Hráč č. 3	**1. polčas**	211	10	7	1/4	2/0
	2. polčas	248	11	8	3/3	2/0
	Spolu	459	21	15	4/7	4/0
Hráč č. 4	**1. polčas**	219	16	11	6/3	2/0
	2. polčas	195	6	4	0/3	1/0
	Spolu	414	22	15	6/6	3/0

In a match played at t_1 (22.3.2025), a significant improvement in player intelligence and decision-making can be clearly identified after the visual scann. The number of scans for all players has increased – most notably for player No. 1 (654), indicating higher engagement in the game. The number of passes received by the players was higher than in t_0 (21 to 24), which is related to their greater involvement in the game chain.

However, the most significant shift occurred in the number of passes before which players scanned – the values ranged from 15 to 19, which is more than double the t_0. Decision-making after the scan improved not only quantitatively, but also qualitatively. Player No. 1 dealt with 19 passes after scanning, 11× of which were successfully forward. Player No. 2 also achieved a high number of successful progressive solutions (9× ahead). Player No. 3 was more often unsuccessful (7 times), but he had a 100% success rate in backward solutions (4× successful), and also his number of passes before which he scanned the space increased significantly. Player No. 4 moved from a passive style to a balanced and efficient performance – 6 successful passes forward and 3 successful backwards.

This data proves that players have not only learned to scan more, but above all have improved in post-scan decision-making, especially towards the opponent's goal, confirming the effectiveness of the training process and the shift towards an active and progressive playing style.

4.1.1 Verification of the normality of differences – Shapiro-Wilk test

To verify the appropriateness of using parametric tests to compare the total number of scans and the number of passes scanned before in matches between times t_0 and t_1, we used the Shapiro-Wilk normality test. We applied this test to the differences between t_1 and t_0 for each player. The test result for the total number of scans was $p = 0.754$, which is higher than the significance level $\alpha = 0.05$. The test result for the number of passes he scanned before was $p = 0.683$, which is also above $\alpha = 0.05$. This means that the differences are normally distributed and we can use the paired t-test

4.1.2 Pair t-test – comparison of match results (t_0 vs t_1) – Total number of scans

Table 12 Comparison of results – paired t-test

Statistics	Value
Number of players	4
Degree of freedom (df)	3
Test statistics (t)	5,28
p-value	0,013
Decision	The difference is statistically significant ($p < 0.05$)

Based on the results of the paired t-test, it can be concluded that there was a statistically significant increase in the number of scans between times t_0 and t_1. The mean difference was positive, and the p-value = 0.013 indicates that the difference found is not random. The results show the positive impact of the training intervention on game attention and the ability to scan the field during the match.

4.1.3 Pair t-test – comparison of match results (t_0 vs t_1) – The number of passes he scanned before

Table 13 Comparison of results – paired t-test

Statistics	Value
Number of players	4
Degree of freedom (df)	3
Test statistics (t)	13,47
p-value	0,0009
Decision	The difference is statistically significant ($p < 0.05$)

Based on the results of the pair t-test, it can be concluded that there was a significant and statistically significant increase in the number of passes after the scan in the match between the periods t_0 and t_1. The result t = 13.47 and p = 0.0009 indicate a strong effect. This difference can be interpreted as a consequence of improved orientation of players in space and more effective decision-making following the use of scanning during match situations.

4.1.4 Match Test Results – Descriptive Statistics – Total number of scans

Table No. 14 Descriptive statistics of the total number of scans in the match

Variable	Diameter	Median	Standard deviation
Scanny t_0	339,25	317,5	45,86
Scanny t_1	513,75	493,5	104,60

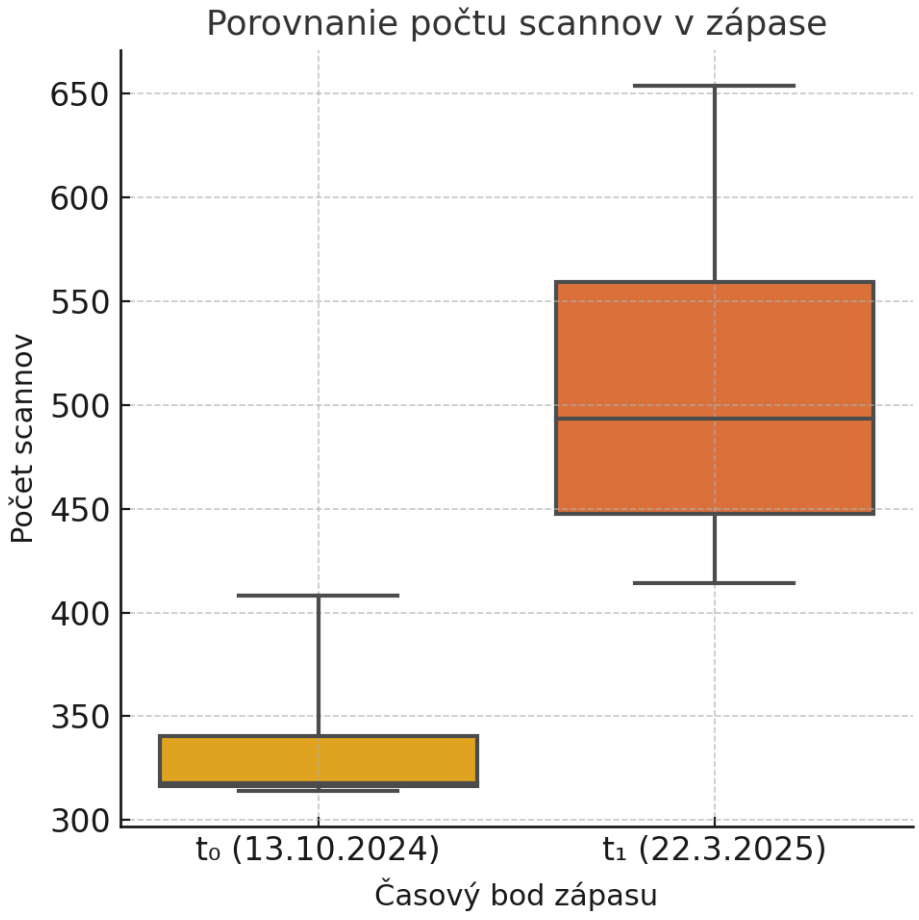

Figure 6 Boxplot of the total number of scanns in the match (t_0 vs t_1)

The number of player scans increased significantly between the t_0 and t_1 periods. From an average of 339.25 scans, the value increased to 513.75. The median increases by more than

170 scans. Although the variability (standard deviation) has increased slightly, the boxfence shows a clear increase in performance. A higher number of scans indicates greater player engagement in the game and a better perception of the space. Cohen's calculated d is 2.98, which confirms the very strong effect of training to increase the visual activity of players during the match.

4.1.5 Match Test Results – Descriptive Statistics – The number of passes he scanned before

Table No. 15 Descriptive statistics of passes after a scan in a match

Variable	Diameter	Median	Standard deviation
Po scanne t_0	5,75	6,0	1,26
After scanne t_1	16,75	16,5	1,89

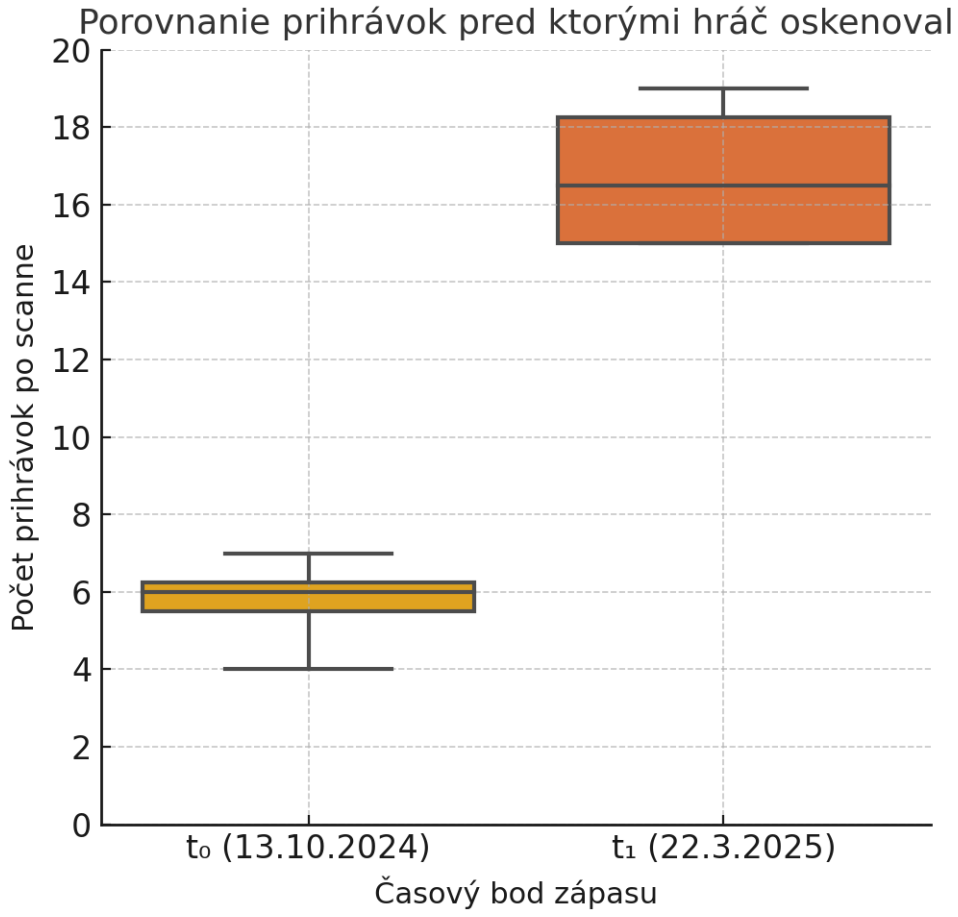

Figure 7 Boxplot of passes after scann in a match (t_0 vs t_1)

The analysis shows a significant improvement in the number of passes preceded by the scan. The average increased from 5.75 to 16.75 and the median from 6 to 16.5. This suggests that

players were more likely to use scanning as part of game decision-making in matches. Boxplot clearly illustrates this with both an increase in the lower quartile and an upward shift in the median. Cohen's calculated d is 3.96 which indicates an extremely large effect, which greatly supports the effectiveness of visual scanning in improving player resolve.

4.1.6Comparison of the results of individual players in matches

There was an approximately 5-month interval between the two matches watched, during which targeted training aimed at improving game indicators took place. Below are the results of the individual variables presented in a set order: Total number of scans, Total number of passes received by the player, Number of passes before which he scanned and then the game solutions of each player separately.

Table 16 Comparison of the results of the total number of Scanns

Player	t0	t1	Difference	Percentage increase (%)
Player 1	408	654	246	60.29
Player 2	317	528	211	66.56
Player 3	318	459	141	44.34
Player 4	314	414	100	31.85

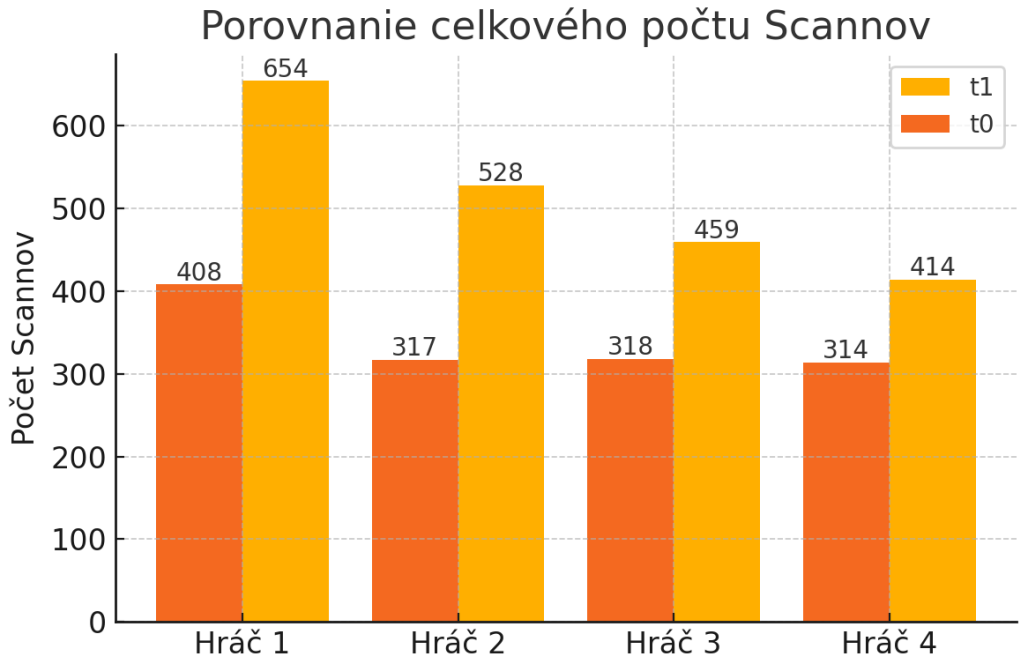

Figure 8 Comparison of the results of the total number of Scanns

The graph shows a comparison of the total number of scans performed by individual players in two different time periods. The results show a clear increase in all players. The highest

relative increase was recorded by player 2 (+66.56%), the smallest player 4 (+31.85%). An increase in visual scanning activity indicates an improvement in decision-making and perception of spatial orientation.

Table 17 Comparison of the results of the total number of passes

Player	t0	t1	Difference	Percentage increase (%)
Player 1	16	24	8	50.0
Player 2	18	22	4	22.22
Player 3	14	21	7	50.0
Player 4	18	22	4	22.22

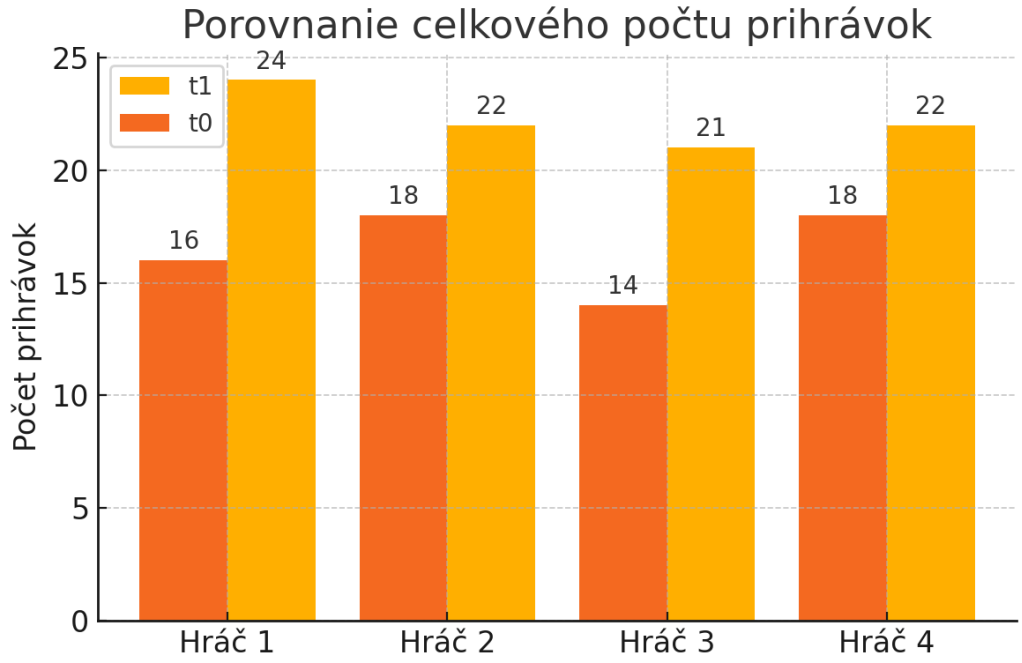

Figure 9 Comparison of the results of the total number of passes

Each player has seen an increase in the number of passes they have received. The largest absolute and percentage increases were achieved by players 1 and 3 (+50%). An increased number of received passes may indicate a player's greater involvement in game situations and trust on the part of teammates.

Table No. 18 Comparison of the results of the number of passes before which he scanned

Player	t0	t1	Difference	Percentage increase (%)
Player 1	6	19	13	216.67
Player 2	7	18	11	157.14
Player 3	6	15	9	150.0
Player 4	4	15	11	275.0

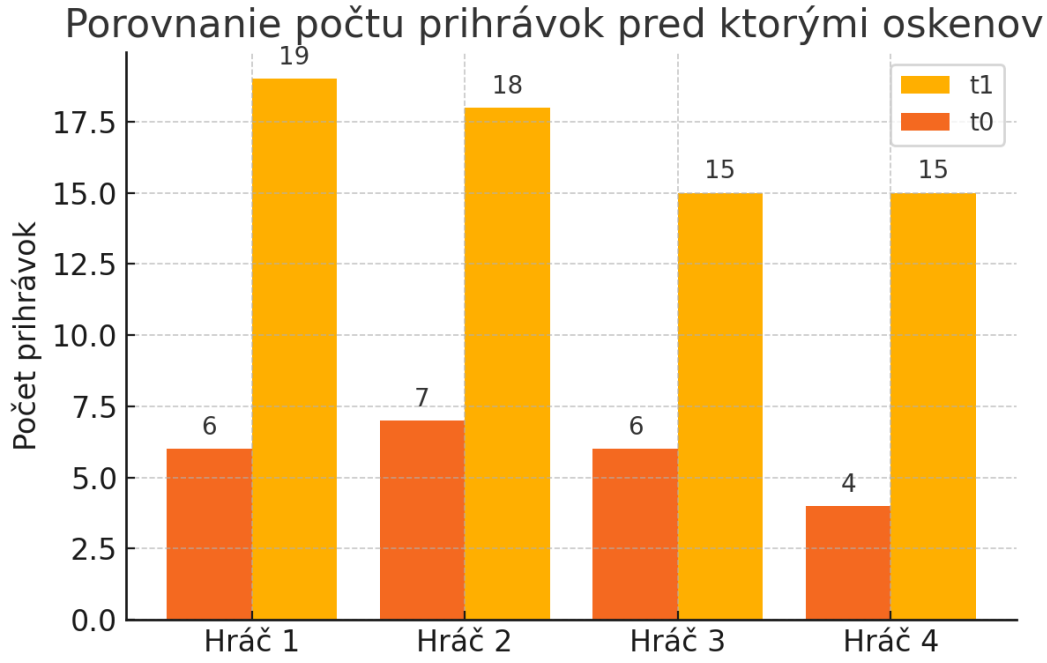

Figure 10: Comparison of the results of the number of passes before which he scanned

All players recorded a very significant increase in the number of passes preceded by scanning. Although player 1 improved the most (from 6 to 19), player 4 had the highest relative increase (+275%). These data show that systematic training positively affected players' ability to prepare for game decisions.

Game Solutions After Scan – Player 1

Table 19 Player 1 – Comparison of the results of game solutions after the scan

Variable	t0	t1	Difference	Percentage increase (%)
Successfully moving forward	2	11	9	450.0
Unsuccessfully forward	2	5	3	150.0
Successfully backwards	2	3	1	50.0
Unsuccessfully backwards	0	0	0	100.0

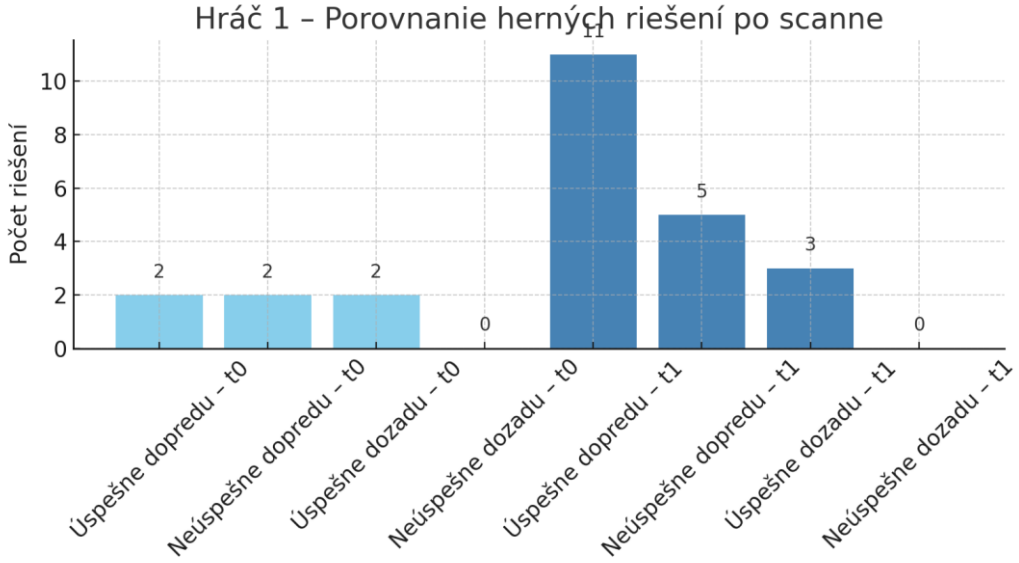

Figure 11 Comparison of the results of game solutions after scanning

Player 1 significantly improved forward solutions after scanning, from 2 to 11 successful passes (+450%). Increasing the number of failures forward corresponds to a more active approach. At the back, it remains reliable with a minimum of errors. The recording confirms the fulfilment of the game philosophy forward.

Game Solutions After Scan – Player 2

Table 20 Player 2 – Comparison of the results of game solutions after the scan

Variable	t0	t1	Difference	Percentage increase (%)
Successfully moving forward	3	9	6	200.0
Unsuccessfully forward	2	3	1	50.0
Successfully backwards	4	4	0	0.0
Unsuccessfully backwards	2	2	0	0.0

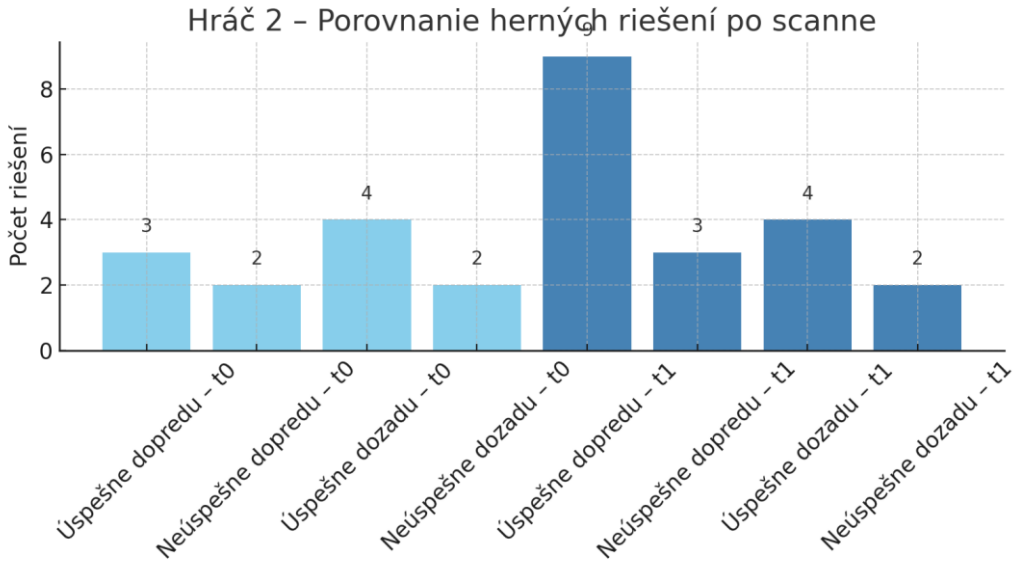

Figure 12 Comparison of the results of game solutions after the scan

Player 2 increased the successful solutions forward from 3 to 9 (+200%) and only slightly added in the unsuccessful ones. The solutions towards the rear have remained at the same level, which points to a consistent style. Moving forward is in line with the tactical goal.

Game Solutions After Scann – Player 3

Table 21 Player 3 – Comparison of the results of game solutions after the scan

Variable	t0	t1	Difference	Percentage increase (%)
Successfully moving forward	1	4	3	300.0
Unsuccessfully forward	3	7	4	133.33
Successfully backwards	2	4	2	100.0
Unsuccessfully backwards	0	0	0	100.0

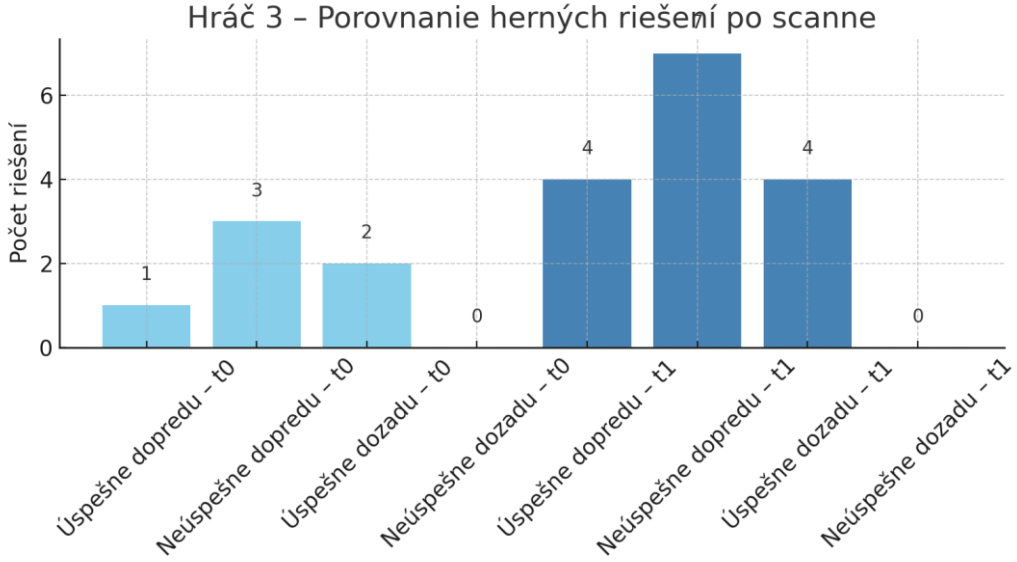

Figure 13 Comparison of the results of game solutions after the scan

Although player 3 also increased unsuccessful solutions forward (from 3 to 7), successful solutions increased from 1 to 4 (+300%), which means an overall improvement. Zero number of failures backwards shows security in decisions.

Game Solutions After Scann – Player 4

Table 22 Player 4 – Comparison of the results of game solutions after the scan

Variable	t0	t1	Difference	Percentage increase (%)
Successfully moving forward	0	6	6	100.0
Unsuccessfully forward	2	6	4	200.0
Successfully backwards	2	3	1	50.0
Unsuccessfully backwards	0	0	0	100.0

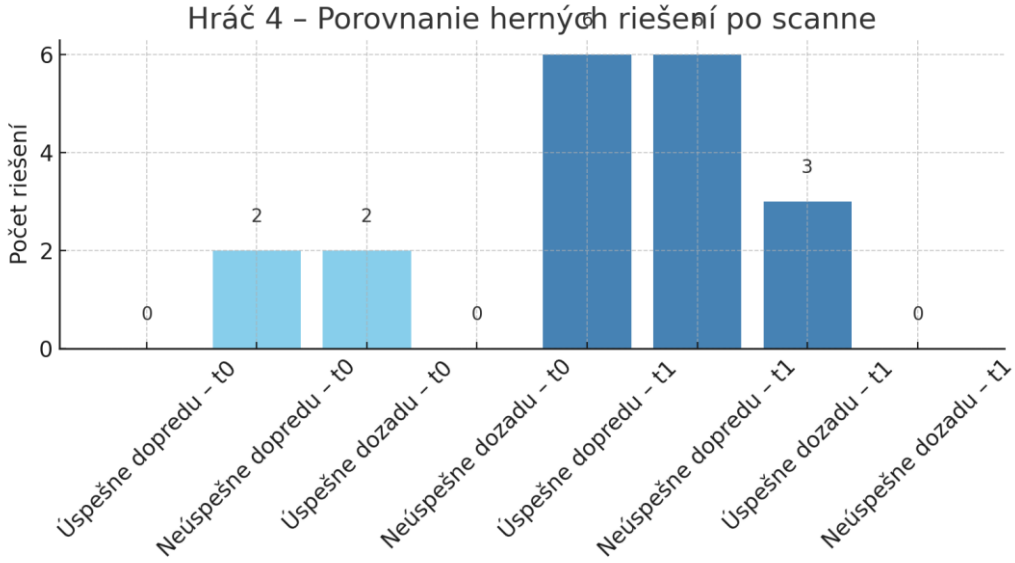

Figure 14 Comparison of the results of game solutions after the scan

Player 4 in T0 did not show any successful solution in advance, in T1 he had 6 of them. This shift is extremely positive and indicates progress in confidence and game courage. At the same time, he kept the zero number of unsuccessful ones behind, which underlines responsibility.

4.1.7 Conclusion on the evaluated results

The results of this part of the analysis show that changes in the training process during the five-month period had a positive impact on the game behavior of the monitored players. The increased number of scans and the increasing proportion of decisions preceded by scanning indicate improvements in sensitivity, readiness and tactical thinking.

The significant increase in successful solutions forward is an important sign that the players were able to combine visual control of the space with an effective offensive solution to the situation, which was one of the main goals of the coach's intervention. In the case of players who have also recorded a higher number of unsuccessful solutions up front, this is often the result of a bolder game, which is desirable in the context of an offensive strategy.

It is also interesting to observe that the solutions towards the back remained either stable or error-free, which points to the confidence and safety of the return pass. So the players did not try to avoid risk at all costs, but on the contrary, thanks to the scanning, they made more purposeful decisions.

In conclusion, it can be stated that systematic training focused on scanning and anticipation had a clearly measurable impact on the behavior of players in match practice.

5 DISCUSSION

The discussion represents a key space for a deeper interpretation of the results obtained and their significance in terms of game performance, cognitive development of players and the training process. In this diploma thesis, several variables were compared before and after the period of the training intervention, which also included the specialized program SIMUST. The results show significant changes in the number of scans, the number of passes before which the player scanned the space, as well as in the quality of game solutions after the scan. Significant changes were observed not only in match situations, but also in the special Scan Preference test.

Match observations showed a consistent increase in all monitored indicators. Players scanned more often, the number of passes before which they purposefully scanned the space increased, and at the same time the success rate of their decisions following this visual survey improved. However, a more detailed analysis of individual data revealed interesting nuances in the reactions of individual players to the SIMUST program. Player No. 1, for example, has made remarkable progress in terms of the quantity of scans performed (from 408 to 654 scans per match) and the quality of forward decision-making (from 2 to 11 successful solutions). On the contrary, player No. 4, who at the beginning of the research showed a tendency to play passively, later transformed into one of the most effective players of the team – as evidenced by the specific goal he scored a week after starting work with SIMUST. In the critical zone in front of the opponent's penalty area, he scanned the space before the key pass, which, by the way, he received from player No. 1, correctly evaluated his first touch with the ball based on the visual information obtained, and then accurately finished into the exposed part of the goal. This moment is a clear demonstration of the transfer of training principles to a real game situation. The player himself then took the initiative to contact the author of the thesis to express his belief that it was the purposeful scanning of the space that helped him react effectively at the decisive moment.

An interesting individual shift can also be observed on the example of player No. 1, who was not in the nomination of the Slovak national team under 15 years of age at the beginning of the research period. However, during the implementation of the SIMUST program, there was a significant improvement in his playing performance, which probably also contributed to his later selection for the national selection. Although we do not have direct evidence that SIMUST was the decisive factor, the player's development shows a link between improved

perceptual equipment and an increase in sports performance, which could also be noticed by the national team coach.

The implemented SIMUST program undoubtedly played a significant role in the observed improvement in the cognitive behavior of players. The program's founder, Siamak Azadi, conducted 2,691 individual tests based on eight years of extensive practice, which highlighted the common phenomenon of one-sided scanning and the lack of ability of players to identify multiple relevant targets in the gaming space. It is this area that the SIMUST program effectively focuses on. The results of the pilot studies, cited by Azadi (2025), showed a remarkable increase in 360° scanning by 65 to 100%, an increase in multi-target awareness by 45 to 100%, and an improvement in pass accuracy by up to 90%. These quantifiable data remarkably correspond with the results of the submitted diploma thesis, where statistically significant differences between the initial (t_0) and final (t_1) measurements were recorded in favor of the monitored group of players. The effectiveness of the SIMUST program probably lies in its comprehensive approach, which combines the theoretical foundations of the importance of visual scanning with practical exercises that simulate dynamic game situations. Repeated training scenarios, aimed at quickly identifying multiple tactical options and then making decisions under time pressure, could gradually optimize players' visual search strategies and improve their ability to efficiently process complex information from the game environment. Targeted feedback provided to players after each practice could also play an important role, allowing them to reflect on their decisions and gradually improve their scanning and decision-making procedures.

The importance of cognitive and perceptual skills in the context of football performance has long been an established area of scientific research. In his groundbreaking work, Jordet (2005) highlights the direct correlation between the frequency of space scans before receiving the ball and the quality of subsequent decision-making by players. His analysis of players playing in the Premier League showed that a higher frequency of scans correlates significantly with a higher success rate of implemented game solutions (Jordet, 2005). In a later study, this author confirmed that world-class elite footballers such as Lionel Messi and Andrés Iniesta performed scans on average every 2.0 to 2.5 seconds before receiving the ball, constantly creating a comprehensive and up-to-date picture of the spatial arrangement of the game (Jordet, 2015). The findings of the submitted diploma thesis are in line with these findings, as the training intervention led to a demonstrable increase in the frequency of scanning in the monitored players.

In their study, Roca et al. (2013) focused on investigating the relationship between perceptual-cognitive skills and decision-making in young footballers. Their research showed that players with a more developed level of perceptual skills showed higher accuracy of decisions and were able to react faster to dynamically changing game situations, which underlines the importance of systematic training in visual anticipation. In the context of our work, these conclusions are confirmed especially in the case of players No. 1 and No. 2, who recorded a clear shift in efficiency (from 4 and 7 to 14 and 13 successful) of their decisions following the scan.

In their extensive systematic review, Woods et al. (2020) confirmed that the ability to effectively perceive the game environment through active visual scanning is one of the key success factors in modern football. Their research also pointed to a frequent lack of young players in the area of paying adequate attention to the space behind their backs, which is directly addressed to one of the main goals of the SIMUST program – to support a comprehensive, 360-degree perception of the playing field.

Van Maarseveen et al. (2018) focused on the differences between elite and less experienced athletes in their analysis of visual search and decision-making in sports. Their findings suggest that elite athletes differ not only in the total number of scans performed, but also in their timing and expediency in the context of the game situation. In this context, the implementation of the SIMUST program can be considered a relevant and effective tool for a more targeted development of game thinking also in the U15 category.

In their work, Pérez and García-Calvo (2022) draw attention to the potential negative impact of cognitive load on the frequency and quality of scans in youth players. Their results indicated that in situations with higher cognitive difficulty, players tended to scan less frequently or with a delay. However, training units with an explicit emphasis on the development of perceptual control and anticipation, such as those implemented in the SIMUST program, have been proven to strengthen this key ability even in conditions of increased mental and physical pressure.

When evaluating the SIMUST program itself, it is important to note that the *Scan Preference test* is only one of its components. In practice, it is an extensive system with several training and testing modules. For example, it is possible to change the length of the display of visual stimuli – in this thesis, the setting was 3.5 seconds, but versions with a shorter length (e.g.

3.0 or 2.6 seconds) are also available, which allows you to increase the difficulty and practice the speed of processing visual information.

SIMUST also includes a number of practical exercises: players can train with a focus on only half of the pitch (180°), or more players are involved at once – even with defenders, simulating real match situations. Exercises can take place with players facing or back to the displays, increasing the complexity of cue processing. An example is the 2-on-1 exercise, where two players deal with scanning and decision-making in the presence of a defender, each working with 6 displays. (A drawing of the exercise can be found in Appendix 1.)

In the case of one-sided behaviour of the player, it is possible to create a variation of the *Scan Preference test using the SIMUST program*, in which the player is shown stimuli exclusively on one side – for example, the left side. This approach allows for the targeted development of the weaker side of game perception, which is of practical importance especially for players with automated one-sided habits.

The obtained results not only confirm the existing knowledge about the importance of cognitive and perceptual skills in football, but also provide valuable information on the effectiveness of the specific SIMUST training program in the context of youth football. The significant improvement in the number of scans, pre-pass scans and the quality of post-training decisions suggests that targeted training can significantly impact key aspects of game performance in a relatively short period of time. The case of player No. 4, who made remarkable progress and was able to transfer the learned skills to a real match situation, is a strong argument for the practical applicability of similar training methods. His spontaneous feedback on the perceived benefit of scanning at a crucial moment underscores the importance of internalizing these cognitive strategies in players.

It is interesting to think about how perceptual-cognitive skills training, such as SIMUST, can also affect other aspects of game performance that were not directly measured in this thesis. For example, improved perception of space and faster information processing could lead to better positional play, more effective pressing, or more successful anticipation of opponents' actions. Future research could focus on investigating these indirect effects of cognitive skills training on the complex game expression of young footballers.

In addition, it is important to place the findings of this work in the broader context of research in the field of sports science and cognitive psychology. The principles on which the SIMUST program is based, such as repeated exposure to stimuli, targeted attention and immediate

feedback, are in line with proven methods of cognitive skills development in other domains as well. For example, research on brain neuroplasticity confirms that repeated practice and learning of new strategies can lead to structural and functional changes in the brain, which may be one of the mechanisms behind the observed improvement in gamers.

In the context of training methodology, the implementation of programs such as SIMUST is an interesting addition to traditional fitness and tactical training methods. While fitness training focuses on the development of fitness parameters and tactical training to master game systems and principles, cognitive skills training focuses on optimizing mental processes, which are key for intelligent and effective game decisions. Integrating all three of these components into a comprehensive training process seems to be the most progressive approach to the development of young footballers.

Another interesting aspect is the potential for individualization of cognitive ability training. Different players may have different strengths and weaknesses in perception, attention, and decision-making. Diagnostic tools, such as the Scan Preference test used in this work, can help identify individual player needs and tailor the training program to target the areas in which players have the greatest reserves. Future research could focus on the development and validation of more sophisticated diagnostic tools and individualised training protocols for the development of cognitive skills in football.

In conclusion, from our point of view, there is a growing body of evidence about the importance of cognitive and perceptual skills for success in football. The implementation of specialized training programs such as SIMUST seems to be an effective way to develop these key skills in young players in a targeted manner. In the future, research should focus on a deeper understanding of the mechanisms of action of such programs, exploring their impact on a wider range of game aspects, and developing individualized training approaches that would maximize the potential of each player. Integrating cognitive skills training into the regular training process can represent a significant step forward in the development of smart and effective footballers of the future.

CONCLUSION

The aim of this diploma thesis was to determine the effectiveness of the experimental program SIMUST for the development of cognitive abilities of football players of AS Trenčín in the category up to 15 years of age. As part of our research, key match variables were monitored in two different time periods before and after the implementation of the program, and a specialized Scan Preference test was carried out, which enabled a more detailed quantification and analysis of the players' ability to effectively perceive the playing space and subsequently make decisions.

Our obtained results clearly showed a significant improvement in all monitored variables. After completing the SIMUST training program, the players demonstrated a higher frequency of scanning the space before receiving the ball, improved the ability to identify several relevant targets on the field and consequently increased the success rate of their decisions in the match. The case of player No. 1, who recorded performance progress during the research period and was subsequently included in the Slovak U15 national team, underlines the potential importance of perceptual training for individual sports growth.

In the special SIMUST Scan Preference test, a consistent shift towards better results was recorded for all participating players, which was reflected in an increase in the number of correct decisions. These observations clearly show that the SIMUST program is an effective tool for supporting a 360-degree perception of the game space, improving anticipation skills and accelerating and improving the selection of optimal game solutions under time pressure.

Based on a thorough analysis of our empirical data obtained, we can confidently confirm both originally established research hypotheses. The H1 hypothesis, assuming a statistically significant increase in the number of scans performed by players during match matches after the implementation of the training program, was unequivocally confirmed. The H2 hypothesis was also confirmed, which concerned a significant improvement in the performance of players in a specialized Scan Preference test after completing a training intervention. At the same time, these findings remarkably correspond with the conclusions of several relevant international researches, which consistently emphasize the key importance of developed visual perception and effective cognitive decision-making in the context of modern football at all levels.

Our work represents a valuable basis for further scientific research of the complex issue of cognitive abilities in football, with a special focus on the critical period of the development

of youth categories. At the same time, it points out in an innovative way the significant potential of connecting modern technologies and specialized training methods in real conditions of Slovak football clubs. The SIMUST program has proven to be an effective tool not only for testing, but also for the practical development of players. Its variability – including the ability to vary the length of the visual stimulus, the scanning range (180°/360°), one-sided aiming, and the involvement of players in different positions (back, front, with the defender, in small groups) – allows for a high degree of individualization and progressive loading. This type of training develops key cognitive components of the game that are often neglected by conventional training units. The use of this program could be successfully extended to other age groups and football clubs in Slovakia, which would significantly support the overall growth of the quality of play and the mental readiness of our players.

We consider the fact that this is the first diploma thesis in Slovakia, which was devoted to the use of the SIMUST system in sports, to be particularly important. The SIMUST facility is currently the only one of its kind in the country, which makes this work groundbreaking and opens up new research and application possibilities.

At the same time, some limits of the work must be admitted – especially the limited number of monitored players and the short duration of the research intervention. In the future, it is therefore recommended to expand the research to a larger sample of players, include different age categories, compare the impact depending on the game position and monitor the sustainability of positive changes in the longer term. An interesting perspective would also be to compare SIMUST with other forms of perceptual and cognitive training, including digital games and VR simulations.

From a personal point of view, the intensive work on this diploma thesis allowed us not only to understand more deeply the complex dynamics of the mental side of football performance, but also to directly apply the acquired theoretical knowledge in the real training process. We believe that this experience will continue to be a significant benefit for us in our future coaching and professional activities.

Recommendations for practice:

Based on the findings of our diploma thesis, it is possible to formulate the following specific recommendations for football coaches and methodologists working with youth:

- **Implementation of training programs aimed at developing cognitive skills:** Our results clearly demonstrated the positive impact of the SIMUST program on the cognitive and perceptual skills of young footballers. It is recommended to consider including similar specialized programs or their elements in regular training units.
- **Emphasis on visual scanning in the training process:** Coaches should purposefully guide players to constantly and efficiently scan the area before receiving the ball and during the game. Exercises focused on peripheral vision, quick recognition of game situations and identification of free spaces and teammates can be used.
- **Use of technological tools:** The SIMUST program is an example of the effective use of technology in football training. It is recommended to look for and implement other technological solutions that can help in the development of players' cognitive and perceptual skills (e.g. special software, VR simulations).
- **Regular testing and monitoring of cognitive abilities:** To effectively track progress and adjust the training process, it is advisable to regularly test the cognitive abilities of players using appropriate diagnostic tools, such as the Scan Preference test.
- **Integrating cognitive training into tactical exercises:** Instead of training cognitive skills in isolation, it is more effective to integrate their development directly into tactical exercises and model games. Players should be constantly encouraged to make quick decisions under pressure and to use the information obtained by scanning the space.
- **Training of trainers in the field of cognitive training:** For the successful implementation of cognitive development methods, it is crucial that trainers have adequate knowledge and skills in this area. It is recommended to organize seminars and workshops focused on cognitive training in football.
- **Individual approach to cognitive development:** Different players have different strengths and weaknesses in the field of cognitive abilities. It is recommended to pay attention to the individual needs of players and adapt the training process to focus on their development areas.

- **Expansion of research in this area** – it is recommended to support other research diploma theses that will deal with the effectiveness of different types of exercises in SIMUST, comparison between positions (defender vs. attacker) or long-term monitoring of results.

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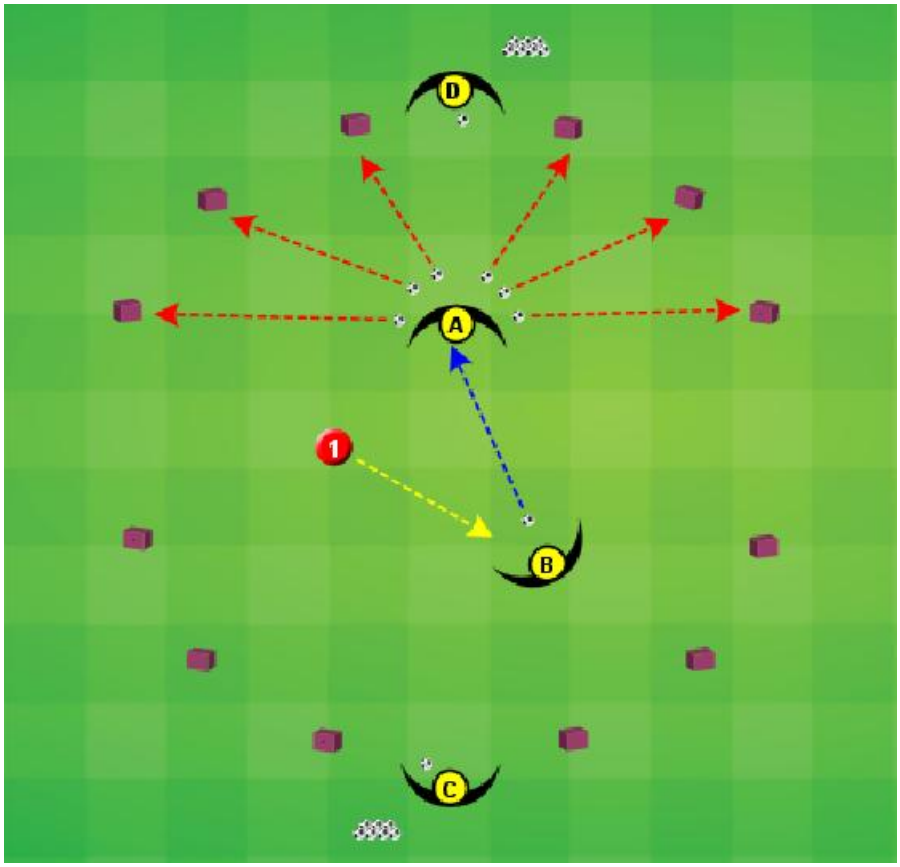
ANNEX

ANNEX 1



Player B passes to player A, who has scanned all 6 displays behind his back. After evaluation, he takes the ball to the correct display and passes the ball against the passing board under the display. At that moment, he is attacked by a defender (red player 1), who tries to take the ball away from him. The task of player A, after bouncing the ball off the passing board, is to take the ball so that the defender does not take it away from him and to pass the ball back to player B. Subsequently, player B performs exactly the same as player A.