

GUILHERME FIGUEIREDO MACHADO

**CONTRIBUTOS DA AVALIAÇÃO E DO TREINAMENTO PARA O
DESENVOLVIMENTO DA TOMADA DE DECISÃO NO FUTEBOL**

Tese apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Educação Física, com cotutela do Programa de doutorado em Pesquisa em Humanidades, Artes e Educação da Universidad de Castilla-La Mancha, no cumprimento parcial dos requisitos para obtenção do título de *Doctor Scientiae*.

Orientadores: Israel Teoldo da Costa
Sixto González-Víllora

**VIÇOSA - MINAS GERAIS - BRASIL
2022**

**Ficha catalográfica elaborada pela Biblioteca Central da Universidade
Federal de Viçosa - Campus Viçosa**

T

M149c
2022 Machado, Guilherme Figueiredo, 1992-
Contributos da avaliação e do treinamento para o
desenvolvimento da tomada de decisão no futebol / Guilherme
Figueiredo Machado. – Viçosa, MG, 2022.
1 dissertação eletrônica (202 f.): il.

Texto em português e inglês.

Orientador: Israel Teoldo da Costa.

Tese (doutorado) - Universidade Federal de Viçosa,
Departamento de Educação Física, 2022.

Referências bibliográficas: f. 20-21.

DOI: <https://doi.org/10.47328/ufvbbt.2023.120>

Modo de acesso: Word Wide Web.

1. Futebol - Treinamento técnico - Avaliação. 2. Futebol -
Jogos - Avaliação. 3. Testes de habilidades cognitivas. 4. Futsal -
Treinamento técnico - Avaliação. 5. Futebol feminino -
Treinamento técnico - Avaliação. I. Costa, Israel Teoldo da,
1980-. II. Universidade Federal de Viçosa. Departamento de
Educação Física. Programa de Pós-Graduação em Educação
Física. III. Título.

CDD 22. ed. 796.33422

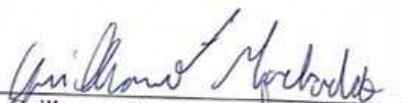
GUILHERME FIGUEIREDO MACHADO

**CONTRIBUTOS DA AVALIAÇÃO E DO TREINAMENTO PARA O
DESENVOLVIMENTO DA TOMADA DE DECISÃO NO FUTEBOL**

Tese apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Educação Física, com cotutela do Programa de doutorado em Pesquisa em Humanidades, Artes e Educação da Universidad de Castilla-La Mancha, no cumprimento parcial dos requisitos para obtenção do título de *Doctor Scientiae*.

APROVADA: 15 de dezembro de 2022.

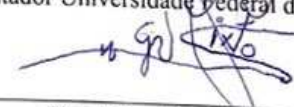
Assentimento:



Guilherme Figueiredo Machado
Autor



Israel Teoldo da Costa
Orientador Universidade Federal de Viçosa



Sixto González-Villora
Orientador Universidad de Castilla-La Mancha

Dedico a Deus por me permitir ter todas as condições
necessárias para executar este projeto.

Dedico à minha família pelo apoio incondicional e por
compartilharem este sonho comigo.

Dedico aos meus amigos por fazerem desta trajetória um
caminho mais agradável.

Dedico à comunidade do futebol que são a motivação para
início e fim deste trabalho.

AGRADECIMENTOS

Primeiramente a Deus, por me permitir iniciar e seguir esta jornada, me dando força e foco nos momentos de dificuldade e colocando tantas pessoas maravilhosas que me deram sustentação ao longo da trajetória.

A minha mãe, Adalete, e meu pai, Rogério, por me apoiarem incondicionalmente na busca dos meus sonhos, sem medir esforços para isso, e me ensinarem os verdadeiros valores (humanos) da vida. Através deles aprendi o verdadeiro valor da educação, o investimento que sempre nos acompanhará.

A minha irmã, Luisa, e meu cunhado, Ramon, por me apoiarem nos momentos de dificuldade e serem incentivadores dos meus sonhos. Obrigado por serem fortaleza quando precisei! Obrigado, Lu, pela contribuição na minha formação, através do exemplo e das inúmeras vezes, que com muita paciência, esteve disponível para estudar comigo na infância. Sua amizade e companheirismo são ímpares para mim.

A minha irmã Marina. Obrigado, Ma, pelo exemplo constante de bondade e humanidade que você passa a todos ao seu redor e por ter sido sempre uma referência de disciplina e dedicação para mim. Sua forma de ser nos lembra que a vida pode ser mais leve.

A minha filha, Sofia, por todo o seu amor e carinho e por ser minha motivação diária para acreditar no dever de construirmos uma sociedade melhor do que à encontramos.

Ao vô Machado (*in memoriam*), por me ensinar que na vida “sucesso” é um substantivo que só funciona como sujeito simples e singular e que a excelência pode ser alcançada em qualquer área.

Aos amigos, que fizeram desta trajetória um caminho muito mais agradável de ser percorrido, nos lembrando que o que fica ao final são as relações que construímos.

A todos os membros do NUPEF que passaram pela minha trajetória ao longo desses anos e contribuíram para a minha formação.

Aos alunos da Especialização em Futebol da UFV, que auxiliaram na execução deste trabalho e enriqueceram as discussões ao longo do processo.

Aos clubes, dirigentes, comissões técnicas e jogadores que participaram do meu estudo. A disponibilidade e boa vontade de vocês foi fundamental para a execução deste projeto.

Ao programa de Pós-graduação em Educação Física da UFV/UFJF e seus membros, por viabilizarem a realização deste projeto.

A Universidade Federal de Viçosa, por toda sua estrutura e beleza que permitiram minha evolução acadêmica e admiração por esta instituição. Ao Departamento de Educação Física e aos professores que contribuíram para a minha formação ao longo de todos esses anos. Tenho orgulho de ter feito minha formação profissional com vocês.

Aos funcionários do Departamento de Educação Física, por toda a dedicação e cordialidade em nos atender. Gostaria de agradecer em especial à Rayanna, Maisa e Laila, que sempre atenderam às inúmeras solicitações com muita boa vontade e cordialidade.

A la Universidad de Castilla-La Mancha (UCLM) y la Facultad de Educación de Albacete y Cuenca, por toda su estructura que permitió mi evolución académica y el respeto por esta institución.

A los profesores, en especial Juan Carlos, y las personas que trabajan en la UCLM. A los doctorandos, en especial a Álvaro, Carlos, Eva, Jacob, Irene, Mercedes y Alberto. Vosotros han sido muy receptivos y cordiales durante toda mi estancia. Un agradecimiento especial a Alejandro y Pilar, que me acogieron como en una segunda casa en España.

A los clubes de España: Conquense, FC Cartagena, Madrid CFF, Leganés y a las personas que los representan: Sergio Blanco, Javi Madrid y todos sus profesionales que nos apoyaran. Un agradecimiento especial a Pilar Sainz de Baranda y Henrique que me han recibido muy bien en Cartagena/Murcia.

Aos professores convidados à participaram da banca de qualificação e de defesa desta tese, Juan Carlos, Filipe Casanova, Filipe Clemente, José Afonso, e Varley. Obrigado por dedicarem seu tempo na avaliação e contribuição para este trabalho. As contribuições de vocês foram valiosas para a qualificação deste trabalho!

Ao Sixto, pela coorientação, amizade e pela recepção fantástica que tive na Espanha. Me senti em casa! Agradeço pelo tempo dedicado no âmbito pessoal e profissional, por fornecer as melhores condições de trabalho possível na UCLM e por contribuir para minha formação nesse período de estância em Albacete. Que essa relação e amizade só se fortaleçam com o tempo.

Ao Israel, pela orientação, amizade, oportunidades e pelos inúmeros conselhos que recebi ao longo da minha trajetória. Obrigado por sempre acreditar no meu potencial e investir seu tempo na minha formação. Que os próximos anos sejam ainda mais profícuos nos âmbitos profissional e pessoal.

Agradeço também às agências de fomento que possibilitaram a realização deste trabalho. O presente trabalho foi realizado com apoio da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Código de Financiamento 001. Este estudo também foi financiado pela Lei de incentivo ao Esporte do Governo de Minas Gerais, pelo Programa

Academia & Futebol do Ministério da Cidadania, através da Secretaria Nacional de Futebol e Defesa dos Direitos do Torcedor, pela FAPEMIG, CNPQ, FUNARBE e pela PPG, CCB e Reitoria da Universidade Federal de Viçosa. A Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), pela concessão da bolsa de estudos durante o período de doutorado no Brasil e também do período sanduíche na Espanha.

“Tente deixar o mundo melhor do que o encontrou”

“Try and leave this world a little better than you found it”

(Baden-Powell)

RESUMO

MACHADO, Guilherme Figueiredo, Universidade Federal de Viçosa, dezembro de 2022. **Contributos da avaliação e do treinamento para o desenvolvimento da tomada de decisão no futebol.** Orientador UFV: Israel Teoldo da Costa. Orientador UCLM: Sixto González-Víllora.

Esta tese teve como objetivo compreender e propor melhorias nos processos de desenvolvimento da capacidade de tomada de decisão no futebol relacionados à avaliação e ao treinamento. Para isso, ela foi composta por seis estudos e os seus objetivos foram: 1) verificar através de uma revisão de escopo o efeito da vivência prévia em atividades relacionadas ao futebol e o efeito de intervenções (de campo e laboratório) na capacidade de tomada de decisão de jovens e adultos praticantes de futebol do sexo masculino e feminino; 2) analisar se jogadoras brasileiras de futebol profissional com diferentes níveis de tomada de decisão podem ser diferenciadas a partir da vivência prévia em atividades relacionadas ao futebol e futsal durante seu desenvolvimento e discutir qual foi a trajetória esportiva que mais contribuiu para o desenvolvimento da capacidade de tomada de decisão; 3) verificar a relação entre a vivência prévia em atividades relacionadas ao futebol e futsal com a qualidade e velocidade da tomada de decisão em diferentes fases do desenvolvimento esportivo de jogadoras de futebol profissional de elite; 4) verificar a influência de 25 sessões de treinamento baseadas nos princípios táticos fundamentais e em jogos reduzidos sobre o desenvolvimento da tomada de decisão perceptivo-cognitiva e perceptivo-motora de jogadores de futebol de base de elite; 5) verificar se a capacidade de tomada de decisão diferencia jogadores selecionados e não selecionados em programas de desenvolvimento de talentos no futebol de base de elite do Brasil; e 6) comparar a vivência prévia em atividades relacionadas ao futebol durante a infância e adolescência entre jogadores de futebol de base de elite do Brasil e Espanha e discutir qual trajetória esportiva caracteriza o desenvolvimento esportivo no futebol de elite do Brasil e Espanha. Considerando o primeiro objetivo, verificou-se que o envolvimento em atividades específicas de futebol, como a prática deliberada e o jogo deliberado desde a infância, é essencial para desenvolver habilidades de tomada de decisão, e intervenções de campo como a abordagem baseada em jogos podem desenvolver alguns comportamentos da tomada de decisão em diferentes contextos (escolar, clubes de futebol e jogadores universitários). Em relação ao segundo objetivo, verificamos que em cada período avaliado (infância, início da adolescência e final da adolescência), as atletas com melhor tomada de decisão acumularam mais tempo

percentual de sua participação em atividades de prática deliberada, em comparação com o grupo de baixa tomada de decisão e a trajetória de diversificação especializado caracterizou a participação no esporte durante a infância. Para o terceiro objetivo, verificamos que a prática deliberada no futebol e no futsal, especialmente durante a infância e início da adolescência, está relacionada a uma melhor qualidade da tomada de decisão, enquanto o jogo deliberado no futebol, principalmente na infância e no início da adolescência, está relacionado a uma capacidade de tomada de decisão mais rápida. Considerando o quarto objetivo, concluímos que 25 sessões de treinamento baseadas nos princípios táticos fundamentais e em jogos reduzidos e condicionados, melhoraram as habilidades perceptivo-cognitivas relacionadas ao tempo de tomada de decisão e às habilidades perceptivo-motoras de tomada de decisão. Em relação ao quinto objetivo, verificamos que os jogadores selecionados pelos clubes de futebol de elite no Brasil possuem melhores habilidades de tomada de decisão em relação ao tempo e a qualidade que decidem em comparação com os não selecionados. Por fim, para o sexto objetivo, verificamos que os jogadores de futebol masculino de elite sub-18 espanhóis e brasileiros foram diferenciados pela idade de início no envolvimento de diferentes atividades no futebol e pela participação em atividades de treinamento durante a infância e início da adolescência. A trajetória esportiva durante a infância dos jogadores de futebol masculino na Espanha foi caracterizada pela trajetória de engajamento precoce, enquanto no Brasil foi caracterizada pela diversificação especializada.

Palavras-chave: Habilidades perceptivo-cognitivas. Leitura do jogo. Treinamento. Histórico esportivo. Identificação e desenvolvimento de talentos. Pedagogia do esporte. Prática deliberada. Jogo deliberado. Futsal. Futebol feminino.

RESUMEN

MACHADO, Guilherme Figueiredo, Universidade Federal de Viçosa, diciembre de 2022. **Contribuciones de la evaluación y el entrenamiento para el desarrollo de la toma de decisiones en el fútbol.** Director UFV: Israel Teoldo da Costa. Director UCLM: Sixto González-Víllora.

Esta tesis tiene como objetivo comprender y proponer mejoras en los procesos de desarrollo de la toma de decisiones en el fútbol relacionadas con la evaluación y el entrenamiento. Para ello, la tesis esta organizada por seis estudios y sus objetivos son: 1) verificar, mediante una revisión de escopo, el efecto de la experiencia previa en actividades relacionadas con el fútbol y el efecto de intervenciones (de campo y de laboratorio) sobre la capacidad de toma de decisiones de jugadores y jugadoras de fútbol jóvenes y adultos; 2) analizar si jugadoras brasileñas de fútbol profesional con diferentes niveles de toma de decisión pueden diferenciarse a partir de la experiencia previa en actividades relacionadas con el fútbol y el fútbol sala durante su desarrollo deportivo y discutir cuál fue la trayectoria deportiva que más contribuyó para el desarrollo de la capacidad de toma de decisión; 3) verificar la relación entre la experiencia previa en actividades relacionadas con el fútbol y el fútbol sala con la calidad y la velocidad de la toma de decisiones en diferentes fases del desarrollo deportivo de jugadoras de fútbol profesional de élite; 4) verificar la influencia de 25 sesiones de entrenamiento basadas en principios tácticos fundamentales y juegos reducidos en el desarrollo perceptivo-cognitivo y perceptivo-motor de la toma de decisión de jóvenes jugadores de fútbol de élite masculinos; 5) verificar si la capacidad de toma de decisiones diferencia a los jugadores seleccionados y no seleccionados en los programas de desarrollo de talentos del fútbol de élite masculino en Brasil; y 6) comparar la experiencia previa en actividades relacionadas con el fútbol durante la infancia y la adolescencia entre jugadores de fútbol de élite de Brasil y España y discutir qué trayectoria deportiva caracteriza el desarrollo deportivo en el fútbol de élite en Brasil y España. Considerando el primer objetivo, encontramos que la participación en actividades específicas del fútbol, como la práctica deliberada y el juego deliberado desde la infancia, es esencial para desarrollar las habilidades de toma de decisiones, y las intervenciones de campo como el enfoque basado en el juego pueden desarrollar algunos aspectos de la toma de decisiones en diferentes contextos (escuela, clubes de fútbol y jugadores universitarios). En cuanto al segundo objetivo, encontramos que en cada periodo evaluado (infancia, inicio de la adolescencia y final de la adolescencia), las jugadoras con mejor toma de decisiones acumularon más tiempo

porcentual de su participación en actividades de práctica deliberada en comparación con el grupo de baja toma de decisiones y la trayectoria de diversificación especializada caracterizó la participación en el deporte durante la infancia. Para el tercer objetivo, encontramos que la práctica deliberada en el fútbol y el fútbol sala, especialmente durante la infancia e inicio de la adolescencia, está relacionada con una mejor calidad en la toma de decisiones, mientras que el juego deliberado en el fútbol, especialmente durante la infancia e inicio de la adolescencia, está relacionado con una capacidad de decisión más rápida. Considerando el cuarto objetivo, concluimos que 25 sesiones de entrenamiento basadas en los principios tácticos fundamentales y en juegos reducidos y condicionados, mejoraron las habilidades perceptivo-cognitivas relacionadas con el tiempo de decisión y las habilidades perceptivo-motoras de decisión. En relación con el quinto objetivo, verificamos que los jugadores seleccionados por los clubes de fútbol de élite en Brasil tienen mejor capacidad de decisión en cuanto al tiempo y la calidad que deciden en comparación con los jugadores no seleccionados. Finalmente, para el sexto objetivo, encontramos que los futbolistas masculinos de élite españoles y brasileños sub-18 se diferenciaban por la edad de inicio en la implicación en diferentes actividades futbolísticas y la participación en actividades de entrenamiento durante la infancia y la adolescencia temprana. La trayectoria deportiva durante la infancia de los futbolistas masculinos en España se caracterizó por una trayectoria de “compromiso temprano”, mientras que en Brasil se caracterizó por una diversificación especializada.

Palabras clave: Capacidades perceptivo-cognitivas. Lectura del juego. Entrenamiento. Historial deportivo. Identificación y desarrollo de talentos. Pedagogía del deporte. Práctica deliberada. Juego deliberado. Fútbol sala. Fútbol femenino.

ABSTRACT

MACHADO, Guilherme Figueiredo, Universidade Federal de Viçosa, December, 2022. **Contributions of evaluation and training for the development of decision-making skills in soccer.** Adviser UFV: Israel Teoldo da Costa. Adviser UCLM: Sixto González-Víllora.

This thesis aimed to understand and propose improvements in the development processes of decision-making skills in soccer related to evaluation and training. To this end, it was composed of six studies and its objectives were: 1) to verify through a scoping review the effect of previous experience in soccer-related activities and the effect of interventions (field and laboratory) on the decision-making skills of youth and adult male and female soccer players; 2) to analyze whether Brazilian professional soccer players with different levels of decision-making skills can be differentiated based on previous experience in soccer and futsal related activities during their development and to discuss which was the sport pathway that most contributed to the development of decision-making skills; 3) to verify the relationship between previous experience in soccer and futsal activities with the quality and speed of decision-making skills at different sport development phases of elite female professional soccer players; 4) to verify the influence of 25 training sessions based on core tactical principles and small-sided and conditioned games on the development of perceptual-cognitive and perceptual-motor decision-making skills in elite academy soccer players; 5) to verify if decision-making skills differentiates selected and non-selected academy soccer players in elite talent development programs in Brazil; and 6) to compare the previous experience in soccer-related activities during childhood and adolescence among elite academy soccer players from Brazil and Spain and discuss which sport pathway characterizes sport development in elite soccer in Brazil and Spain. Considering the first objective, we found that involvement in soccer-specific activities, such as deliberate practice and deliberate play from childhood, is essential to develop decision-making skills, and field interventions, such as the game-based approaches, can develop some behaviors of decision-making in different contexts (school, soccer clubs, and college players). In relation to the second objective, we found that in each period evaluated (childhood, early adolescence, and late adolescence), athletes with better decision-making skills accumulated more percentage time of their participation in deliberate practice activities compared to the low decision-making group and the specialized diversification pathway characterized sport participation during childhood. For the third objective, we found that deliberate practice in soccer and futsal, especially during childhood and early adolescence, is related to a better

quality of decision-making skills. In contrast, deliberate play in soccer, especially during childhood and early adolescence, is related to faster decision-making ability. Considering the fourth objective, we concluded that 25 training sessions based on core tactical principles and small-sided and conditioned games improved perceptual-cognitive skills related to decision-making time and perceptual-motor decision-making skills. Concerning the fifth objective, we found that players selected by elite soccer clubs in Brazil have better decision-making skills regarding the time and quality they decide than non-selected players. Finally, for the sixth objective, we found that Spanish and Brazilian elite U-18 male soccer players were differentiated by the age they started their involvement in different soccer activities and their participation in practice activities during childhood and early adolescence. The sport pathway during the childhood of male soccer players in Spain was characterized by the early engagement, while in Brazil, it was characterized by the specialized sampling pathway.

Keywords: Perceptual-cognitive skills. Game reading. Training. History profile. Talent identification and development. Sport pedagogy. Deliberate practice. Deliberate play. Futsal. Women's football.

LISTA DE FIGURAS

INTRODUÇÃO

Figura 1. Modelo de Desenvolvimento da Participação Esportiva (MDPE) (Adaptado de CÔTÉ; BAKER; ABERNETHY, 2007).	20
Figura 2. Modelos de desenvolvimento esportivo propostos para o futebol (Adaptado de FORD et al., 2009 e SIEGHARTSLEITNER et al., 2018).	22

CAPÍTULO 1

Figura 1. Flow chart of the methodology used for the article search based on the preferred reporting items for systematic review (PRISMA).	42
--	----

CAPÍTULO 3

Figura 1. Description of the core tactical principles assessed by the TacticUP® test: a) offensive; b) defensive (Source: Teoldo et al., 2022).	96
---	----

CAPÍTULO 4

Figura 1. Description of the core tactical principles assessed by the TacticUP® test: a) offensive; b) defensive (Source: Teoldo et al., 2022).	122
Figura 2. Exemplar planning and organization of a training activity based on the core tactical principles.	125

CAPÍTULO 5

Figura 1. Description of the core tactical principles assessed by the TacticUP® test: a) offensive; b) defensive (Source: Teoldo et al., 2022).	150
---	-----

CAPÍTULO 6

Figura 1. The average hours per year between 6 to 15 years of age in three soccer activities (play, practice, and competition) for a) Brazilian players; and b) Spanish players.	179
--	-----

LISTA DE QUADROS

CAPÍTULO 3

Quadro 1. Variables assessed with the Participation History Questionnaire	95
Quadro 2. Variables assessed with the decision-making test (TacticUP®)	98

CAPÍTULO 4

Quadro 1. Tactical principles taught, and training time per session.	127
---	-----

CAPÍTULO 6

Quadro 1. Variables assessed with the Participation History Questionnaire	175
---	-----

LISTA DE TABELAS

CAPÍTULO 1

Tabela 1. Studies with the main topic developmental activities.....	45
Tabela 2. Studies with the main topic intervention	47

CAPÍTULO 2

Tabela 1. Comparisons between high and low decision-making skill groups based on different types of soccer developmental activities	74
---	----

CAPÍTULO 3

Tabela 1. Spearman correlation between decision-making skills and accumulated hours in developmental activities in different stages	101
---	-----

CAPÍTULO 4

Tabela 1. Descriptive statistics and pairwise comparisons in analyses of quality of decision-making, decision-making time and tactical efficiency.....	129
--	-----

CAPÍTULO 5

Tabela 1. Descriptive statistics and pairwise comparisons analyses of quality of decision-making and decision-making time for each age group	152
--	-----

CAPÍTULO 6

Tabela 1. Comparisons between Brazilian and Spanish players on their milestones and sports developmental activities in childhood and early adolescence	177
Tabela 2. The statistical and descriptive analyses for the practice structure between Brazilian and Spanish players.....	180

LISTA DE ABREVIACÕES

3D MOT: *3D Multiple Object Tracking*.

CBF: Confederação Brasileira de Futebol.

CSDE: Conselho Superior de Esportes Espanhol.

DICP: *defensive principles inside the center of play*.

DMGAC: *didactic model game action competencies*.

DMSP: *Development Model of Sport Participation*.

DOCP: *Defensive principles outside the center of play*.

FIFA: Federação Internacional de Futebol.

FUT-SAT: Sistema de Avaliação Tática no Futebol.

GPET: *Game Performance Evaluation Tool*.

HS: *High skill*.

IBGE: Instituto Brasileiro de Geografia e Estatística.

LS: *Low skill*.

MCDE: Ministério Espanhol de Cultura e Esporte.

MDPE: Modelo de Desenvolvimento da Participação Esportiva.

OICP: *Offensive principles inside the center of play*.

OOCPP: *Offensive principles outside the center of play*.

PHQ: *Participation History Questionnaire*.

PRISMA: *Preferred Reporting Items for Systematic Reviews and Meta-Analyses*.

RFEF: Real Federação Espanhola de Futebol.

SSCG: *Small-sided and conditioned games*.

SSG: *Small-sided games*.

TGfU: *Teaching Games for Understanding*.

THE FA: Federação Inglesa de Futebol.

SUMÁRIO

INTRODUÇÃO GERAL	19
OBJETIVOS	33
CAPÍTULO I	34
ESTUDO 1: EFFECTS OF DEVELOPMENTAL ACTIVITIES AND INTERVENTIONS ON DECISION- MAKING SKILLS IN SOCCER PLAYERS: A SCOPING REVIEW	35
CAPÍTULO II	63
ESTUDO 2: CONTRIBUTION OF DELIBERATE PRACTICE, PLAY, AND FUTSAL TO THE ACQUISITION OF DECISION-MAKING SKILLS IN BRAZILIAN PROFESSIONAL FEMALE SOCCER PLAYERS	64
CAPÍTULO III	88
ESTUDO 3: THE RELATIONSHIP BETWEEN DELIBERATE PRACTICE, PLAY, AND FUTSAL IN CHILDHOOD AND ADOLESCENCE AND THE DEVELOPMENT OF DIFFERENT DECISION-MAKING SKILLS IN PROFESSIONAL FEMALE SOCCER PLAYERS.....	89
CAPÍTULO IV	114
ESTUDO 4: DEVELOPING COGNITIVE AND MOTOR DECISION-MAKING SKILLS THROUGH 25 SESSIONS OF TACTICAL PRINCIPLES AND SMALL-SIDED GAMES IN YOUTH SOCCER	115
CAPÍTULO V	142
ESTUDO 5: SELECTED SOCCER PLAYERS ARE QUICKER AND BETTER DECISION-MAKERS IN ELITE BRAZILIAN YOUTH ACADEMIES.....	143
CAPÍTULO VI	168
ESTUDO 6: TWO PATHWAYS IN ELITE YOUTH SOCCER: COMPARISON OF DEVELOPMENTAL ACTIVITIES IN SOCCER, FUTSAL, AND PRACTICE STRUCTURE BETWEEN BRAZIL AND SPAIN .	169
CONSIDERAÇÕES FINAIS	191

Introdução Geral

O desempenho no futebol depende da capacidade dos indivíduos de tomarem decisões eficientes, e que podem ser divididas em habilidades perceptivo-cognitivas e perceptivo-motoras, onde ambas contribuem para o desenvolvimento da expertise no esporte (MCPHERSON; KERNODLE, 2003; WILLIAMS; FORD; DRUST, 2020). As habilidades perceptivo-cognitivas podem ser consideradas aquilo que alguém é capaz de perceber e compreender, enquanto as habilidades perceptivo-motoras referem-se ao que se é capaz de perceber e fazer por meio do movimento (MATERNIUK, 1976; STARKES, J.; CULLEN; MACMAHON, 2004). Nesse contexto, a tomada de decisão pode ser definida como uma escolha de ação, e é um resultado que pode ser observado como uma resposta motora ou verbal (BRUCE *et al.*, 2012; MACMAHON; MCPHERSON, 2009). A tomada de decisão também está associada à capacidade de leitura de jogo dos jogadores, que pode ser definida no futebol como a habilidade dos jogadores em perceberem e integrarem as informações em movimento no campo, incluindo a bola, companheiros de equipe, adversários, bem como as ações que eles executam (HARTIGH *et al.*, 2018; TEOLDO; GUILHERME; GARGANTA, 2021; WILLIAMS, 2000). Nesse contexto, o desenvolvimento da tomada de decisão no futebol depende de diferentes fatores, tais como a experiência prévia dos indivíduos na modalidade, a qualidade das vivências que tiveram ao longo da sua formação esportiva e a fase de desenvolvimento esportivo que se encontram (WILLIAMS; FORD; DRUST, 2020).

Trajetórias de desenvolvimento esportivo no futebol

Em relação às fases de desenvolvimento esportivo, o modelo teórico proposto por Côté e colaboradores (1999; 2007), conhecido como Modelo de Desenvolvimento da Participação Esportiva (MDPE) – ver figura 1 – tem sido amplamente utilizado no mundo para compreender o processo de formação esportiva em diferentes esportes, incluindo vários estudos no futebol (ERIKSTAD *et al.*, 2018; FORD *et al.*, 2020; HENDRY *et al.*, 2019). Além disso, esse modelo tem sido utilizado em pesquisas que buscam otimizar e direcionar políticas de investimento público para qualificar os sistemas de formação esportiva em diferentes países (CÔTÉ; VIERIMAA, 2014).

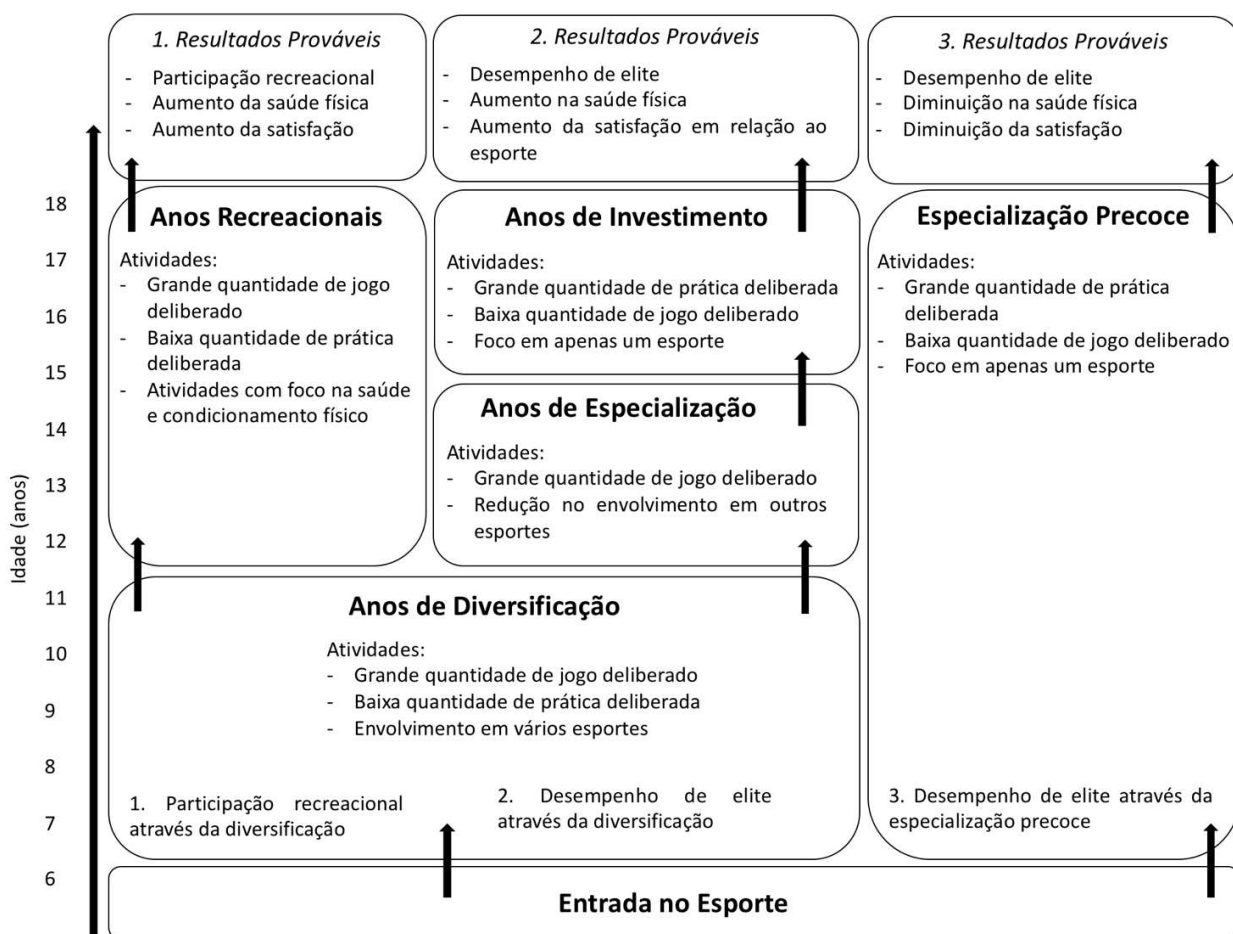


Figura 1. Modelo de Desenvolvimento da Participação Esportiva (MDPE) (Adaptado de CÔTÉ; BAKER; ABERNETHY, 2007).

Esse modelo teórico divide a formação esportiva em diferentes estágios, que são classificados em: i) anos de diversificação (6-12 anos de idade); ii) anos de especialização (13-15 anos de idade); iii) anos de investimento (a partir dos 16 anos de idade até à vida adulta); iv) especialização precoce (a partir dos 6 anos de idade até à vida adulta); e v) anos recreacionais (a partir dos 13 anos de idade até à vida adulta). Esses diferentes estágios, são caracterizados pelo tipo de atividades envolvidas na prática do(s) esporte(s), pela idade dos indivíduos e pelo número de esportes praticados. Os tipos de atividades são denominados de prática deliberada e jogo deliberado. A prática deliberada é caracterizada por atividades realizadas com o propósito de melhorar a performance (e não necessariamente de gerar satisfação) e requerem um alto esforço cognitivo e/ou físico, além de associarem-se positivamente ao desenvolvimento de determinadas habilidades (ex.: treinamento sistematizado com a equipe liderado pelo treinador) (ERICSSON; KRAMPE; TESCH-ROMER, 1993). Por outro lado, o jogo deliberado é caracterizado por uma forma de atividade esportiva intrinsecamente motivadora, que proporciona gratificação imediata, e que é projetada especificamente para maximizar a

satisfação na atividade (ex.: jogar futebol no parque com os amigos) (CÔTÉ, 1999).

Os estágios de participação deste modelo estão contidos nas diferentes “trajetórias esportivas”, que podem levar ao contexto recreacional ou ao alto rendimento. Os anos de diversificação são caracterizados pela grande participação em atividades de jogo deliberado (ex.: jogar futebol no parque com amigos), baixa participação em atividades de prática deliberada (ex.: treinamento sistematizado pelo treinador), além do envolvimento em diversos esportes (ex.: futebol, basquete, vôlei e handebol). Os anos de especialização têm como característica um equilíbrio entre o tempo de jogo deliberado e prática deliberada, além da redução do envolvimento em outros esportes. Já nos anos de investimento, há grande participação em atividades de prática deliberada, baixa participação em atividades de jogo deliberado e envolvimento limitado a apenas uma modalidade. Por fim, a especialização precoce é caracterizada pela grande participação em atividades de prática deliberada, baixa participação em atividades de jogo deliberado e o envolvimento em apenas um esporte, desde o início da prática esportiva, durante a infância. Já os anos recreacionais são marcados pela grande participação em atividades de jogo deliberado, baixa participação em atividades de prática deliberada e o envolvimento em atividades com foco na saúde e condicionamento físico.

Assim, o MDPE apresenta três possíveis trajetórias principais no esporte (ver figura 1), que são: i) participação recreacional, através da diversificação e do jogo deliberado; ii) participação no alto rendimento, através da diversificação e do jogo deliberado; e iii) participação no alto rendimento, através da especialização precoce e da prática deliberada. Além dessas trajetórias com fluxo vertical, o modelo também prevê oportunidades para movimentos horizontais (ex.: passar do estágio de investimento ao recreacional), permitindo que os indivíduos modifiquem seu nível de envolvimento no esporte, se assim desejarem.

A partir deste modelo, nos últimos anos pesquisadores de diferentes países se propuseram a investigar qual trajetória esportiva estava associada ao alcance de um alto desempenho no futebol, considerando especialmente os anos iniciais de formação (6-12 anos) (BAKER, J; CÔTÉ; ABERNETHY, 2003; FORD *et al.*, 2009; WARD *et al.*, 2007). Através desses trabalhos verificou-se que uma trajetória alternativa às propostas pelo MDPE estava presente no desenvolvimento esportivo de jogadores de futebol que alcançaram um desempenho de elite no futebol (ver figura 2). Essa trajetória alternativa, denominada de *engajamento precoce*, é caracterizada por um grande envolvimento no esporte principal (futebol) em atividades tanto de prática deliberada, quanto de jogo deliberado desde os anos iniciais de formação esportiva (6–12 anos), assim como por uma baixa diversificação (participação) em outros esportes (FORD *et al.*, 2009). Ou seja, essa trajetória esportiva defende que o envolvimento desde a infância em atividades de futebol de treinamento sistematizado, quando acompanhadas pelo acúmulo de vivências de jogo deliberado leva ao alcance de um maior desempenho no futebol futuramente.

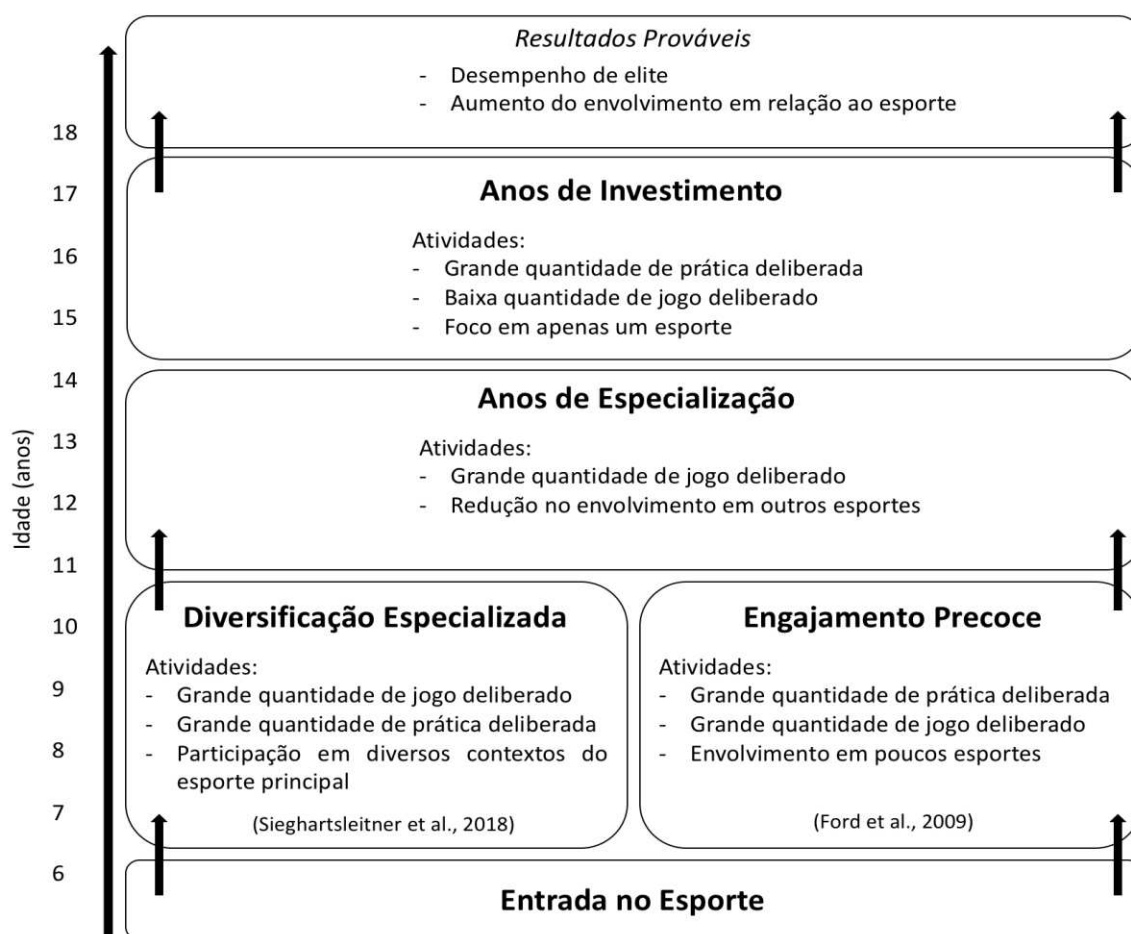


Figura 2. Modelos de desenvolvimento esportivo propostos para o futebol (Adaptado de FORD et al., 2009 e SIEGHARTSLEITNER et al., 2018).

Posteriormente à proposta desta trajetória alternativa mencionada acima, uma nova interpretação para o conceito de diversificação esportiva foi proposta por Coté e Ericksson (2015). O entendimento deste termo passou a estar relacionado com a diversificação dos tipos de atividades em contextos esportivos diferentes (ex.: jogar futebol de areia com os amigos, futsal, futebol no parque ou participar de competições) e não mais exclusivamente à diversificação de esportes jogados (ex.: jogar voleibol, handebol e basquetebol) como foi proposto inicialmente no modelo MDPE (CÔTÉ, 1999). Este novo entendimento, aliado a diversos estudos, demonstraram a importância tanto do jogo deliberado quanto da prática deliberada para o alcance de altos níveis de desempenho e maior nível competitivo (FORD *et al.*, 2009; FORD; WILLIAMS, 2012; FORSMAN *et al.*, 2016; HAUGAASEN; TOERING; JORDET, 2014; ROCA; WILLIAMS; FORD, 2012) que deram sustentação para a proposta de mais uma trajetória esportiva no futebol. Essa nova trajetória proposta por Sieghartsleitner e colaboradores (2018) é denominada de *diversificação especializada*. Além desta trajetória defender o envolvimento em atividades tanto de jogo deliberado, quanto de prática deliberada desde os anos iniciais de formação esportiva (6–12 anos) – como na proposta de Ford et al. (2009) – ela também preconiza a diversificação de atividades de futebol em diferentes contextos (ex.: jogar futebol na rua, no treinamento sistematizado ou jogar futsal). Portanto, devemos considerar os diferentes tipos de atividades vivenciadas durante a formação esportiva e as diferentes propostas de trajetórias esportivas apresentadas acima, para entender quais contribuem mais para o desenvolvimento da tomada de decisão no futebol.

Desenvolvimento da tomada de decisão no futebol

Diversos estudos têm demonstrado que a interação entre a prática e o jogo deliberado são importantes para o desenvolvimento da tomada de decisão dos atletas, apesar de não haver um consenso sobre quando é o período ou idade ideal para focar no acúmulo desses diferentes tipos de atividades (BAKER, J.; CÔTÉ, 2003; MACHADO *et al.*, 2020; ROCA; WILLIAMS; FORD, 2012; SIEGHARTSLEITNER *et al.*, 2018). Até o momento, estudos tem apontado para uma forte influência do contexto cultural em que os indivíduos estão inseridos no acúmulo desses diferentes tipos de atividades no futebol (FORD *et al.*, 2012). Portanto, conhecer as experiências e vivências prévias dos indivíduos no futebol, se faz necessário, para entender quais contextos eles vivenciaram durante a formação esportiva, especialmente durante a infância (6-12 anos).

Após os anos iniciais de formação esportiva (por volta dos 12 anos de idade), a prática

deliberada passa a assumir uma maior importância no desenvolvimento esportivo no futebol dos indivíduos em comparação com o jogo deliberado, independente da cultura em que ele está inserido (FORD *et al.*, 2012; FORD; WILLIAMS, 2012). Em função disso, a qualidade dos estímulos vivenciados no treinamento sistematizado do futebol a partir dessa idade ganha ainda mais importância para o desenvolvimento dos atletas. Desta forma, é necessário investigar de forma empírica como a prática e o jogo deliberado podem contribuir para o desenvolvimento da tomada de decisão, considerando tanto situações ofensivas e defensivas, quanto aspectos perceptivo-cognitivos e perceptivo-motores.

Pesquisas realizadas na área de identificação e seleção de talentos mostraram que tanto as habilidades de leitura de jogo quanto habilidades de tomada de decisão perceptivo-cognitivas e perceptivo-motoras são fatores essenciais para que os jogadores sejam selecionados em programas de treinamento para continuar o seu processo de formação no futebol (CARDOSO *et al.*, 2020, 2019; HARTIGH *et al.*, 2018). O estudo realizado por Cardoso e colaboradores (2020) mostrou que jovens jogadores de futebol de elite ($16,7 \pm 3,1$ anos de idade) que possuíam habilidades perceptivo-cognitivas mais rápidas para tomar decisões, quando comparados aos seus pares menos rápidos, possuíam: i) melhor capacidade de leitura do jogo, utilizando estratégias de busca visual mais eficientes; e ii) apresentavam um menor esforço cognitivo para tomar decisões. Em consonância com esses achados, outro estudo verificou que jovens jogadores de futebol ($10,9 \pm 0,43$ anos de idade) selecionados para continuar em um programa de desenvolvimento de talentos possuíam melhores habilidades de leitura de jogo do que jogadores não selecionados. Os jogadores selecionados eram capazes de estruturar e integrar melhor as informações do jogo (por exemplo, colegas de equipe, adversários e o campo de jogo) (HARTIGH *et al.*, 2018).

Portanto, considerando estes resultados apresentados acima como um todo, observa-se que tanto a leitura de jogo quanto a tomada de decisão desempenham um papel essencial ao longo do processo de desenvolvimento esportivo de jogadores de futebol, desde idades iniciais (aproximadamente dez anos) até o final da formação esportiva (aproximadamente 20 anos). Apesar disso, os estudos relacionados ao desenvolvimento dessas habilidades em jogadores de futebol, até o momento tiveram o foco principal em amostras masculinas (MACHADO *et al.*, 2020; ROCA; WILLIAMS; FORD, 2012) e na avaliação da qualidade da tomada de decisão (BAKER, J.; CÔTÉ, 2003; MACHADO *et al.*, 2020; ROCA; WILLIAMS; FORD, 2012), mas não da velocidade de tomada de decisão. Nesse contexto, destaca-se o importante papel de compreender melhor o desenvolvimento da velocidade da tomada de decisão, considerando a

mudança da dinâmica do jogo nos últimos anos, requerendo dos atletas uma tomada de decisão mais rápidas em função do aumento da velocidade do jogo em partidas oficiais (WALLACE; NORTON, 2014). Além disso, até onde sabemos, não foi encontrado nenhum estudo que avaliasse o processo de desenvolvimento da tomada de decisão em jogadoras de futebol feminino, considerando tanto os comportamentos ofensivos quanto defensivos. Ademais, um trabalho recente publicado por Williams, Ford e Drust (2020), relacionado ao desenvolvimento de talentos no futebol, apontou que ao longo dos últimos 20 anos poucas pesquisas foram conduzidas com atletas femininas no futebol e atletas sul-americanos. Portanto, este recente e importante trabalho, realizado por pesquisadores que são líderes mundiais nesta área de pesquisa, concluiu que existe a necessidade de ampliar o escopo de pesquisas no âmbito do futebol feminino e no contexto sul-americano em relação a este tema.

Importância da componente tática para o ensino do futebol

No contexto do ensino do futebol, a componente tática assume uma importância fundamental durante o processo de formação e desenvolvimento de atletas, uma vez que toda ação realizada no jogo tem por fim um objetivo tático (GARGANTA, 2009). Assim, tática pode ser conceituada como “...a gestão (posicionamento e deslocamento/movimentação) do espaço de jogo pelos jogadores e equipes” (TEOLDO; GUILHERME; GARGANTA, 2021). Desta forma, o ensino-aprendizagem da tática deve ser baseado na construção teórica a propósito da lógica do jogo, o que permite uma sistematização do treinamento através de conteúdos de forma contextualizada, facilitando assim o desenvolvimento da tomada de decisão do atleta ao longo do processo de formação (GONZÁLEZ-VÍLLORA *et al.*, 2015; TEOLDO; GUILHERME; GARGANTA, 2021).

Em função disso, a organização dos conteúdos de ensino-aprendizagem da tática tem sido realizada baseada em princípios táticos. Os princípios táticos são um conjunto de normas sobre o jogo que proporcionam aos jogadores a possibilidade de atingirem rapidamente soluções táticas para os problemas advindos das situações de jogo (GARGANTA; PINTO, 1994). Esses princípios táticos devem estar presentes nos comportamentos dos jogadores durante uma partida e são classificados em diferentes categorias, tais como princípios táticos gerais, operacionais e fundamentais (TEOLDO *et al.*, 2009). Cada categoria de princípio apresenta um nível de complexidade distinto, o que tem implicações diretas na organização destes conteúdos ao longo da formação esportiva.

A proposição para ensino-aprendizagem desses princípios advém de uma linha teórica

da psicologia cognitiva (NEISSER, 1967). Isto pressupõe determinados níveis de maturação e desenvolvimento motor, cognitivo e social, que tem como referência as fases de desenvolvimento da criança e do adolescente. A partir disso, recomenda-se o início do ensino-aprendizagem dos princípios gerais e operacionais por volta dos 6/7 anos de idade, pelo fato das crianças terem deixado a fase egocêntrica e terem passado para uma fase de maior sociabilidade (TEOLDO; GUILHERME; GARGANTA, 2021). Isto implica no aumento da interação com outras crianças, o que é necessário para a compreensão de conceitos relacionados à presença de companheiros de equipe e adversários. Em relação ao início do ensino-aprendizagem dos princípios fundamentais, é sugerido por volta dos 11/12 anos de idade, por necessitarem pensamento abstrato para sua execução, o que é possível quando o desenvolvimento cognitivo da criança já está em estágio maduro ou em fase final de maturação (TEOLDO; GUILHERME; GARGANTA, 2021).

Apesar dessas referências teóricas sobre os períodos e idades mais adequados para ensino-aprendizagem de cada categoria de princípios, ainda há necessidade de mais comprovações empíricas sobre como os diferentes tipos de atividades vivenciadas no futebol pelos indivíduos pode favorecer o desenvolvimento da tomada de decisão relacionada a esses princípios táticos. Dessa forma, se faz necessário investigar de forma empírica como a prática e o jogo deliberado podem contribuir para o aprendizado de diferentes categorias de princípios táticos (GONZÁLEZ-VÍLLORA *et al.*, 2015). Como a literatura aponta para uma maior importância do treinamento sistematizado após os anos iniciais de formação esportiva (por volta dos 12 anos de idade), momento em que deve ocorrer o foco do ensino nos princípios fundamentais, se faz necessário buscar implantar metodologias que sejam eficazes para o desenvolvimento desses conteúdos (MACHADO *et al.*, 2020; TEOLDO; GUILHERME; GARGANTA, 2021).

Nessa linha, a utilização de uma metodologia de ensino centrada no aluno e pautada no jogo, como através da utilização de jogos reduzidos e condicionados, se destaca como alternativa em consonância com o ensino dos princípios táticos do futebol (GONZÁLEZ-VÍLLORA *et al.*, 2020; SILVA; CONTE; CLEMENTE, 2020; SOUZA *et al.*, 2014). Esse tipo de metodologia pode ser implementada considerando avanços científicos que identificaram atividades associadas ao desenvolvimento da expertise no futebol em diferentes idades (FORD *et al.*, 2009; GONZÁLEZ-VÍLLORA; GARCÍA-LÓPEZ; CONTRERAS-JORDÁN, 2015; MACHADO *et al.*, 2020; ROCA; FORD, 2020).

Outro aspecto importante a ser considerado no processo de treinamento no futebol é o contexto ao qual o atleta está inserido, uma vez que diferentes aspectos culturais, como por exemplo, o país do atleta, pode interferir no tipo de prática vivenciada. Um recente estudo realizado por Roca e Ford (2020), verificou que países como Espanha e Portugal, tem uma maior semelhança na estruturação do seu treinamento, voltado para aspectos mais táticos do jogo, quando comparados à países como a Inglaterra e Alemanha, que valorizam proporcionalmente mais o desenvolvimento de aspectos mais físicos durante o treinamento. Este tipo de pesquisa, facilita o entendimento de como diferentes metodologias de treino desenvolvidas em um determinado país, podem ser transferidas e aplicadas em outros contextos, a depender da cultura de treinamento utilizado. Nesse sentido, seria interessante entender melhor o processo da estruturação do treinamento no contexto sul-americano em relação ao contexto europeu, uma vez que ambos os continentes são as principais potências do futebol mundial e os maiores formadores de jogadores de futebol do mundo (2021). Adicionalmente, estudos realizados nessa linha de pesquisa avaliaram predominantemente países europeus (FORD; YATES; WILLIAMS, 2010; ROCA; FORD, 2020). Essas informações facilitariam a compreensão de como metodologias de treino desenvolvidas em ambos os contextos poderiam ser aplicadas ou adaptadas para suas respectivas culturas.

Além disso, para avaliação da eficácia de uma metodologia de ensino é necessário utilizar instrumentos que sejam coerentes com os conteúdos que serão ensinados (GONZÁLEZ-VÍLLORA *et al.*, 2015). No que se refere à avaliação da tomada de decisão no futebol, tais instrumentos devem ser específicos para a modalidade, permitindo avaliar tanto situações ofensivas quanto defensivas (MACHADO; TEOLDO, 2020). Atualmente, existe a disponibilidade de tais instrumentos que permitem a avaliação da tomada de decisão a partir de uma mesma base teórica (princípios táticos fundamentais do futebol), que avaliam: i) a tomada de decisão perceptivo-motora, através do Sistema de Avaliação Tática no Futebol (FUT-SAT) (TEOLDO *et al.*, 2011); e ii) a tomada de decisão perceptivo-cognitiva através do teste de vídeo TacticUP® (MACHADO; TEOLDO, 2020). Desta forma, o uso de ambos os instrumentos permite avaliar os atletas em situações de jogo ofensivas e defensivas através de suas habilidades perceptivo-cognitivas e perceptivo-motoras, que são componentes complementares da tomada de decisão.

Avanços necessários nessa linha de pesquisa

Para que haja uma efetividade ainda maior no processo de ensino-aprendizagem no

futebol, se faz necessário organizar a literatura científica acerca do desenvolvimento da tomada de decisão no futebol, considerando as diferentes fases de formação esportiva (MACHADO *et al.*, 2020; TEOLDO; GUILHERME; GARGANTA, 2021). Informações advindas de tais estudos poderiam verificar como estratégias de ensino, que colocam o indivíduo como centro do processo e consideram suas necessidades individuais, mesmo em um esporte coletivo, podem auxiliar no ensino do futebol e desenvolvimento da capacidade de tomada de decisão. Dessa forma, há a necessidade de investigações que possam subsidiar melhorias nos processos de desenvolvimento das diferentes componentes (ex.: qualidade e velocidade) da capacidade de tomada de decisão no futebol relacionados à avaliação e ao treinamento, ampliando os estudos para incluir amostras femininas e sul-americanas. Verificar como a utilização de avaliações objetivas da capacidade de tomada de decisão no processo de seleção de atletas ao longo da formação pode favorecer a retenção de jogadores com um maior potencial para continuarem no processo de desenvolvimento de talentos seria importante para melhora desses processos. Também se faz necessário compreender se o contexto cultural que se está inserido (diferentes países) apresenta relação e influência na vivência prévia em diferentes atividades de futebol (prática deliberada e jogo deliberado), e se isso influencia na estruturação de estímulos que favoreçam o desenvolvimento da tomada de decisão (ROCA; FORD, 2020). Isso permitiria obter informações científicas que dessem sustentação para a construção de currículos de formação sistematizados com impacto à nível nacional e internacional, que favoreçam o desenvolvimento da tomada de decisão, assim como a componente tática ao longo do processo de formação esportiva de jogadores de futebol.

Para uma abordagem robusta deste processo, a estruturação desta tese foi feita a partir de um estudo teórico (revisão sistemática) e cinco estudos experimentais. Desta forma, os estudos dessa tese estão organizados em quatro eixos: i) utilização de uma revisão sistemática para organizar o conhecimento científico produzido acerca do desenvolvimento da tomada de decisão no futebol (capítulo um); ii) investigações que permitam avanços no processo de estruturação do treinamento e desenvolvimento da tomada de decisão (capítulos dois, três e quatro); iii) estudo para verificar a importância da capacidade de tomada de decisão para jogadores de futebol em formação permanecerem selecionados no processo de desenvolvimento de talentos na no futebol de elite (capítulo cinco); e iv) estudo que compare o contexto de formação na América do Sul (Brasil) e Europa (Espanha) em relação às atividades vivenciadas no futebol e a estruturação do treinamento, a fim de facilitar a transferência das informações científicas produzidas em ambos os contextos (capítulo seis). Por fim, são

apresentadas as considerações finais, que discute a relação e resume os principais achados dos seis estudos da tese.

Referências

BAKER, J.; CÔTÉ, J. Sport-specific practice and the development of expert decision-making in team ball sports. **Journal of Applied Sport Psychology**, vol. 15, no. 1, p. 12–25, 2003. <https://doi.org/10.1080/10413200390180035>.

BAKER, J; CÔTÉ, J; ABERNETHY, B. Learning from the experts: Practice activities of expert decision makers in sport. **Research Quarterly for Exercise and Sport**, vol. 74, no. 3, p. 342–347, 2003. DOI 10.1080/02701367.2003.10609101.

BRUCE, L; FARROW, D; RAYNOR, A; MANN, D. But I can't pass that far! The influence of motor skill on decision making. **Psychology of Sport and Exercise**, vol. 13, no. 2, p. 152–161, 2012. DOI 10.1016/j.psychsport.2011.10.005.

CARDOSO, F; GONZÁLEZ-VÍLLORA, S; GUILHERME, J; TEOLDO, I. Young soccer players with higher tactical knowledge display lower cognitive effort. **Perceptual & Motor Skills**, vol. 126, no. 3, p. 499–514, Jun. 2019. DOI <https://doi.org/10.1177/0031512519826437>.

CARDOSO, F; NEVES, J; ROCA, A; TEOLDO, I. The association between perceptual-cognitive processes and response time in decision making in young soccer players. **Journal of Sports Sciences**, vol. 39, no. 8, p. 926–935, 2020. DOI 10.1080/02640414.2020.1851901.

CÔTÉ, J. The Influence of the family in the development of talent in sport. **The Sport Psychologist**, vol. 13, no. 4, p. 395–417, 1999. DOI 10.1123/tsp.13.4.395.

CÔTÉ, J; BAKER, J; ABERNETHY, B. Practice and play in the development of sport expertise. In: EKLUND, R; TENENBAUM, G (eds.). **Handbook of Sport Psychology**. 3rd ed. New Jersey: John Wiley & Sons, 2007. p. 184–202.

CÔTÉ, J; ERICKSON, K. Diversification and deliberate play during the sampling years. In: BAKER, Joseph; FARROW, D (eds.). **Routledge Handbook of Sport Expertise**. Abingdon: Routledge, 2015. p. 305–316.

CÔTÉ, J; VIERIMAA. The developmental model of sport participation: 15 years after its first conceptualization. **Science & Sports**, vol. 29S, no. SUP, p. S63–S69, 2014. DOI <http://dx.doi.org/10.1016/j.scispo.2014.08.133>.

ERICSSON, A; KRAMPE, R; TESCH-ROMER, C. The role of deliberate practice in the acquisition of expert performance. **Psychological Review**, vol. 100, no. 3, p. 363–406, 1993. DOI 10.1037/0033-295X.100.3.363.

ERIKSTAD, M; HØIGAARD, R; JOHANSEN, B; KANDALA, N; HAUGEN, T. Childhood football play and practice in relation to self-regulation and national team selection; a study of Norwegian elite youth players. **Journal of Sports Sciences**, vol. 36, no. 20, p. 2304–2310, 2018. DOI 10.1080/02640414.2018.1449563.

FIFA. **Ten years of international transfers: A report on international football transfers worldwide 2011-2020**, 2021. <https://doi.org/10.1080/13533310308559344>.

FORD, P; HODGES, N; BROADBENT, D; O'CONNOR, D; SCOTT, D; DATSON, N; ANDERSSON, H; WILLIAMS, M. The developmental and professional activities of female international soccer players from five high-performing nations. **Journal of Sports Sciences**, vol. 38, no. 11–12, p. 1432–1440, 2020. DOI 10.1080/02640414.2020.1789384.

FORD, P; CARLING, C; GARCES, M; MARQUES, M; MIGUEL, C; FARRANT, A; STENLING, A; MORENO, J; GALL, F; HOLMSTRÖM, S; SALMELA, J; WILLIAMS, M. The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. **Journal of Sports Sciences**, vol. 30, no. 15, p. 1653–1663, 2012. DOI 10.1080/02640414.2012.701762.

FORD, P; WARD, P; HODGES, N; WILLIAMS, M. The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. **High Ability Studies**, vol. 20, no. 1, p. 65–75, 2009. DOI 10.1080/13598130902860721.

FORD, P; YATES, I; WILLIAMS, M. An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. **Journal of Sports Sciences**, vol. 28, no. 5, p. 483–495, 2010. DOI 10.1080/02640410903582750.

FORD, P; WILLIAMS, A. The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. **Psychology of Sport and Exercise**, vol. 13, no. May, p. 349–352, 2012. DOI 10.1016/j.psychsport.2011.09.004.

FORSMAN, H; BLOMQUIST, M; DAVIDS, K; KONTTINEN, N; LIUKKONEN, J. The role of sport-specific play and practice during childhood in the development of adolescent Finnish team sport athletes. **International Journal of Sports Science and Coaching**, vol. 11, no. 1, p. 69–77, 2016.

GARGANTA, J. Trends of tactical performance analysis in team sports: bridging the gap between research, training and competition. **Revista Portuguesa de Ciências do Desporto**, vol. 9, no. 1, p. 81–89, 2009. DOI 10.5628/rpcd.09.01.81.

GARGANTA, J; PINTO, J. O ensino do futebol. In: GRAÇA, A; OLIVEIRA, J (eds.). **O ensino dos Jogos Desportivos**. Porto: CEJD/FCDEF-UP, 1994. p. 97–137.

GONZÁLEZ-VÍLLORA, S; FERNANDEZ-RIO, J; GUIJARRO-JAREÑO, E; SIERRA-DÍAZ, M. **The game-centred approach to sport literacy**. Abingdon: Routledge, 2020.

GONZÁLEZ-VÍLLORA, S; GARCÍA-LÓPEZ, L M; CONTRERAS-JORDÁN, O R. Decision making and skill development in youth football players. **Revista Internacional de Medicina y Ciencias de la Actividad Física y del Deporte**, vol. 15, no. 59, p. 467–487, 2015.

GONZÁLEZ-VÍLLORA, S; SERRA-OLIVARES, J; PASTOR-VICEDO, J; TEOLDO, I. Review of the tactical evaluation tools for youth players, assessing the tactics in team sports: football. **Springerplus**, vol. 4, no. 663, p. 1–17, 2015. DOI 10.1186/s40064-015-1462-0.

HARTIGH, R; STEEN, S; HAKVOORT, B; FRENCKEN, W; LEMMINK, K. Differences in game reading between selected and non-selected youth soccer players. **Journal of Sports Sciences**, vol. 36, no. 4, p. 422–428, 2018. DOI 10.1080/02640414.2017.1313442.

HAUGAASEN, M; TOERING, T; JORDET, G. From childhood to senior professional football: A multi-level approach to elite youth football players' engagement in football-specific activities. **Psychology of Sport and Exercise**, vol. 15, no. 4, p. 336–344, 2014. DOI 10.1016/j.psychsport.2014.02.007.

HENDRY, D; CROCKER, P; WILLIAMS, M; HODGES, N. Tracking and comparing self-determined motivation in elite youth soccer: Influence of developmental activities, age, and skill. **Frontiers in Psychology**, vol. 10, no. MAR, p. 1–10, 2019.

MACHADO, G; GONZÁLEZ-VÍLLORA, S; SARMENTO, H; TEOLDO, I. Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. **International Journal of Performance Analysis in Sport**, vol. 20, no. 6, p. 1072–1091, 2020. DOI 10.1080/24748668.2020.1829368.

MACHADO, G; TEOLDO, I. TacticUP Video Test for soccer: Development and validation. **Frontiers in Psychology**, vol. 11, no. 1690, p. 1–12, 2020.

MACMAHON, C; MCPHERSON, S. Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! **International Journal of Sport Psychology**, vol. 40, no. 4, p. 565–579, 2009.

MATERNIUK, R. **Information Processing in Motor Skills**. New York, NY: Holt, Rinehart, and Winston, 1976.

MCPHERSON, S; KERNODLE, M. Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In: STARKES, J L; ERICSSON, K A (eds.). **Expert performance in sports: advances in research on sport expertise**. Champaign: Human Kinetics, 2003. p. 137–167.

NEISSER. **Psicologia Cognitiva**. New York: Appleton-Century-Crafts, 1967.

ROCA, A; FORD, P. Decision-making practice during coaching sessions in elite youth football across European countries. **Science and Medicine in Football**, vol. 4, no. 4, p. 263–268, 2020. DOI 10.1080/24733938.2020.1755051.

ROCA, A; WILLIAMS, M; FORD, P. Developmental activities and the acquisition of superior anticipation and decision making in soccer players. **Journal of Sports Sciences**, vol. 30, no. 15, p. 1643–1652, 2012.

SIEGHARTSLEITNER, R; ZUBER, C; ZIBUNG, M; CONZELMANN, A. “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. **Frontiers in Psychology**, vol. 9, no. FEB, p. 1–12, 2018.

SILVA, A; CONTE, D; CLEMENTE, F. Decision-making in youth team-sports players: A

systematic review. **International Journal of Environmental Research and Public Health**, vol. 17, no. 11, p. 1–33, 2020.

SOUZA, C; MULLER, E; TEOLDO, I; GRAÇA, A. Quais comportamentos táticos de jogadores de futebol da categoria sub-14 podem melhorar após 20 sessões de treino? **Revista Brasileira de Ciências do Esporte**, vol. 36, no. 1, p. 71–86, 2014.

STARKES, J.; CULLEN, J.; MACMAHON, C. A life-span model of the acquisition and retention of expert perceptual-motor performance. *In*: HODGES, N; WILLIAMS, M (eds.). **Skill acquisition in sport: Research, theory and practice**. London: Routledge, 2004.

TEOLDO, I; GARGANTA, J; GRECO, P; MESQUITA, I. Princípios Táticos do Jogo de Futebol: conceitos e aplicação. **Revista Motriz**, vol. 15, no. 3, p. 657–668, 2009.

TEOLDO, I; GUILHERME, J; GARGANTA, J. **Para um futebol jogado com ideias: Concepção, treinamento e avaliação do desempenho tático de jogadores e equipes**. 2nd ed. Curitiba: Appris, 2021.

TEOLDO, I; GARGANTA, J; GRECO, P; MESQUITA, I; MAIA, J. Sistema de avaliação tática no Futebol (FUT-SAT): Desenvolvimento e validação preliminar. **Motricidade**, vol. 7, no. 1, p. 69–84, 2011.

WALLACE, J; NORTON, K. Evolution of World Cup soccer final games 1966-2010: Game structure, speed and play patterns. **Journal of Science and Medicine in Sport**, vol. 17, no. 2, p. 223–228, 2014. DOI 10.1016/j.jsams.2013.03.016.

WARD, P; HODGES, N; STARKES, J; WILLIAMS, M. The road to excellence: deliberate practice and the development of expertise. **High Ability Studies**, vol. 18, no. 2, p. 119–153, 2007. DOI 10.1080/13598130701709715.

WILLIAMS, M; FORD, P; DRUST, B. Talent identification and development in soccer since the millennium. **Journal of Sports Sciences**, vol. 38, no. 11–12, p. 1199–1210, 2020. DOI 10.1080/02640414.2020.1766647.

WILLIAMS, M. Perceptual skill in soccer: Implications for talent identification and development. **Journal of Sports Sciences**, vol. 18, no. 9, p. 737–750, 2000.

Objetivos

Objetivos Gerais

- Compreender e propor melhorias nos processos de desenvolvimento da capacidade de tomada de decisão no futebol relacionados à avaliação e ao treinamento.

Objetivos Específicos

- Estudo 1: Verificar através de uma revisão de escopo: i) o efeito da vivência prévia em atividades relacionadas ao futebol; e ii) o efeito de intervenções (de campo e laboratório): na capacidade de tomada de decisão de jovens e adultos praticantes de futebol do sexo masculino e feminino.
- Estudo 2: i) analisar se jogadoras brasileiras de futebol profissional com diferentes níveis de tomada de decisão podem ser diferenciadas a partir da vivência prévia em atividades relacionadas ao futebol e futsal durante seu desenvolvimento; ii) discutir qual foi a trajetória esportiva que mais contribuiu para o desenvolvimento da capacidade de tomada de decisão.
- Estudo 3: Verificar a relação entre a vivência prévia em atividades relacionadas ao futebol e futsal com a qualidade e velocidade da tomada de decisão em diferentes fases do desenvolvimento esportivo de jogadoras de futebol profissional de elite.
- Estudo 4: Verificar a influência de 25 sessões de treinamento baseadas nos princípios táticos fundamentais e em jogos reduzidos sobre o desenvolvimento da tomada de decisão perceptivo-cognitiva e perceptivo-motora de jogadores de futebol de base de elite.
- Estudo 5: Verificar se a capacidade de tomada de decisão diferencia jogadores selecionados e não selecionados em programas de desenvolvimento de talentos no futebol de base de elite do Brasil.
- Estudo 6: i) comparar a vivência prévia em atividades relacionadas ao futebol durante a infância e adolescência entre jogadores de futebol de base de elite do Brasil e Espanha; ii) discutir qual trajetória esportiva caracteriza o desenvolvimento esportivo no futebol de elite do Brasil e Espanha.

Capítulo I

Estudo 1: Artigo de Revisão

Este capítulo foi submetido como artigo de revisão para a revista:

Journal of Sport and Exercise Psychology

Estudo 1: Effects of developmental activities and interventions on decision-making skills in soccer players: A scoping review

Guilherme Machado; Sixto González-Víllora; Victor Reis Machado; Israel Teoldo

Abstract: The development of soccer players' ability to make efficient and quick decisions are gaining even more importance in the last few years because it is predictive of players' future success and due to changes in the dynamics of competitive soccer matches. However, no previous reviews assessed the influence of developmental activities and interventions on decision-making skills in soccer players. Therefore, in this scoping review, we aimed to investigate: i) the effect of interventions (field and laboratory); and ii) the effect of developmental activities on perceptual-cognitive and perceptual-motor decision-making skills of youth and adult male and female soccer players. We used the PRISMA guidelines to search six databases for relevant publications before 6 June 2022. The population was soccer players, and the outcome were perceptual-cognitive and perceptual-motor decision-making skills. There were found 4,123 articles in the databases. Twenty-six studies were included in this scoping review, and 65.4% were published in the last five years (2018-2022). Four studies investigated developmental activities and 22 interventions. The average score for methodological quality was 85.5%. We concluded that high involvement in soccer-specific activities like deliberate practice and play since childhood is essential to developing decision-making skills compared to non-specific activities in other sports. Moreover, field interventions like Game-based Approaches can effectively develop some behaviors of decision-making skills in different contexts (school, soccer academy, and university players). Conversely, the effectiveness of laboratory interventions in developing decision-making skills is unclear. Finally, limitations and future directions in this research field are provided.

Keywords: coaching; training; profile history; cognition; football; sport pedagogy.

Resumo: O desenvolvimento da capacidade dos jogadores de futebol em tomarem decisões rápidas e eficientes está ganhando ainda mais importância nos últimos anos, uma vez que está associado à predição do sucesso futuro de jogadores e devido às mudanças na dinâmica do jogo de futebol. Entretanto, nenhuma revisão anterior avaliou a influência da vivência prévia em atividades de futebol e de intervenções sobre a capacidade de tomada de decisão de jogadores de futebol. Portanto, esta revisão de escopo teve como objetivo verificar: i) o efeito de intervenções (de campo e de laboratório); e ii) o efeito da vivência prévia em atividades relacionadas ao futebol nas habilidades perceptivo-cognitivas e perceptivo-motoras de tomada de decisão de jogadores de futebol jovens e adultos, masculinos e femininos. Utilizamos as diretrizes do PRISMA para pesquisar seis bases de dados de publicações relevantes no período anterior à 6 de junho de 2022. A população investigada foi de jogadores de futebol, e associadas as habilidades perceptivo-cognitivas e perceptivo-motoras de tomada de decisão. Foram encontrados 4.123 artigos nas bases de dados. Vinte e seis estudos foram incluídos nesta revisão de escopo, e 65,4% foram publicados nos últimos cinco anos (2018-2022). Quatro estudos investigaram a influência da vivência prévia em atividades de futebol e 22 de intervenções. A pontuação média para a qualidade metodológica foi de 85,5%. Concluímos que um grande envolvimento em atividades específicas de futebol, como a prática deliberada e o jogo deliberado desde a infância, é essencial para desenvolver habilidades de tomada de decisão em comparação com atividades não específicas em outros esportes. Além disso, intervenções de campo como a abordagem baseada em jogos podem desenvolver alguns comportamentos da tomada de decisão em diferentes contextos (escolar, clubes de futebol e jogadores universitários). Por outro lado, a eficácia de intervenções de laboratório no desenvolvimento da tomada de decisão não é clara. Finalmente, são fornecidas limitações e direções futuras nesta área de pesquisa.

Palavras-chave: treino; treinamento; histórico esportivo; cognição; futebol; pedagogia do esporte

Introduction

The development of soccer players' ability to make efficient and quick decisions are gaining even more importance in the last few years because it is predictive of players' future success (Murr et al., 2018) and due to changes in the dynamics of competitive soccer matches. The game has evolved, and players' demands to make decisions with less time and space have increased compared to a few decades ago (Wallace & Norton, 2014). Due to such changes, the chief of *Global Football Development* for FIFA, Arsène Wenger, has stated that the next frontier in soccer is to train the player's brains and their decision-making skills and, therefore, FIFA has included in their agenda for the next years the need to develop better structural conditions and coach education to develop training programs that allow players to develop such skills (FIFA, 2019). In this regard, decision-making skills can be divided into perceptual-cognitive and perceptual-motor skills, both contributing to the development of sport expertise (McPherson & Kernodle, 2003; Williams et al., 2020). Perceptual-cognitive skills can be described as what one perceives and understands, while perceptual-motor skills refer to what one perceives and responds to through movement (Materniuk, 1976; Starkes et al., 2004). In this context, decision-making can be defined as a choice of action and an outcome identified through a motor or verbal response (Bruce et al., 2012; Macmahon & Mcpherson, 2009).

In order to understand how decision-making skills can be developed in soccer, research has been conducted analyzing i) the contribution of different developmental activities (e.g., deliberate practice, deliberate play, and competition) through the life span of athletes (Machado et al., 2020; Roca et al., 2012); and ii) the effectiveness of intervention programs to develop such skills (Práxedes et al., 2016). Overall, studies showed that deliberate play (e.g., playing soccer with friends in the park), deliberate practice (e.g., training with the team), and different intervention strategies (e.g., Teaching Games for Understanding and non-linear pedagogy) contribute to developing decision-making skills. However, there is no consensus in the literature on the ideal period or age to focus on the accumulation of different developmental activities or the application of different types of interventions (Machado et al., 2020; Práxedes et al., 2019; Roca et al., 2012; Sierra-Ríos et al., 2020).

In this context, although a growing body of knowledge has been recently published about the relationship of decision-making skills with developmental activities (Hendry et al., 2018; Machado et al., 2020; Roca & Ford, 2021) and interventions (Harenberg et al., 2022; Khalifa et al., 2021; Valencia-Sánchez & Arias, 2021), to the best of our knowledge, no previous reviews have been conducted about the influence of developmental activities on decision-making skills in soccer. Additionally, even though a recent review (Silva et al., 2021)

analyzed the effectiveness of interventions on decision-making skills, it focused on team sports and included only one research on soccer (Práxedes et al., 2016). Thus, it is necessary to organize the available literature about developmental activities and interventions carried out in soccer to provide a more detailed picture of how decision-making skills could be developed more effectively throughout the sports development pathway of soccer players.

The relevance of the results from this review may impact the development of public policies and formulation of future strategies by Federations and Confederations (e.g., FIFA, CBF, RFEF, THE FA) for actions that promote the teaching of soccer more coherently and based on empirical data. Moreover, it may aid soccer coaches and teachers by allowing them to qualify their intervention and directly impact the athletes, who will have access to a more qualified sports formation. Finally, it also can lead the effort of sports scientists in this research field to directions that need further understanding. For this reason, this review may optimize the use of financial, infrastructure, and human resources used throughout the sports education of children, adolescents and adults by directing these resources towards more effective actions in teaching soccer and developing players. Therefore, in this scoping review, we aimed to investigate: i) the effect of interventions (field and laboratory); and ii) the effect of developmental activities on perceptual-cognitive and perceptual-motor decision-making skills of youth and adult male and female soccer players.

Materials and Methods

Search strategy and inclusion criteria

A systematic review of the available literature on developmental activities and interventions on decision-making skills in soccer was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses – Scoping Review (PRISMA-ScR) guidelines (Tricco et al., 2018). The Population, Intervention, Comparison, Outcome (PICO) framework was adapted and employed to develop the search strategy. The population of interest was soccer players. The intervention was: 1) developmental activities in sport related to soccer activities; or 2) laboratory or field interventions. No comparison was used because the review sought to investigate what interventions have been carried out in this topic. The outcome were perceptual-cognitive and perceptual-motor decision-making skills.

In order to ensure article quality, six databases were used for the search: 1) Web of Science (all databases); 2) SCOPUS; 3) PubMed; 4) SPORTDiscuss; 5) PsycINFO; and 6) Scielo. The search was carried out for relevant publication prior to 6 June 2022. The title,

abstract, and keywords were searched through the following descriptors: [(soccer OR football) AND (decision-making OR “decision making” OR “response time” OR “response accuracy” OR “tactical awareness” OR “game performance” OR “game reading” OR game-reading OR awareness OR perceptual-cognitive OR “perceptual cognitive”) AND (intervention OR train* OR program OR pract* OR coaching OR “developmental activities” OR “history profile” OR development OR “deliberate practice” OR “deliberate play” OR play OR “early engagement” OR “specialized sampling” OR sampling OR diversification OR specialization) NOT (referee OR injur* OR “american football” OR “australian football”)]. Only empirical research was considered for further analysis.

The inclusion criteria for the articles were: 1) published in peer-reviewed scientific journals; 2) the validity and reliability of the instruments used to assess decision-making in the studies should have been previously established and published in scientific journals; 3) the study was carried out with male or female soccer players (youth or adult); 4) written in English, Portuguese or Spanish language. On the other hand, the exclusion criteria were applied if the article: 1) was related to any other sport different from soccer; 2) was a review, opinion, or a conference abstract; 3) was an intervention focusing on deleterious effects on decision-making (e.g., mental fatigue and dehydration); and 4) the intervention was not described in detail. In case of disagreement, it was solved by discussion between the two review authors.

Two independent reviewers (GM and VM) separately screened titles and abstracts to identify articles based on the inclusion criteria. For those articles, full-text were screened by those reviewers to establish whether the inclusion criteria were met. Disagreements were solved by discussion between both reviewers.

A backward search was carried out through the screening of references for those selected articles in databases. Those references that exhaustively matched the inclusion criteria were included in the review.

Extraction of data and quality of the studies

The quality of the studies was assessed with a risk-of-bias quality form (16 items) adapted from (Law et al., 1998) and previously used in systematic reviews in sport (Sarmiento, Anguera, Pereira, & Araújo, 2018; Sarmiento et al., 2018). The items in the form assessed articles based on: objective (item 1); relevance of background literature (item 2); study design (items 3); sample included (items 4 and 5); informed consent obtention (item 6); outcome measures (items 7 and 8); description of methods (item 9); results significance (item 10); analysis methods (item 11); practical importance (item 12); drop-outs description (item 13);

appropriateness of conclusion (item 14); practical implications (item 15); and study limitations (item 16). The assessment for each item was a binary scale (1 – meet criteria; 0 – does not meet the criteria). The quality of the articles was expressed individually as a final score corresponding to the sum of the scores that met the criteria (1) divided by the total number of scored items (16). Articles were classified based on their final scores as: low methodological quality ($\leq 50\%$); good methodological quality (between 51% and 75%), and; excellent methodological quality ($> 75\%$) as used in previous studies (Faber et al., 2016; Sarmento, Anguera, et al., 2018; Wierike et al., 2013).

We used a data extraction sheet (adapted from Cochrane Consumers and Communication Review Group's data extraction template). Initially, one of the researchers assessed the studies included in this review, and a second researcher checked the inputted data. Any disagreement was solved by consensus between both researchers.

We used narrative analysis to synthesise and analyse the information collected from each included publication. This approach involved the grouping of studies according to the type of decision-making skills assessed and the type of situations assessed (e.g., offensive with the ball or defensive). Common themes were identified by calculating a percentage value of each descriptive category, and inferences were made about the data.

Results

Search, Selection and Inclusion of Publications

Initially, there was found 4,123 articles in the aforementioned databases. All these articles were exported to the reference software manager (Mendeley Desktop, v. 1.19.8). In the next step, all duplicates ($n=1,430$) were removed, both automatically and manually. Afterward, the remaining 2,693 articles were screened for relevance based on their title and abstract, resulting in the exclusion of 2,636 articles. The remaining 57 articles were screened based on their full-text. There were 36 articles excluded based on the inclusion/exclusion criteria, which left 20 articles for in-depth reading and analysis. The main reasons for exclusion are described in the flow chart (see Figure 1). Subsequently, a backward search based on the references from those 20 selected articles was performed and other 6 articles were included for consideration. In total 26 articles were reviewed in this paper.

The chronological analysis of the articles included in this review showed that the selected articles were published between 2006 and 2022. Furthermore, almost two thirds of the total articles included in this review (65.4%) were published in the last five years (2018 to 2022).

In regard to the countries of the samples studied, 11 were represented in at least one study of this review. These countries were: Spain (n=8; 30.8%); Portugal (n=5; 19.2%); UK (n=4; 15.4%); Canada (n=2; 7.7%); Australia (n=1; 3.8%); Brazil (n=1; 3.8%); Czech Republic (n=1; 3.8%); Colombia (n=1; 3.8%); Greece (n=1; 3.8%); Tunisia (n=1; 3.8%); and USA (n=1; 3.8%). In terms of continents, we found an overrepresentation of studies in Europe (n=19; 73.0%), followed by North America (n=3; 11.5%), South America (n=2; 7.7%), Africa (n=1; 3.8%) and Oceania (n=1; 3.8%).

Quality of the studies

Considering the quality of the studies (see Table 1) the main results were: 1) The average score for methodological quality of the 26 included articles was 85.5%; 2) 24 (92.3%) articles achieved an excellent methodology quality (>75%); and 3) 2 (7.7%) article achieved a good methodology quality (between 51% and 75%).

It was found some possible limitations of the 26 selected articles, which were related to two items assessed: 1) item 5 – a majority of studies (n=23; 88.5%) did not justified the sample size; and 2) item 13 – many studies (n=20; 76.9%) did not inform about drop-outs.

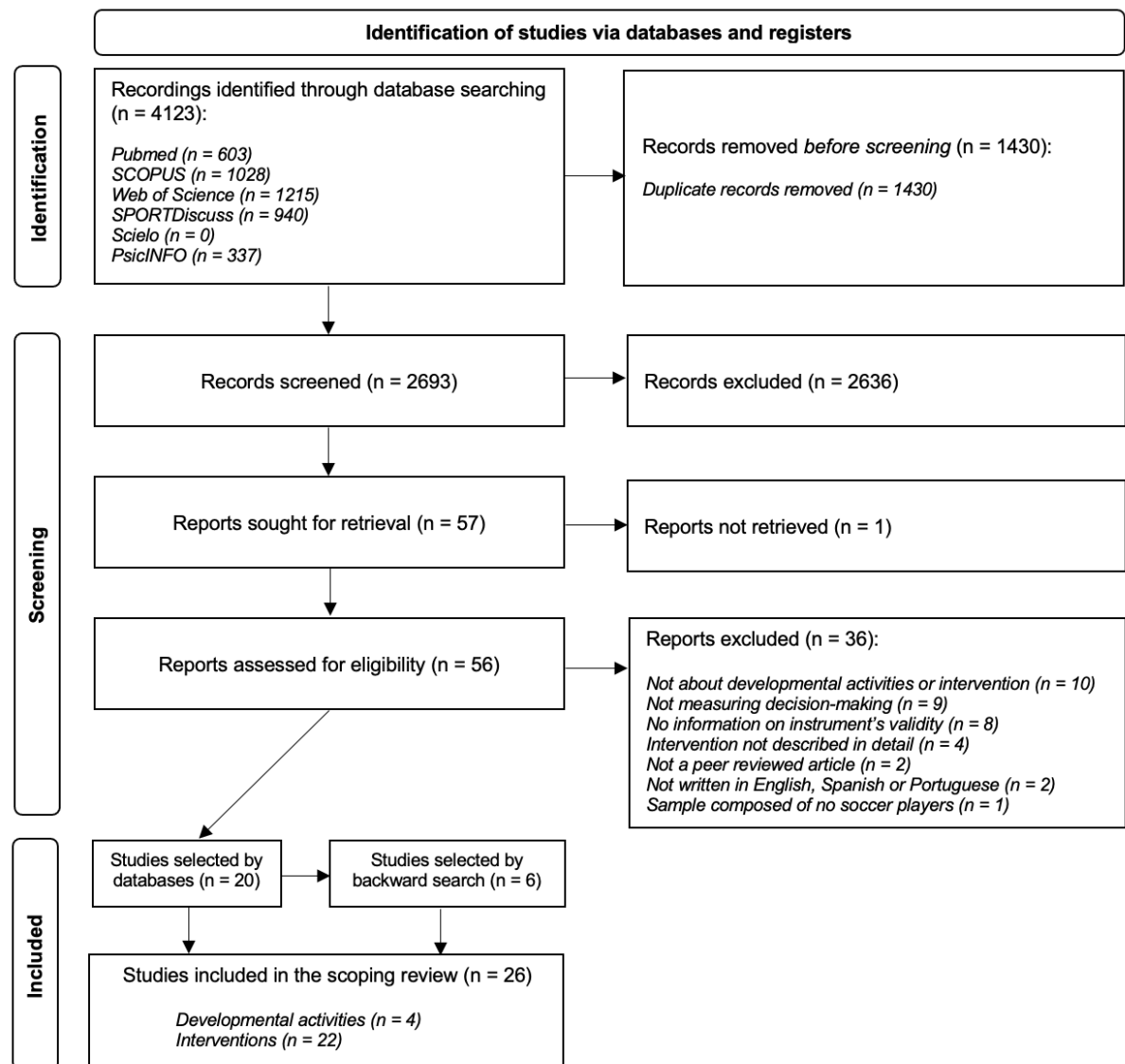


Figure 1. Flow chart of the methodology used for the article search based on the preferred reporting items for systematic review (PRISMA).

Study Characteristics

The characteristics of the 26 studies included in this scoping review are presented in Tables 1 and 2. The 26 studies included a total of 1262 participants, which 879 males, 256 females, and 127 were not reported. Considering the four studies about developmental activities, it included a total of 363 participants, which all of them were carried out with males, and none with female players (see Table 1). The 22 studies about intervention included a total of 899 participants, which 516 males, 256 females, and 127 were not reported (see Table 2).

In terms of the context of the sample of the 26 included studies, they were carried out in soccer clubs (n=12), schools (n=10), universities (n=3) and soccer schools (n=1). Regarding the four studies about developmental activities, all of them were carried out in soccer clubs (n=4). The 22 studies about intervention were carried out in schools (n=10), soccer academies (n=9), and universities (n=3).

In terms of the age of the samples included in the 26 studies, they were conducted with children (6-12 years) (n=15), adolescents (13-18 years) (n=7), and adults (>19 years) (n=4). Considering the four studies about developmental activities, they were carried out with adolescents (13-18 years) (n=2), and adults (>19 years) (n=2). Finally, the 22 studies about intervention were carried out with children (6-12 years) (n=15), adolescents (13-18 years) (n=5), and adults (>19 years) (n=2).

Type of Decision-making assessed

In terms of the type of decision-making assessed in the 26 studies, the great majority assessed perceptual-motor skills (n=21), followed by perceptual-cognitive skills (n=4) and both skills (n=1). Considering the four studies about developmental activities, mostly assessed perceptual-cognitive skills (n=3) with objective video-based tests, and fewer perceptual-motor skills (n=1) with a subjective rating scale filled by coaches. The 22 studies with intervention, we found that the most of them assessed perceptual-motor skills (n=20), followed by perceptual-cognitive skills (n=1) and both skills (n=1).

Moreover, among the total studies, almost all assessed the quality of decision-making (n=25), and only one assessed both decision-making quality and speed (n=1). The studies carried out with developmental activities, we found that all of them assessed the quality of decision-making (n=4), and none assessed decision-making speed. Considering the studies about intervention, quality of decision-making was assessed in almost all (n=21), and one

assessed both decision-making quality and speed (n=1).

Developmental activities

The four studies carried out with developmental activities assessed many variables related to sports development. We found that the most common variables assessed were deliberate practice (e.g., practice with team) (n=4); deliberate play (e.g., game of soccer with friends) (n=4); competition (e.g., league games) (n=3); and milestones (e.g., start age in different soccer activities) (n=2). Moreover, other variables were assessed less frequently, such as “% play” (e.g., % hrs in play considering the sum of play and practice) (n=1) and microstructure practice (e.g., individual, pairs, drills, group tactics and collective tactics activities in team practice) (n=1).

Table 1. Studies with the main topic developmental activities.

Article Information		Participants Information			Decision-making assessment Information				Developmental Activities Information		
Author	Quality	Participants (M±SD)	Context	Gender	Decision-making assessed	Methodology & Instrument	Situations assessed	Type of variable	Developmental activities / milestones assessed	Periods Analyzed	Main results
Roca & Ford (2021)	94%	N=48 (20.2±2.1); high-creative: n=12; low-creative: n=12	Adult - soccer club level	Male	PCS	Video - SSCT	OwB	Quality	Practice; play; competition / start age in: soccer; supervised training; soccer league; elite training program; semi-professional level; professional level.	Childhood (6-12 years); early adolescence (13-15 years); adolescence (13-18 years)	High skill group spent more hours per year in deliberate play during childhood and early adolescence (i.e., 6–15 years of age) compared with their low-skill counterparts. No differences were reported for hours spent in deliberate practice and competition nor in milestones.
Machado et al. (2020)	88%	N=149 (14.9±1.6); high-skill: n=50; low-skill: n=50	Adolescent - soccer club level	Male	PCS	Video - TacticUP	OwB; OwfbB; Def	Quality	Macrostructure: team practice; individual practice; play; competition. Microstructure of team practice: individual; pair; drills; group tactics; collective tactics; low decision-making opportunities; high decision-making opportunities; players'perceived opportunities to make decisions.	Whole career (6~14.9)	The main activities that differentiated high-/low-skill groups in both offensive and defensive decision-making skills in the macrostructure activities were: i) team practice; and in the microstructure: ii) collective tactics; and iii) "high decision-making opportunities". The high-skill group accumulated more hours in the aforementioned activities.
Hendry et al. (2018)	88%	N=102 (14.8±0.6); academy-only: n=76; youth-professional only: n=17; adult-professional: n=9	Adolescent - soccer club level	Male	PMS	Subjective Scale - Skill rating	OwB, OwtB, Def	Quality	Practice; play; play %.	Childhood (5-12 years); whole career (5 to 16-18 years)	For players that transitioned to youth-professional, creative decision-making skill ratings at T2 (16-18 years) positive correlated to childhood practice and whole career practice. Moreover, tactical decision-making skill ratings negatively correlated to play % during childhood and positively correlated to practice during the whole career.
Roca et al. (2012)	81%	N=64 Skilled: N=48 (20.7±2.4) Recreational: N=16 (22.1±2.8)	Adult - soccer club & recreational level	Male	PCS	Video - PCT	OwB	Quality	Practice; play; competition / start age in: soccer; supervised training; soccer league; elite training program; semi-professional level.	Childhood (6-12 years); adolescence (13-18 years)	Play in soccer during childhood was the strongest predictor of perceptual-cognitive expertise. Soccer practice during adolescence was also a predictor, albeit its impact was relatively modest. Competition and milestones showed no differences.

NR: not reported; PMS: perceptual-motor skills; PCS: perceptual-cognitive skills; SSCT: soccer-specific creativity test; PCT: perceptual-cognitive test; OwB: offensive with the ball; OwtB: offensive without the ball; Def: defensive; Play %: percentual time in play considering the total time spent in play and practice activities.

Interventions

It was observed a variety of interventions applied within the 22 studies. Considering the experimental groups, it was found the following interventions: Teaching Games for Understanding (TGfU) (n=4); non-linear pedagogy (n=3); Sport Education plus Invasion Games Competence Model (n=3); Sport Education (n=1); 3D MOT (n=2); Tactical Game Approach (n=2); combined tactical model (n=1); Games Approach (n=1); Didactic Model Game Action Competences (n=1); small-sided games (SSG) with numerical superiority (n=1); SSG with numerical equality (n=1); verbal interaction during training (n=1); trained peer-teacher (n=1); alternated teaching units (n=1). On the other hand, the control groups used the following approaches: direct instruction (n=5); Technical Approach (n=3); watch soccer videos (n=2); non-verbal interaction during training (n=1); linear pedagogy (n=1); untrained peer-teachers (n=1); combined technical model (n=1); traditional teaching units (n=1).

Table 2. Studies with the main topic intervention.

Article Information		Participants Information			Decision-making Assessment Information				Intervention Information						
Authors (Year)	Quality	Participants (M±SD)	Context	Gender	Decision-making assessed	Methodology & Instrument	Situations assessed	Type of variable	Total sessions	Duration (w)	Sessions per week	Time per session (m)	Groups	Intervention /Control Effectiveness	Main results
Studies with school players															
Farias et al (2019)	88%	N=26 (12.3); boys=16; girls=10	Children - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	16	NR	2	45	Intervention: Sport Education (SE) + Invasion Games Competence model (IGCM)	↑	The intervention improved decisions on situations of creating scoring opportunities and overall game performance.
Farias et al. (2015)	81%	N=24 (10.3 years); boys=16; girls=8	Children - school	Male & female	PCS; PMS	SSG & Questionnaire - GPOI & GUT	OwB; OwtB; Def	Quality	17	NR	2	45-90	Intervention: Sport Education (SE) + Invasion Games Competence model (IGCM)	↑	PCS improved on defensive decisions for girls and offensive decisions for girls and boys. PMS improved on defensive and offensive decisions for girls and boys.
Mesquita et al. (2012)	88%	N=26 (10-12 years); boys=17; girls=9	Children - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	22	NR	NR	NR	Intervention: Sport Education (SE) + Invasion Games Competence model (IGCM)	↑	Defensive and offense decisions improved for girls, but not for boys. Groups of low, medium and high skill level developed defensive decision skills, but not offensive.
Farias et al (2018)	88%	N=26 (12.3±1.3); boys=16; girls=10	Children - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	18	9	2	45	Intervention: Sport Education (SE)	↑	The SE intervention improved game performance in soccer.
Garcia-Ceberino et al (2020)	81%	N=35 (10.6±0.5); boys=19; girls=16; Intervention: N=17; Control: N=18	Children - school	Male & female	PMS	SSG - IMLPFoot	OwB; OwtB; Def	Quality	9	NR	NR	40	Intervention: Tactical games approach soccer (TGAS); Control: Direct instruction soccer (DIS)	→ / →	Decision-making skills showed no improvements in both intervention programs.
Gouveia et al. (2019)	94%	N=62 (13-16 years); boys=35; girls=27; Intervention: N=41; Control: N=21	Adolescent - school	Male & female	PMS	SSG - GPAI	Owb; OwtB	Quality	24	8	3	45	Intervention 1: Tactical games approach (TGA) of soccer, handball and basketball; Control: Technique approach (TA) of soccer, handball and basketball	↑ / ↑	Both TGA and TA groups improved their on-the-ball decision-making. No differences was found for effectiveness of these two approaches.
Chatzopoulos & Drakou (2006)	81%	N=101 (12-13 years); Intervention 1: N=49; Intervention 2: N=52	Children & adolescent - school	Male	PMS	SSG - Modified GPAI	Owb	Quality	15	5	3	30	Intervention 1: Games approach (GA); Control: Technique approach (TA)	↑ / →	Decision-making skills in situations with the ball improved in the GA group, but not in the TA group.
Khalifa et al (2021)	69%	N=30 (15.4±0.6); boys=18; girls=12	Adolescent - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	12	6	2	60	Intervention: Verbal interaction during training (play-discuss-play); Control: non-verbal interaction during training (play-passive recovery-play)	↑ / ↑	Both groups improved their decisions from pre- to post-test, but the verbal interaction group had greater improvement.
Whipp et al (2015)	88%	N=200 (12.5±0.6); boys=106; girls=94; Intervention: N=94; Control: N=106	Children - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	10	5	2	30	Intervention: Trained peer-teachers (T-PT); Control: Untrained peer-teachers (U-PT)	↑ / →	Game performance improved for the T-PT group, but not for the U-PT group.
Viciano et al. (2017)	94%	N=85 (10.6±0.6); boys=39; girls=46; Intervention: N=43; Control: N=42	Children - school	Male & female	PMS	SSG - GPAI	OwB; OwtB; Def	Quality	10	8	2	60	Intervention: Alternated teaching units of soccer and basketball (ATU); Control: Traditional teaching units of soccer and basketball (TTU)	→ / →	ATU group had a higher improvement in decision-making index in overall invasion sports compared to TTU group, but not in soccer.

Table 2. (Continued).

Article Information		Participants Information			Decision-making Assessment Information				Intervention Information						
Authors (Year)	Quality	Participants (M±SD)	Context	Gender	Decision-making assessed	Methodology & Instrument	Situations assessed	Type of variable	Total sessions	Duration (w)	Sessions per week	Time per session (m)	Groups	Intervention /Control Effectiveness	Main results
Studies with soccer academy players															
Sierra-Ríos et al (2020)	94%	Intervention: N=15 (10.0±0.1); Control: N=15 (10.6±0.6)	Children - soccer club	Male	PMS	SSG - GPET	OwB; OwtB	Quality	12	6	2	80	Intervention: Teaching Games for Understanding (TGfU); Control: Direct Instruction (DI)	↑ / →	Decision-making skills improved for the TGfU group in offensive actions off the ball, but not for actions with the ball, while no improvement for the DI group was found.
Práxedes et al. (2017)	88%	N=9 (10.6±0.5)	Children - Soccer club	Male	PMS	SSG - GPET	OwB	Quality	22	12	2	60	Intervention: Teaching Games for Understanding (TGfU)	↑	Total decision-making skills and decisions in passing actions improved, while no improvement was found for decisions in dribbling actions.
Práxedes et al (2016)	88%	N=18 (10.7±0.6); Intervention: N=9; Control: N=9	Children - soccer club	Male	PMS	Competition Match - GPET	OwB	Quality	21	12	2	60	Intervention: Teaching Games for Understanding (TGfU); Control: Technical approach (TA)	↑ / →	The TGfU group improved decision-making skills related to passing and dribbling situations, compared to the TA group.
Harvey et al (2010)	81%	N=34 (14-18 years); High-skill (varsity)=18 (14-18 years); Low-skill (first year)=16 (14-15 years)	Adolescent - soccer club & recreational	Male	PMS	SSG - GPAI	OwB; Def	Quality	8	8	1	45-60	Intervention: Teaching Games for Understanding (TGfU)	→	The TGfU intervention group did not improved the number of correct decisions, although it decreased the number of inappropriate decision in post-test for the high-skill group, but not for the low-skill group.
Roberts et al (2020)	88%	Intervention: N=11 (16.4±0.4); Control: N=11 (16.1±0.2)	Adolescent - soccer club	NR	PMS	Skill test - LSST	OwB	Quality; Speed	8	4	2	60	Intervention: "pitch-based" non-linear pedagogy training (NLP); Control: "pitch-based" linear pedagogy training (LP)	↑ / →	Improvement in decision-making in a shooting task was found for the NLP group, but not for the LP group.
Práxedes et al (2019)	81%	N=19 (10.6±0.5); Intervention: N=10; Control: N=9	Children - soccer club	NR	PMS	Competition Match - GPET	OwB	Quality	14	7	2	60	Intervention: Non-linear pedagogy (NLP); Control: Direct instruction model (DIM)	↑ / →	Decision-making skills related to passing situations improved with the NLP group.
Práxedes et al (2018)	81%	Intervention: N=10 (10.6±0.5); Control: N=9 (11.8±0.7)	Children - soccer club	Male	PMS	Competition Match - GPET	OwB	Quality	14	7	2	60	Intervention: Non-linear pedagogy (NLP); Control: Direct instruction model (DIM)	↑ / →	The NLP group improved decision-making skills related to passing situations, but not in dribling situations.
Valencia-Sánchez & Arias (2021)	88%	N=36 (10.0±0.6)	Children - soccer school	NR	PMS	SSG - FUT-SAT	OwB; OwtB; Def	Quality	12	12	1	80	Intervention: Didactic model game action competences (DMGAC); Control: Didactical model of direct instruction (DMDI)	↑ / →	Participants in DMGAC attained a higher tactical performance index than those who participated in DMDI in the post-test.
Práxedes et al (2018)	88%	Intervention: N=10 (10.6±0.5); Control: N=9 (10.7±0.5)	Children - soccer club	NR	PMS	Competition Match - GPET	OwB	Quality	14	7	2	60	Intervention 1: SSG with numerical superiority (SSGNS); Intervention 2: SSG with numerical equality (SSGNE)	↑ / →	Decision-making skills related to passing situations improved in the SSGNS intervention with the average skill-level group, but not for the SSGNE intervention nor the low skill-level group.
Studies with university players															
Harenberg et al (2022)	100%	Intervention: N=16 (19.3±1.1); Control: N=15 (18.9±0.6)	Adult - university	Male & female	PCS	Video - Soccer-specific motor response	OwB	Quality	10	4	NR	25-30	Intervention: 3D MOT; Control: Watched soccer scenes	→ / →	Non-significant changes in decision-making were found. The results did not confirm an association of 3D MOT and decision-making in soccer.
Romeas et al (2016)	88%	Intervention: N=9 (21.3±0.8); Active control: N=7 (21.4±1.0); Passive control: N=7 (22.5±0.7)	Adult - university	Male	PCS; PMS	SSG & Questionnaire - Specific coding & SPSP	OwB	Quality	10	5	2	NR	Intervention: 3D MOT; Active Control: Watched soccer scenes; Passive Control: none	↑ / →	Perceptual-motor decision-making accuracy in passing improved for the 3D-MOT group compared to control groups, but not in dribbling and shooting. Subjective perceptual-cognitive decision-making accuracy also improved in the 3D-MOT group compared to control groups.
Psotta & Martin (2011)	75%	N=24; Intervention: N=12 (20.7±0.8); Control: N=12 (21.0±0.7)	Adult - University	Female	PMS	Competition Match - SPOS	OwB	Quality	10	5	2	90	Intervention: Combined tactical model (CTA); Control: Combined technical model (CTE)	↑ / ↑	Decision making index was enhanced after intervention in both CTA and CTE groups. decision-making in passing situations improved in the CTA group, but not in dribbling and shooting.

NR: not reported; PMS: perceptual-motor skills; PCS: perceptual-cognitive skills; GPAI: Game Performance Assessment Instrument; GPOI: Game Performance Observation Tool; GUT: Game Understanding Test; IMLPfoot: Instrument for the Measurement of Learning and Performance in Football; GPET: Game Performance Evaluation Tool; LSST: Loughborough shooting skill test; FUT-SAT: System of Tactical Assessment in Soccer; SPSP: Sport Performance Scale application; SPOS: Soccer Performance Observation System; OwB: offensive with the ball; OwtB: offensive without the ball; Def: defensive; ↑: significant increase; →: no significant difference.

Discussion

This scoping review aimed to investigate: i) the effect of interventions (field and laboratory); and ii) the effect of developmental activities on perceptual-cognitive and perceptual-motor decision-making skills of youth and adult male and female soccer players. Overall, studies about developmental activities focused mainly on the development of perceptual-cognitive skills (75%) with only male samples (100%), while most studies about intervention accessed only perceptual-motor skills (90.9%). Regarding quality, almost all studies included in this scoping review possessed excellent quality 92.3%.

Developmental activities

The studies carried out with developmental activities showed the contribution of different types of activities for developing decision-making skills across different phases of sports formation (e.g., childhood and adolescence). Deliberate play during childhood (i.e., 6-12 years) was positively related to the quality of defensive perceptual-cognitive decision-making skills (Roca et al., 2012) and offensive creative decision-making skills measured through objective video-based tests. Moreover, deliberate play during early adolescence (i.e., 13-15 years) was positively associated with offensive creative decision-making skills (Roca & Ford, 2021). On the other hand, one study (Hendry et al., 2018) found no association between deliberate play in childhood and adolescence with perceptual-motor decision-making skills related to tactical and creative actions, although it was assessed through a subjective coaching rate scale.

One explanation for the contribution of deliberate play to better decision-making skills is its nature, which usually couples perceptual-cognitive and perceptual-motor skills in unstructured activities (Berry et al., 2008). Those activities usually can be characterized by 1) mimicking game-like sub-phases situations (e.g., 2x2, 3x3); 2) providing modified tasks and environmental constraints (e.g., smaller and irregular playing fields); and 3) having variability of practice in uncertain contexts (e.g., require many soccer skills to be executed in a random format). Such practice characteristics induce athletes to provide quick solutions for game problems and provides a stimulus for players to develop skills related to creative and intelligent decision-making (Roca & Ford, 2021).

Considering the deliberate practice, studies showed a positive association with perceptual-cognitive decision-making skills in defensive (Machado et al., 2020; Roca et al., 2012) and offensive (Machado et al., 2020) situations, during adolescence (i.e., 13-18 years) (Roca et al., 2012) and childhood plus early adolescence altogether (i.e., 6 to ~15 years)

(Machado et al., 2020). Moreover, it was found a positive correlation between deliberate practice with perceptual-motor decision-making skills related to creative actions during childhood (Hendry et al., 2018) and related to tactical and creative actions during childhood plus adolescence altogether (i.e., 5 to ~17 years) (Hendry et al., 2018). In this regard, involvement with structured activities with its primary aim of developing performance looks to be an important aspect for athletes to develop their decision-making quality through their sport formation (Mann et al., 2007). This context usually provides athletes with exercises focusing on performance improvement with valuable feedback from the coaching staff (Roca & Ford, 2020). Moreover, a recent study found that soccer practice has been changing throughout the last 15 years to provide players nowadays with higher opportunities to make decisions (Roca & Ford, 2020) compared to practice prior to 2010 (Ford et al., 2010). Such a practice characteristic has been associated with the acquisition of better offensive and defensive decision-making quality in soccer (Machado et al., 2020).

In terms of the contribution of other types of activities, albeit deliberate play and practice, the study of Machado et al. (2020) that analyzed perceptual-cognitive decision-making skills in the period of childhood plus early adolescence altogether (i.e., 6 to ~15 years) showed a positive association between: i) competition with offensive skills; ii) individual practice with defensive skills; and iii) the microstructure of practice such as activities of group tactics (i.e., 2x2 up to 4x4) and collective tactics (i.e., 5x5 up to 11x11) with offensive and defensive skills. On the other hand, other studies showed no association between perceptual-cognitive decision-making skills and milestones (e.g., start age at playing and practicing soccer) nor the number and hours accumulated in other sports (Roca et al., 2012; Roca & Ford, 2021).

Overall, these findings suggest that high involvement in soccer-specific activities is essential to develop decision-making skills in soccer compared to non-specific activities in other sports. Deliberate play has an important role, especially during childhood, but also during early adolescence (Roca et al., 2012; Roca & Ford, 2021), while deliberate practice contributes to the development of decision-making skills during childhood and adolescence (Hendry et al., 2018; Machado et al., 2020). Altogether, these results provide support for participation in high amounts of soccer-specific activities like deliberate play and practice since childhood to develop decision-making skills. Therefore, it partially supports the early engagement pathway proposed by Ford et al. (2009) and the specialized sampling pathway proposed by Sieghartsleitner et al. (2018).

Interventions

Studies with school players

Most studies conducted with school players assessed the effectiveness of a hybrid intervention based on Sport Education plus Invasion Games Competence model (n=3) or Sports Education (n=1), with sessions varying between 16 to 22. All of them were carried out with children and found a positive impact of such intervention on perceptual-motor decision-making skills for offensive situations (Farias et al., 2015, 2019; Mesquita et al., 2012), defensive situations (Farias et al., 2015; Mesquita et al., 2012) and overall performance (Farias et al., 2018, 2019). Moreover, such studies showed that skill level (Mesquita et al., 2012) and sex (Farias et al., 2015; Mesquita et al., 2012) were moderate factors of intervention effectiveness, indicating that stimulus must be individualized to different needs of children within the same group or classrooms (Machado & Teoldo, 2020).

Another three studies in this review investigated the effectiveness of intervention focusing on more tactical aspects of the game through the tactical games approach (n=2) and games approach (n=1) compared to technical approaches. No consensus about the effectiveness of interventions was found, as two of them (Chatzopoulos et al., 2006; Gouveia et al., 2019) showed improvements in perceptual-motor decision-making skills in situations with the ball for the tactical intervention, and one showed no improvements (Garcia-Ceberino et al., 2020). This inconsistent result is probably due to the difference in the number of intervention sessions. The study from Garcia-Ceberino (2020) applied only eight sessions, while the other two varied between 15 and 24 sessions. It indicates that more than eight sessions are needed to develop decision-making skills through a tactical approach intervention.

Two studies in this review investigated the active role of students during an intervention, such as verbal interaction during training (play-discuss-play) (Khalifa et al., 2021) and students as peer teachers (Whipp et al., 2015). Both studies showed positive effects on perceptual-motor decision-making skills for the verbal interaction group and the peer-teacher group in overall (offensive and defensive situations) decision accuracy. Such results reinforce the importance of players performing an active and central role in sports training programs (Harvey & Jarrett, 2014).

Finally, one study assessed the effectiveness of alternated teaching units of soccer and basketball compared to a traditional teaching unit of soccer and basketball to improve perceptual-motor decision-making skills (Viciania et al., 2017). The study found improvements in overall decision-making in invasion sports, but not specific to soccer during the ten sessions.

It suggests that more specific training, focusing on soccer content, is needed to develop decision-making skills in soccer (Roca & Ford, 2020).

Studies with academy players

Most studies in this review investigated the effectiveness of TGfU intervention (n=4) on decision-making skills. Improvements in perceptual-motor skills were reported in three out of four studies related to offensive actions without the ball (Sierra-Rios et al., 2020) and in offensive actions with the ball in passing situations (Práxedes et al., 2016, 2017) and dribbling situations (Práxedes et al., 2016). On the other hand, the study by Harvey et al. (2010) showed no improvements in decision-making skills related to offensive and defensive actions with the ball. One possible explanation for no improvements is that the study had fewer training sessions (n=8), while other TGfU interventions varied between 12 to 22 sessions. Moreover, it was the only study carried out with adolescents that assessed decision-making skills through the GPAI instrument, which assesses more general aspects of game performance. On the other hand, the other three studies were carried out with children and used the GPET instrument, which assesses more specific principles (operational) of soccer than GPAI (González-Víllora et al., 2015). These results suggest that more than eight TGfU sessions are needed to improve decision-making skills, which should be assessed with more specific soccer instruments.

In terms of non-linear pedagogy interventions, three studies found a positive effect on players' perceptual-motor skills. The two studies that assessed decision-making through competitive matches found improvements in passing situations (Práxedes et al., 2018, 2019), but not in dribbling situations (Práxedes et al., 2018). Moreover, Roberts et al. (2020) showed improvements in decision-making in shooting situations assessed throughout a shooting skill task. It suggests that the approach used in non-linear pedagogy of coupling perceptual-cognitive and perceptual-motor skills in different learning tasks provides a good environment for players' decision-making skills development. These results also indicate that non-linear pedagogy effectively develops different perceptual-motor skills related to actions with the ball, like passing and shooting, but not for dribbling situations. Perhaps decision-making skills in dribbling situations might take longer to develop than other skills, and more than 14 sessions could be necessary for its development.

Other three types of interventions were found in the context of soccer academy players. The study conducted by Valencia-Sánchez and Arias (2021) showed that the didactic model game action competencies (DMGAC) improved players' decision-making skills considering the overall performance in offensive with and without the ball and defensive situations, assessing the core tactical principles of soccer in children compared to a direct instruction didactic model.

Moreover, Práxedes (2018) found that an intervention with small-sided games (SSG) with numerical superiority could develop offensive decision-making skills related to passing situations of average-level players. On the other hand, this same study found that another intervention with SSG with numerical equality led to no improvements in passing decision-making skills in average-level and low-level players. It indicates the importance of making an initial diagnostic assessment of players' level to adjust specific tasks for their individual needs to develop their decision-making skills (Teoldo et al., 2022).

Overall, these studies suggest that different Game-based Approaches such as TGfU, non-linear pedagogy, DMGAC, and SSG can effectively develop some behaviors of perceptual-motor decision-making skills, especially those related to offensive actions with the ball. Moreover, to assess the effectiveness of interventions is necessary to use instruments adequate to players' age and sports development phases (González-Víllora et al., 2015). For instance, the literature suggests that during childhood (6-12 years), instruments that assess more general behaviors of the soccer game, such as KORA (Memmert, 2010) – general tactical principles - and GPET (García-López et al., 2013) – operational tactical principles - should be used (Teoldo et al., 2022). Additionally, from the end of childhood (around 10 years onward) to older ages (adolescence and adulthood), more specific behaviors of soccer should be assessed, like the core tactical principles and specific tactical principles. Instruments like TacticUP (Machado & Teoldo, 2020) and FUT-SAT (Teoldo et al., 2011) allow the assessment of perceptual-cognitive and perceptual-motor skills, respectively, related to the core tactical principles, while game performance analysis could be used to assess specific tactical principles (Teoldo et al., 2022).

Studies with university players

The three studies conducted on university players found no consensus about the effectiveness of interventions. Two of them assessed the effectiveness of a laboratory 3D Multiple Object Tracking (3D MOT) training. On the one hand, Romeas et al. (2016) found improvements in perceptual-motor decision-making accuracy in passing situations but not in dribbling and shooting, and also improvements in subjective perceptual-cognitive decision-making accuracy. On the other hand, Harenberg et al. (2022) found no improvements in perceptual-cognitive decision-making skills in passing situations after conducting the same training program then Romeas et al. (2016). These contradictory results probably relate to the different methods used to assess decision-making skills. While Romeas et al. (2016) assessed perceptual-motor skills with SSG, Harenberg et al. (2022) assessed perceptual-cognitive skills through a video-based test. This discrepancy could be addressed in future studies using

complementary instruments to assess both perceptual-cognitive and perceptual-motor skills based on similar theoretical backgrounds (Machado & Teoldo, 2020).

Another study (Psotta & Martin, 2011) assessed the effectiveness of a combined tactical model training on perceptual-motor skills related to passing, dribbling, and shooting decision-making skills. It was found improvements for passing situations but not for dribbling and shooting situations, similar to other studies carried out with university players (Romeas et al., 2016) and soccer academy players (Práxedes et al., 2017, 2018). Therefore, decision-making skills related to passing situations apparently evolve quickly compared to dribbling and shooting skills.

Limitations and future directions

Some limitations of the articles included in this review must be acknowledged. The topic of developmental activities showed only four studies, and none included female samples. Moreover, all the studies focused on the quality of decision-making and none on the development of decision-making speed, although literature indicates that both decision-making speed and quality are different and complementary aspects of players' performance (Mann et al., 2007). Other countries and continents should be investigated once developmental activities suffer a great influence of cultural aspects (Ford et al., 2012), and three articles were from the UK and one from Brazil. Assessment of perceptual-motor skills through objective tests and not only with subjective measures should be carried out in the future. Other variables used in studies with developmental activities could be included in future studies about decision-making development. For example, other similar sports related to soccer, such as futsal, could provide a deeper understanding of this topic (Ford et al., 2012) and test further the contribution of different developmental pathways proposed in previous years, such as the early engagement (Ford et al., 2009) and specialized sampling (Sieghartsleitner et al., 2018), for the development of decision-making skills.

Regarding interventions, only one study among the 22 analyzed assessed the effect of interventions on decision-making speed. Therefore, future studies should investigate this variable further. Additionally, we identified that no study carried out with soccer clubs (n=9): i) assessed perceptual-cognitive decision-making skills, ii) included female participants; nor iii) included adult participants. Among the 22 studies about intervention, only three of them found no improvements in decision-making skills. Interestingly, all three applied ten intervention sessions (n=2) or less (n=1), while most studies showing positive outcomes for interventions applied 12 sessions or more (n=14). It suggests that future studies should apply at least 12

sessions when investigating the effectiveness of interventions on decision-making skills. Soccer coaches and Physical Education teachers should acknowledge this information to apply interventions with at least 12 sessions to develop decision-making skills.

Conclusions

This study was the first to scope peer-reviewed literature on: i) developmental activities and their contribution to the development of decision-making skills in soccer players; and ii) the effect of interventions on soccer players' decision-making skills. Our findings suggest that high involvement in soccer-specific activities is essential to developing decision-making skills compared to non-specific activities in other sports. Furthermore, deliberate play has an important role, especially during childhood, but also during early adolescence (Roca et al., 2012; Roca & Ford, 2021), while deliberate practice contributes to the development of decision-making skills during childhood and adolescence (Hendry et al., 2018; Machado et al., 2020). In terms of interventions, we found that Game-based Approaches such as TGfU, non-linear pedagogy, small-sided games, Invasion Games Competence model, and Tactical Games Approach can effectively develop some behaviors of perceptual-motor decision-making skills in different contexts, like school players, soccer academy players, and university players. Moreover, the effectiveness of laboratory interventions to develop decision-making skills in soccer players is not guaranteed, as little research was conducted on this topic (Harenberg et al., 2022; Romeas et al., 2016), and they found contradictory results. Finally, the limitations of the current literature were discussed, and future directions were presented.

Declaration of competing interest

The authors have no conflicts of interests to declare.

Funding

This study was supported by the Sports incentive law of the Government of Minas Gerais, by the Academy & Soccer Program of the Ministry of Citizenship, through the National Secretariat of Football and Defense of Fans' Rights; the SEESP-MG, FAPEMIG, CNPq, Funarbe, the Dean's Office for Graduate and Research Studies and the Centre of Life and Health Sciences from the leading institution. This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance Code 001.

References

Berry, J., Abernethy, B., & Côté, J. (2008). The contribution of structured activity and

- deliberate play to the development of expert perceptual and decision-making skill. *Journal of Sport and Exercise Psychology*, 30(6), 685–708. <https://doi.org/10.1123/jsep.30.6.685>
- Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. *Psychology of Sport and Exercise*, 13(2), 152–161. <https://doi.org/10.1016/j.psychsport.2011.10.005>
- Chatzopoulos, D., Tsormbatzoudis, H., & Drakou, A. (2006). Combinations of technique and games approaches: Effects on game performance and motivation. *Journal of Human Movement Studies*, 50(3), 157 – 170.
- Faber, I. R., Bustin, P. M. J., Oosterveld, F. G. J., Elferink-Gemser, M. T., & Nijhuis-Van der Sanden, M. W. G. (2016). Assessing personal talent determinants in young racquet sport players: a systematic review. *Journal of Sports Sciences*, 34(5), 395–410. <https://doi.org/10.1080/02640414.2015.1061201>
- Farias, C. F., Mesquita, I. R., & Hastie, P. A. (2015). Game performance and understanding within a hybrid sport education season. *Journal of Teaching in Physical Education*, 34(3), 363–383. <https://doi.org/10.1123/jtpe.2013-0149>
- Farias, C., Valério, C., & Mesquita, I. (2018). Sport education as a curriculum approach to student learning of invasion games: Effects on game performance and game involvement. *Journal of Sports Science and Medicine*, 17(1), 56–65.
- Farias, Cláudio, Mesquita, I., & Hastie, P. A. (2019). Student game-play performance in invasion games following three consecutive hybrid Sport Education seasons. *European Physical Education Review*, 25(3), 691–712. <https://doi.org/10.1177/1356336X18769220>
- FIFA. (2019). *Make football trully global: The vision 2020-2023*.
- Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., Stenling, A., Moreno, J., Gall, F. Le, Holmström, S., Salmela, J., & Williams, A. M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, 30(15), 1653–1663. <https://doi.org/10.1080/02640414.2012.701762>
- Ford, P. R., Ward, P., Hodges, N. J., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. *High Ability*

-
- Studies*, 20(1), 65–75. <https://doi.org/10.1080/13598130902860721>
- Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. *Journal of Sports Sciences*, 28(5), 483–495. <https://doi.org/10.1080/02640410903582750>
- García-Ceberino, J. M., Gamero, M. G., Feu, S., & Ibanez, S. J. (2020). Differences in technical and tactical learning of football according to the teaching methodology: a study in an educational context. *Sustainability*, 12(16), 6554. <https://doi.org/10.3390/su12166554>
- García-López, L. M., González-Víllora, S., Gutiérrez, D., & Serra, J. (2013). Development and validation of the game Performance Evaluation Tool (GPET) in soccer. *Revista Euroamericana de Ciencias Del Deporte*, 2(1), 89–99.
- González-Víllora, S., Serra-Olivares, J., Pastor-Vicedo, J., & Teoldo, I. (2015). Review of the tactical evaluation tools for youth players, assessing the tactics in team sports: football. *Springerplus*, 4(663), 1–17. <https://doi.org/https://doi.org/10.1186/s40064-015-1462-0>
- Gouveia, E., Gouveia, B., Marques, A., Kliegel, M., Rodrigues, A., Prudente, J., Lopes, H., & Ihle, A. (2019). The effectiveness of a tactical games approach in the teaching of invasion games. *Journal of Physical Education and Sport*, 19(3), 962–970.
- Harenberg, S., McCarver, Z., Worley, J., Murr, D., Vosloo, J., Kakar, R. S., McCaffrey, R., Dorsch, K., & Höner, O. (2022). The effectiveness of 3D multiple object tracking training on decision-making in soccer. *Science and Medicine in Football*, 6(3), 355–362. <https://doi.org/10.1080/24733938.2021.1965201>
- Harvey, S., & Jarrett, K. (2014). A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy*, 19(3), 278–300. <https://doi.org/10.1080/17408989.2012.754005>
- Harvey, S., Cushion, C. J., Wegis, H. M., & Massa-Gonzalez, A. N. (2010). Teaching games for understanding in American high-school soccer: A quantitative data analysis using the game performance assessment instrument. *Physical Education and Sport Pedagogy*, 15(1), 29 – 54. <https://doi.org/10.1080/17408980902729354>
- Hendry, D. T., Williams, A. M., & Hodges, N. J. (2018). Coach ratings of skills and their

- relations to practice, play and successful transitions from youth-elite to adult-professional status in soccer. *Journal of Sports Sciences*, 36(17), 2009–2017. <https://doi.org/10.1080/02640414.2018.1432236>
- Khalifa, W. Ben, Zouaoui, M., Zghibi, M., & Azaiez, F. (2021). Effects of verbal interactions between students on skill development, game performance and game involvement in soccer learning. *Sustainability*, 13(1), 160. <https://doi.org/10.3390/su13010160>
- Law, M., Stewart, D., Pollock, N., Letts, L., Bosch, J., & Westmorland, M. (1998). *Critical review form: quantitative studies*. McMaster University.
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Machado, G., & Teoldo, I. (2020). TacticUP Video Test for soccer: Development and validation. *Frontiers in Psychology*, 11(1690), 1–12. <https://doi.org/10.3389/fpsyg.2020.01690>
- Macmahon, C., & Mcpherson, S. U. E. L. (2009). Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! *International Journal of Sport Psychology*, 40(4), 565–579.
- Mann, D. T. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457–478. <https://doi.org/10.1123/jsep.29.4.457>
- Materniuk, R. (1976). *Information Processing in Motor Skills*. Holt, Rinehart, and Winston.
- McPherson, S. L., & Kernodle, M. (2003). Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: advances in research on sport expertise* (pp. 137–167). Human Kinetics.
- Memmert, D. (2010). Testing of tactical performance in youth elite soccer. *Journal of Sports Science and Medicine*, 9(2), 199–205.

- Mesquita, I., Farias, C., & Hastie, P. (2012). The impact of a hybrid Sport Education-Invasion Games Competence Model soccer unit on students' decision making, skill execution and overall game performance. *European Physical Education Review*, 18(2), 205–219. <https://doi.org/10.1177/1356336x12440027>
- Murr, D., Feichtinger, P., Larkin, P., O'Connor, D., & Höner, O. (2018). Psychological talent predictors in youth soccer: A systematic review of the prognostic relevance of psychomotor, perceptual-cognitive and personality-related factors. *PLoS ONE*, 13(10). <https://doi.org/10.1371/journal.pone.0205337>
- Práxedes, A, Del Villar Álvarez, F., Moreno, A., Gil-Arias, A., & Davids, K. (2019). Effects of a nonlinear pedagogy intervention programme on the emergent tactical behaviours of youth footballers. *Physical Education & Sport Pedagogy*, 24(4), 332–343. <https://doi.org/10.1080/17408989.2019.1580689>
- Práxedes, A, Domínguez, A. M., Serrano, J. S., García-González, L., & Álvarez, F. del V. (2017). The effects of a comprehensive teaching program on dribbling and passing decision-making and execution skills of young footballers. *Kinesiology*, 49(1), 74 – 83. <https://doi.org/10.26582/k.49.1.6>
- Práxedes, A, Moreno, A., Sevil, J., García-González, L., & Del Villar, F. (2016). A preliminary study of the effects of a comprehensive teaching program, based on questioning, to improve tactical actions in young footballers. *Perceptual and Motor Skills*, 122(3), 742–756. <https://doi.org/10.1177/0031512516649716>
- Práxedes, Alba, Moreno, A., Gil-Arias, A., Claver, F., Del Villar, F., Praxedes, A., Moreno, A., Gil-Arias, A., Claver, F., & Del Villar, F. (2018). The effect of small-sided games with different levels of opposition on the tactical behaviour of young footballers with different levels of sport expertise. *PLOS ONE*, 13(1), e0190157. <https://doi.org/10.1371/journal.pone.0190157>
- Psotta, R., & Martin, A. (2011). Changes in decision making skill and skill execution in soccer performance: The intervention study; [Změny dovedností v rozhodování a provedení činnosti ve fotbalovém výkonu: Intervenční studie]. *Acta Universitatis Palackianae Olomucensis, Gymnica*, 41(2), 7–15. <https://doi.org/10.5507/ag.2011.008>
- Roberts, S. J., Rudd, J. R., & Reeves, M. J. (2020). Efficacy of using non-linear pedagogy to

- support attacking players' individual learning objectives in elite-youth football: A randomised cross-over trial. *Journal of Sports Sciences*, 38(11–12), 1454–1464. <https://doi.org/10.1080/02640414.2019.1609894>
- Roca, A., & Ford, P. R. (2021). Developmental activities in the acquisition of creativity in soccer players. *Thinking Skills and Creativity*, 41, 100850. <https://doi.org/10.1016/j.tsc.2021.100850>
- Roca, A., & Ford, P. R. (2020). Decision-making practice during coaching sessions in elite youth football across European countries. *Science and Medicine in Football*, 4(4), 263–268. <https://doi.org/10.1080/24733938.2020.1755051>
- Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, 30(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>
- Romeas, T., Guldner, A., & Faubert, J. (2016). 3D-Multiple Object Tracking training task improves passing decision-making accuracy in soccer players. *Psychology of Sport and Exercise*, 22, 1–9. <https://doi.org/10.1016/j.psychsport.2015.06.002>
- Sarmiento, H, Anguera, M., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports Medicine*, 48(4), 907–931. <https://doi.org/10.1007/s40279-017-0851-7>
- Sarmiento, H, Clemente, F., Araújo, D., Davids, K., McRobert, A., & Figueiredo, A. (2018). What performance analysts need to know about research trends in association football (2012–2016): A systematic review. *Sports Medicine*, 48, 799–836. <https://doi.org/10.1007/s40279-017-0836-6>
- Sarmiento, Hugo, Clemente, F. M., Harper, L. D., Costa, I. T. da, Owen, A., & Figueiredo, A. J. (2018). Small sided games in soccer—a systematic review. *International Journal of Performance Analysis in Sport*, 18(5), 693–749. <https://doi.org/10.1080/24748668.2018.1517288>
- Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2018). “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. *Frontiers in Psychology*, 9(FEB), 1–12. <https://doi.org/10.3389/fpsyg.2018.00188>

- Sierra-Ríos, J. V., Clemente, F. M., Rey, E., & González-Víllora, S. (2020). Effects of 6 weeks direct instruction and teaching games for understanding programs on physical activity and tactical behaviour in u-12 soccer players. *International Journal of Environmental Research and Public Health*, 17(14), 1–14. <https://doi.org/10.3390/ijerph17145008>
- Sierra-Rios, J. V, Clemente, F. M., Rey, E., Gonzalez-Villora, S., Sierra-Ríos, J. V., Clemente, F. M., Rey, E., & González-Víllora, S. (2020). Effects of 6 weeks direct instruction and teaching games for understanding programs on physical activity and tactical behaviour in u-12 soccer players. *International Journal of Environmental Research and Public Health*, 17(14), 5008. <https://doi.org/10.3390/ijerph17145008>
- Silva, A. F., Ramirez-Campillo, R., Sarmiento, H., Afonso, J., & Clemente, F. M. (2021). Effects of training programs on decision-making in youth team sports players: A systematic review and meta-analysis. *Frontiers in Psychology*, 12(May), 663867. <https://doi.org/10.3389/fpsyg.2021.663867>
- Starkes, J., Cullen, J., & MacMahon, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In N. Hodges & M. Williams (Eds.), *Skill acquisition in sport: Research, theory and practice*. Routledge.
- Teoldo, I., Garganta, J., Greco, P., Mesquita, I., & Maia, J. (2011). System of tactical assessment in soccer (FUT-SAT): Development and preliminary validation. *Motricidade*, 7(1), 69–83. [https://doi.org/10.6063/motricidade.7\(1\).121](https://doi.org/10.6063/motricidade.7(1).121)
- Teoldo, I., Guilherme, J., & Garganta, J. (2022). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., ... Straus, S. E. (2018). PRISMA extension for scoping reviews (PRISMA-ScR): Checklist and explanation. *Annals of Internal Medicine*, 169(7), 467–473. <https://doi.org/10.7326/M18-0850>
- Valencia-Sánchez, W. G., & Arias, E. A. (2021). Effects of the didactic model of game action competences on tactical performance, motivation, and perception of skill in young football players. *Journal of Physical Education and Sport*, 21(6), 3556–3568. <https://doi.org/10.7752/jpes.2021.06481>

- Viciano, J., Mayorga-Vega, D., Guijarro-Romero, S., & Martínez-Baena, A. (2017). Effect of two alternated teaching units of invasion team sports on the tactical learning in primary schoolchildren. *International Journal of Performance Analysis in Sport*, 17(3), 256–270. <https://doi.org/10.1080/24748668.2017.1331575>
- Wallace, J. L., & Norton, K. I. (2014). Evolution of World Cup soccer final games 1966-2010: Game structure, speed and play patterns. *Journal of Science and Medicine in Sport*, 17(2), 223–228. <https://doi.org/10.1016/j.jsams.2013.03.016>
- Whipp, P. R., Jackson, B., Dimmock, J. A., & Soh, J. (2015). The effects of formalized and trained non-reciprocal peer teaching on psychosocial, behavioral, pedagogical, and motor learning outcomes in physical education. *Frontiers in Psychology*, 6(FEB), 149. <https://doi.org/10.3389/FPSYG.2015.00149>
- Wierike, S. C. M., Van Der Sluis, A., Van Den Akker-Scheek, I., Elferink-Gemser, M. T., & Visscher, C. (2013). Psychosocial factors influencing the recovery of athletes with anterior cruciate ligament injury: A systematic review. *Scandinavian Journal of Medicine and Science in Sports*, 23(5), 527–540. <https://doi.org/10.1111/sms.12010>
- Williams, A. M., Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.1766647>

Capítulo II

Estudo 2: Artigo original um

Este capítulo foi submetido como artigo original para a revista:
International Journal of Sport and Exercise Psychology

Estudo 2: Contribution of deliberate practice, play, and futsal to the acquisition of decision-making skills in Brazilian professional female soccer players

Guilherme Machado; Sixto González-Víllora; Israel Teoldo

Abstract: Previous research on the development of decision-making skills in soccer players focused, especially on male samples. This is the first study to analyse decision-making skills development in female soccer players, considering the assessment of both offensive and defensive behaviors. The purpose of this study was twofold: 1) to analyse whether Brazilian professional female soccer players with different levels of decision-making skills can be differentiated based on their engagement in various types and amounts of soccer activities during their development; 2) to discuss what sport's education pathway contributed most for the development of decision-making skills. The sample comprised 77 Brazilian professional female soccer players. Decision-making skills was assessed based on an objective video-based test (TacticUP®). We used a retrospective questionnaire to collect information about previous participation in different soccer activities. We found differences among high skill (HS) and low skill (LS) decision-making groups regarding their participation in developmental activities in every period that was assessed (childhood, early, and late adolescence). In summary, we found that in every period set, the HS group accumulated more percentage time of their participation in soccer activities in practice compared to the LS group. Moreover, the HS group gathered more hours of practice in futsal and total practice (i.e., considers the accumulated practice time in soccer and futsal) in early adolescence (13-15 years) compared to the LS group. We concluded that the specialized diversification pathway is the one that best characterizes the sports involvement of better decision-makers during childhood.

Keywords: female football; female sport; deliberate practice/play and futsal; tactical awareness; perceptual-cognitive skills.

Resumo: Pesquisas anteriores sobre o desenvolvimento da capacidade de tomada de decisão em jogadores de futebol focaram, especialmente em amostras masculinas. Este é o primeiro estudo a analisar o desenvolvimento da capacidade de tomada de decisão em jogadoras de futebol feminino, considerando a avaliação tanto de comportamentos ofensivos quanto defensivos. Este estudo teve dois objetivos: 1) analisar se as jogadoras de futebol profissionais brasileiras com diferentes níveis de tomada de decisão podem ser diferenciadas considerando a vivência prévia em atividades relacionadas ao futebol ao longo da formação; 2) discutir qual trajetória esportiva mais contribuiu para o desenvolvimento da tomada de decisão. A amostra foi composta por 77 jogadoras brasileiras de futebol profissional. A capacidade de tomada de decisão foi avaliada com base em um teste de vídeo objetivo (TacticUP). Utilizamos um questionário retrospectivo para coletar informações sobre a participação anterior em diferentes atividades de futebol. Encontramos diferenças entre os grupos de alta tomada de decisão (ATD) e baixa tomada de decisão (BTD) quanto à sua vivência prévia em atividades relacionadas ao futebol em cada período que foi avaliado (infância, início da adolescência e final da adolescência). Resumidamente, verificamos que em cada período avaliado, o grupo de ATD acumulou mais tempo percentual de sua participação em atividades de prática deliberada, em comparação com o grupo de BTD. Além disso, o grupo ATD acumulou mais horas de prática deliberada no futsal e na prática total (considera o tempo acumulado de prática deliberada no futebol e no futsal) no início da adolescência (13-15 anos) em comparação com o grupo LS. Concluimos que a trajetória esportiva de diversificação especializado durante a infância é o que melhor caracteriza o envolvimento esportivo das jogadoras com alta tomada de decisão.

Palavras-chave: futebol feminino; esporte feminino; prática/jogo deliberada e futsal; consciência tática; habilidades perceptivo-cognitivas.

Introduction

The performance in soccer depends on an individual's competence to make efficient decisions, which can be divided into perceptual-cognitive and perceptual-motor skills, where both contribute to the development of expertise in the sport (McPherson and Kernodle 2003; Williams, Ford, and Drust 2020). Perceptual-cognitive skills can be considered to be what one is able to perceive and understand, while perceptual-motor skills refer to what one is able to perceive and do through movement (Materniuk 1976; Starkes, Cullen, and MacMahon 2004). In this context, decision-making can be defined as an action choice, and it is an outcome that can be observed as a motor or verbal response (Bruce et al., 2012; Macmahon & Mcpherson, 2009). In the last few years the study of perceptual-cognitive skills has received an increasing attention by the field of talent identification and development in soccer, as many studies have shown the association of such component with game performance (Andrade et al., 2021; Cardoso et al., 2019; Gonçalves et al., 2020).

In this context, the development of decision making in soccer depends on different factors, such as individuals' previous experience in the sport, the quality of the experiences they have had during their sports education, and the phase of sport development depending on their age (Williams et al. 2020). Regarding the phases of sport development, the theoretical model proposed by Côté and collaborators (1999; 2007; 2014), known as the Development Model of Sport Participation (DMSP), has been widely used in the world to understand the process of sport education in different sports (Murata et al., 2021), including several studies in soccer (Ford et al., 2020; Roca et al., 2012). In addition, this model has been used in research that seeks to optimize and direct public investment policies to qualify sports training systems in different countries (Côté & Vierimaa, 2014; Godbout & Gréhaigne, 2020).

This theoretical model divides sports education into different stages, which are classified as: 1) sampling years (6-12 years old); 2) specialization years (13-15 years old); 3) investment years (from 16 years old to adulthood); and 4) early specialization (from 6 years old to adulthood). These different stages are characterized by the type of activities involved in the practice of the sport(s). It also considers the age of the individuals and the number of sports practiced. The types of activities are called deliberate practice and deliberate play. The deliberate practice is characterized by activities performed with the purpose of improving performance (and not necessarily to generate satisfaction) and require a high cognitive and/or physical effort, besides

being positively associated with the development of specific abilities (e.g., systematized practice with the team led by the coach) (Ericsson et al., 1993). On the other hand, deliberate play is characterized by a form of intrinsically motivating sports activity that provides immediate gratification and is specifically designed to maximize satisfaction in the activity (e.g., playing soccer in the park with friends) (Côté, 1999). Thus, the initial DMSP proposed by Côté presents two possible main trajectories in sport to reach elite performance, which are: 1) participation in elite performance, through early sampling (in other sports) and high amounts of deliberate play; and 2) participation in elite performance, through early specialization (in the main sport) and high amounts of deliberate practice.

Based on the proposal of the DMSP model, in recent years, researchers from different countries proposed to investigate which sports trajectory was associated with the achievement of elite performance in soccer, considering especially the initial years of sport participation (6-12 years) (Ford et al., 2020, 2009; Sieghartsleitner et al., 2018). These works found an alternative trajectory to those proposed by the DMSP for the sport's development of soccer players who reached an elite performance and higher competitive level compared to those who did not reach such high-performance levels. This alternative trajectory, called the early engagement hypothesis, is characterized by involvement in the primary sport (soccer) in both activities of deliberate practice and deliberate play since the early years of sports participation (6-12 years), as well as by a low sampling (participation) in other sports (Ford et al., 2009). In other words, this sports trajectory argues that the involvement from early ages in soccer activities of structured practice, when accompanied by the accumulation of experiences of deliberate play in soccer, leads to higher performance in soccer in the future.

Subsequently to the proposal of this alternative trajectory mentioned above, a new interpretation for the concept of sports diversification during the sampling years was proposed by Côté and Erickson (2015). The understanding of this term came to be related to the diversification of the types of activities in different sporting contexts (e.g., playing beach soccer, futsal, soccer in the park, or participating in structured practice). Therefore, the understanding of “diversification” (or sampling) was no longer exclusive to the diversification of sports played (e.g., volleyball, handball, and basketball), as was initially proposed in the DMSP (Côté, 1999). Together with several studies, this new understanding has demonstrated the importance of both deliberate play and deliberate practice to achieve elite performance and higher competitive level (Ford et al., 2009;

Ford & Williams, 2012; Haugaasen et al., 2014; Roca et al., 2012) that supported the proposal of another sports trajectory in soccer. This new trajectory proposed by Sieghartsleitner et al. (2018) is the specialized diversification. This trajectory advocates the engagement in both deliberate play and deliberate practice activities from the early years of sports education (6-12 years) - as in Ford et al. (2009) proposal. However, it also advocates diversification of soccer activities in different contexts, such as street soccer, beach soccer, futsal and structured team practice.

Therefore, we must consider the different types of activities experienced during the sport's education and the different proposals of sport's trajectories presented above, to understand which contribute most for the development of soccer players regarding their decision-making skills. Several studies have shown that the interaction of both types of activities (deliberate play and practice) is essential for the development of decision-making in athletes. However, there is no consensus on the ideal period or age to focus on the accumulation of these different types of activities (Machado et al. 2020; Roca et al. 2012; Sieghartsleitner et al. 2018). Therefore, knowing the previous experiences of individuals in soccer is necessary to understand which contexts they have experienced during their sports training, especially in the childhood (6-12 years).

Although some studies have already sought to investigate which activities contribute to the development of decision-making in soccer players, the focus has been on male samples (Roca, Williams, and Ford 2012; Machado et al. 2020). To the best of our knowledge, we found no research that evaluated the process of decision-making development in female soccer players, considering the assessment of both offensive and defensive behaviors (Barquero-Ruiz et al., 2020). Therefore, the evaluation should be based on the contribution to the game as a whole and not only on individual performance where the players is assessed just in situations with the ball. Moreover, there has been much more research in men's sports (Scharfen & Memmert, 2019) and men's soccer (Ivarsson et al., 2020). To give a picture of such discrepancy, a recent systematic review and meta-analysis on psychological factors associated with future performance in soccer (Ivarsson et al., 2020) found that the total sample size included in the selected studies was 3070 males and only 26 female players. In other words, it means that male samples were more than 100 times overrepresented in studies in this research area.

Researchers generally have good intentions and even include that studies should be done with female samples in their future research prospects. However, then we find out that this is not happening. For instance, a recent work published by Williams, Ford, and Drust (2020), related to

the talent development in soccer found that little research has been conducted with female athletes in soccer and South American athletes during the last 20 years. Therefore, this recent and important work, concluded that there is a need to broaden the scope of research to cover female athletes and the South American context, based on theory driven assumptions (e.g., DMSP model) regarding this theme.

Thus, there is a need for research that can subsidize the construction of a structured curriculum that favors the development of decision-making skills throughout sports development education of female soccer players. For that, it is necessary to understand how previous experience in different soccer activities (e.g., deliberate practice and deliberate play) may contribute for the development of decision-making skills in elite female soccer players. Therefore, the purpose of this study was twofold: 1) to analyse whether the engagement in various types and amounts of soccer activities during childhood and adolescence can differentiate Brazilian professional female soccer players with different levels of decision-making skills; and 2) to discuss what sport's education pathway contributed most for the development of decision-making skills in female soccer.

Materials and Methods

Study Design

In this study, we used the quasi-experimental methodological design. We examine the type and amount of soccer developmental activities that contributed to distinguish Brazilian professional soccer players with different levels of decision-making skills. Players' decision-making skills was assessed based on an objective video-based test - TacticUP® (Machado and Teoldo 2020). Scores in the test were used to create groups with high and low decision-making skills. We used a retrospective questionnaire (Ford et al., 2010; Haugaasen et al., 2014) to collect information about previous participation in different soccer activities.

Participants

The sample comprised 77 Brazilian professional female soccer players ($M = 23.4 \pm 4.2$ years of age) from six soccer teams of three different states in Brazil. Participants should be competing on the professional national league in Brazil for inclusion criteria. Data collection was carried out with previous approval from club officials and athletes. The present study was approved by the Ethics

Committee for Research with Human Beings from the leading institution (Approval number: 4.924.597) and is in accordance with the norms established by the National Health Council (466/2012), and by the Declaration of Helsinki (2013) for research with human beings. Participants provided signed and informed consent.

Measures and Procedures for Data Collection

Decision-making skills (TacticUP®)

TacticUP® is an online platform (www.tacticup.com.br) that allows the assessment of decision-making skills of players (Machado and Teoldo 2020). In addition, this platform allows evaluating response accuracy of players' decision-making skills, based on the core tactical principles of the offensive and defensive phases, in situations with and without the ball (Teoldo et al., 2021).

Before the start of the test, the online platform displays instructions to participants regarding the test structure and procedures, and three trial scenes are exhibited to familiarize the subjects with the assessment, thus excluding the possibility of low performance due to lack of comprehension of the task. These three trial scenes include: two offensive sequences (one in which the player being observed is in possession of the ball, and another in which he is not in possession) and one defensive sequence (the player being observed is in the defensive phase of play). These three conditions enable participants to familiarize themselves with the characteristics of the video sequences they were about to watch. The test was carried out using laptop computers with internet, to enable the access to the tests in the TacticUP® platform. The test took around 20 minutes per player. The measure used in this study was the decision-making general index, which is comprised by the average of the offensive and defensive indexes (further details are available in Machado and Teoldo 2020).

Developmental Activities (Participation History Questionnaire)

The Participation History Questionnaire (PHQ), used in several studies (Ford et al. 2010; Haugaasen et al. 2014; Roca et al. 2012), including studies with Brazilian youth samples (Ford et al. 2012; Machado et al. 2020) was used to measure the soccer activities undertaken by players. The test-retest reliability and the concurrent validity of the PHQ were shown in Ford et al (2010). This questionnaire allowed us to gather information on engagement in soccer developmental activities. Five variables related to developmental sport activities, also included in previous studies

(Ford et al., 2012; Helsen et al., 1998; Hendry & Hodges, 2018), were assessed: 1) practice in soccer; 2) play in soccer; 3) percentage of time in play; 4) practice in futsal; 5) number of other sports. Team practice in soccer was related to soccer activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team). Deliberate play activities in soccer are related to play-type games with specific rules created and supervised by participants, in which the primary goal is enjoyment (e.g., playing a soccer game with friends in the park). The % time in play was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer. Team practice in futsal was related to futsal activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team). The number of other sports considered the participation in other sports than soccer, where participants were involved for more than three months in contexts that were not physical education classes.

In addition to these five variables mentioned above, we proposed the inclusion of a sixth variable in this study. This variable comprises the time spent in soccer practice plus futsal practice, where we called “total practice”. It was a composite metric calculated based on variables collected through the questionnaire. We proposed the inclusion of such variable, considering two main points: 1) the new interpretation of sports diversification through the opportunity to play activities related to the primary sport in different settings and contexts (Côté & Erickson, 2015; Sieghartsleitner et al., 2018); and 2) the cultural aspect in Brazil, where most soccer players have played futsal during their sports formation since childhood (Ford et al., 2012).

Therefore, to complete the questionnaire, participants should provide the number of hours per week and the number of months per year they spent in those soccer activities since they start participation in soccer. They also provided information about the number of weeks from each year they were injured and unable to participate in soccer activities. This information was given retrospectively, from the present season, going backward in a one-year interval up to 5 years of age, or the age they started participation in soccer activities. The calculation of the accumulated hours in soccer activities was performed by multiplying hours reported per week by weeks per year; minus weeks per year that players reported injuries that prevented them from participating in soccer activities. For the number of weeks per year, we considered a 40 weeks season for practice, as used in previous study (Roca et al., 2012).

This retrospective questionnaire was applied online, using a mobile phone, tablet or computer with internet access, where the researcher in charge explained how to fill out the questionnaire. After the initial explanation, the participants answered the questionnaire, while the researcher was available to answer any questions that arose during the completion of the form. The application took approximately 60 minutes per player.

Statistical Analysis

Soccer players were divided according to their decision-making skills. Players were separated into three skill groups (low, medium, and high). Only the low skill group (LS) and high skill group (HS) were considered for data analysis. This procedure was used to ensure that the division criteria of participants in different skill subgroups (based on the score of the TacticUP®) were based on objective criteria that statistically differentiated both groups analyzed, as used in previous research (Ford et al. 2010; Machado et al. 2020; Roca et al. 2012; Williams et al. 2012). Moreover, the TacticUP® variable used in our study (general index) was the strongest variable generated by this assessment system to detect differences among different expertise levels in soccer players (Machado and Teoldo 2020).

In addition, developmental activities data were analysed for three age periods: 1) 6–12 years of age (i.e., childhood); 2) 13–15 years of age (i.e., early adolescence); and 3) 16–18 years of age (i.e., late adolescence) to match the developmental stages outlined by Côté (1999). Afterward, we verified the between-group differences in all the variables measured by the PHQ using an independent t-test or Mann-Whitney U-test, considering the data distribution. Distributions were checked with a Kolmogorov-Smirnov test. The level of significance was set as $p < .05$. The effect size used for the independent t-test was Cohens's d (Cohen, 1988), and for Mann-Whitney tests was calculated through the formula described by Fritz, Morris, and Richler (2012) as $(r = Z/\sqrt{n})$. The interpretation of the effect size value was made as follows Cohen (1988): small effect (.1 - .29); medium effect (.3 - .49); and large effect ($> .5$). For statistical procedures was utilized the software SPSS (Statistical Package for Social Sciences) 22.0.

Results

The focus of our study was to understand the sports education in female soccer players since childhood (6-12 years), passing through the phase of sport development during early adolescence

(13-15 years) up to the step to “semi-professionalization” in late adolescence/young adulthood (16-18 years). Therefore, we present our results divided into three different age periods as follows.

Childhood (6-12 years)

The high skill (HS) group showed statistically lower values in the *% time in play* ($M = 53.9$, $SD = 31.5$) compared to the low skill (LS) group ($M = 79.9$, $SD = 25.7$), $U = 119.0$, $z = -2.582$, $p = .010$, $r = .365$, *medium effect* (see table 1). In other words, it means that during this period, the HS group spent, on average, 53.9% of the time in play activities in soccer and 46.1% of the time in practice activities in soccer. On the other hand, during this period, the LS group spent higher amounts of time in play activities in soccer, which was, on average, 79.9% of the time and only 20.1% in practice activities in soccer.

Early adolescence (13-15 years)

It was the period where we found the most differences among both groups. The HS group showed statistically lower values in the *% time in play* ($M = 38.6$, $SD = 29.6$) compared to the LS group ($M = 59.2$, $SD = 32.6$), $t(45) = 2.273$, $p = .028$, $d = .660$, *large effect* (see table 1). It means that the HS group spent, on average, 38.6% of the time in play activities in soccer and 61.4% of the time in practice activities in soccer. In contrast, the LS group spent, on average, 59.2% of the time in play activities in soccer and 40.8% in practice activities in soccer.

Moreover, considering the amount of time (h) spent in *practice in futsal*, the HS group showed statistically higher values ($M = 487.8$, $SD = 542.3$) compared to the LS group ($M = 236.9$, $SD = 379.0$), $U = 202.5$, $z = -2.001$, $p = .045$, $r = .282$, *small effect*. The last statistically difference found for this period was the amount of time (h) spent in *total practice (soccer + futsal)*, where the HS group showed statistically higher values ($M = 1108.0$, $SD = 871.7$) compared to the low skill (LS) group ($M = 695.4$, $SD = 744.4$), $U = 198.5$, $z = -2.212$, $p = .027$, $r = .312$, *medium effect*.

Late adolescence (16-18 years)

The HS group showed statistically lower values in the *% time in play* ($M = 22.3$, $SD = 21.3$) compared to the LS group ($M = 39.2$, $SD = 26.1$), $U = 182.0$, $z = -2.361$, $p = .018$, $r = .333$, *medium effect* (see table 1). It means that the HS group spent, on average, 22.3% of the time in play activities in soccer and 77.7% of the time in practice activities in soccer. On the contrary, the LS group spent, on average, 39.2% of the time in play activities in soccer and 60.8% in practice activities in soccer.

Table 1. Comparisons between high and low decision-making skill groups based on different types of soccer developmental activities.

DEVELOPMENTAL ACTIVITIES	High Decision-Making Skills (M ± SD; n = 25)	Low Decision-Making Skills (M ± SD; n = 25)	p	Effect size
Childhood (6-12 years)				
Practice in soccer (h)	550.8 ± 739.5	322.1 ± 695.8	0.090	-
Play in soccer (h)	994.7 ± 1450.3	1909.9 ± 2263.6	0.303	-
% time in play ¹	53.9 ± 31.5	79.9 ± 25.7	0.010*	0.365 (medium effect)
Practice in futsal (h)	558.6 ± 958.2	357.3 ± 662.6	0.221	-
Total practice (soccer + futsal) (h)	1087.0 ± 1253.6	679.3 ± 1054.0	0.076	-
Number of other sports	1.1 ± 1.2	0.8 ± 1.0	0.396	-
				0.010* 0.365 (m)
Early adolescence (13-15 years)				
Practice in soccer (h)	640.0 ± 628.3	458.5 ± 613.2	0.167	-
Play in soccer (h)	490.5 ± 698.3	963.6 ± 1185.7	0.214	-
% time in play ¹	38.6 ± 29.6	59.2 ± 32.6	0.028*	0.660 (large effect)
Practice in futsal (h)	487.8 ± 542.3	236.9 ± 379.0	0.045*	0.282 (small effect)
Total practice (soccer + futsal) (h)	1108.0 ± 871.7	695.4 ± 744.4	0.027*	0.312 (medium effect)
Number of other sports	1.2 ± 0.8	1.4 ± 1.1	0.693	-
Late adolescence (16-18 years)				
Practice in soccer (h)	973.4 ± 702.7	833.7 ± 711.7	0.313	-
Play in soccer (h)	318.3 ± 568.8	703.0 ± 871.0	0.127	-
% time in play ¹	22.3 ± 21.3	39.2 ± 26.1	0.018*	0.333 (medium effect)
Practice in futsal (h)	319.8 ± 418.9	236.2 ± 371.2	0.297	-
Total practice (soccer + futsal) (h)	1293.2 ± 744.8	1069.8 ± 878.0	0.218	-
Number of other sports	0.8 ± 0.6	1.2 ± 1.0	0.102	-
				0.028* 0.660 (l)
				0.045* 0.282 (s)
				0.027* 0.312 (m)

¹ % time in play was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer.

* significant differences (p < 0.05)

Discussion

The purpose of this study was twofold: 1) to analyse whether the engagement in various types and amounts of soccer activities during childhood and adolescence can differentiate Brazilian professional female soccer players with different levels of decision-making skills; and 2) to discuss what sport's education pathway contributed most for the development of decision-making skills in female soccer.

We found differences among high skill (HS) and low skill (LS) decision-making groups regarding their participation in developmental activities in every period that was assessed (childhood, early and late adolescence). In summary, we found that in every period set, the HS group accumulated more percentage time of their participation in soccer activities in practice compared to the LS group. Moreover, the HS group gathered more hours of practice in futsal and in total practice (i.e., considers the accumulated practice time in soccer and futsal) in early adolescence (13-15 years), when compared to the LS group.

In the childhood period, we found differences in only one variable assessed, which was the percentual time in play. This variable considers the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer. The HS group accumulated less time in play activities (average of 53.9%) than the LS group (average of 79.9%). It shows that the HS group was more involved in structured practice in soccer during this sport developmental phase than the LS group. Similar results were found by a study that assessed elite male youth players from the UK (~15 years) (Hendry et al., 2018). In this study, a greater percentage of time spent in practice in childhood was positively associated to higher ratings of creative and tactical skills. In the same vein, another study carried out with youth male players from Brazil (~14.9 years), found that players who possessed better tactical decision-making skills accumulated more hours of practice in soccer during their sport formation compared to players with lower decision-making skills (Machado et al. 2020). Moreover, both groups (high and low decision-makers) assessed in the aforementioned study also possessed higher amounts of time spent in play activities compared to practice activities in soccer, which is similar to the finds of our results. These results altogether suggest that high amounts of time spent in practice in soccer (~45% in average) during childhood, when coupled with a considerable amount of time spent in deliberate play (~55% in average), favors the development of decision-making skills in older ages, such as adolescence and adulthood.

In turn, early adolescence was the period that we found the most differences among the HS and LS groups. In this period, we found that the HS group showed a lower percentage of time spent in play soccer activities (average of 38.6%) than the LS group (average of 59.2%). We highlight that this variable was the one that showed a larger effect size among all variables assessed (large effect) to differentiate both HS and LS groups, which shows its importance during this period of sport formation. It means that in the early adolescence period, the HS group had a shift in the type of activities they participated in soccer compared to childhood. The involvement was mainly focused on practice activities in soccer (~ 60% on average) and less on play activities in soccer (~ 40% on average). On the other hand, the LS group continued their involvement in soccer activities, more focused on play activities (~ 60% on average) and less on practice activities (~ 40% on average). Furthermore, the HS group showed a similar pattern of participation in soccer activities for the early adolescence period compared to a study carried out with professional female soccer players who participated in their country's national squad (Ford et al., 2020). In this study, the female players accumulated during early adolescence more hours of practice activities in soccer compared to play activities in soccer.

In addition, a previous study on decision-making skills development carried out with male samples showed a different pattern than found in our results (Roca, Williams, and Ford 2012). They found that male soccer players with better decision-making skills accumulated more deliberate play hours during adolescence. Perhaps such differences among genders suggest that it requires a different pedagogical treatment than men's sports or that male coaches working with women's teams need to develop distinct coaching philosophies during different phases of sport formation (O'Brien-Smith et al., 2020).

Moreover, we found that the HS group accumulated more hours of practice in futsal and more hours of total practice (futsal + soccer) than the LS group. These results align with recent research that advocates the potential of engagement in futsal practice to contribute to talent development in soccer (Oppici et al., 2019; Travassos et al., 2018; Yiannaki et al., 2018). Yiannaki, Carling, and Collins (2018) found that a large majority (~ 90%) of soccer coaches interviewed in their study considered the futsal useful in soccer talent development and would consider using it in their coaching/game provision. It is because futsal can aid the acquisition of skills that could transfer to soccer environments and, consequently, enhance players' performance in soccer. Moreover, there is empirical evidence that futsal practice promotes the transfer of tactical-technical

skills (e.g., passing skills) to soccer (Oppici et al., 2019). This potential of positive transfer between futsal skills to soccer skills has been attributed to similarities between perceptual-cognitive and perceptual-motor skills of both sports.

Furthermore, due to the characteristics of futsal, such as fewer players and dimensions compared to soccer, it may contribute to a wide range of technical and tactical abilities and decrease the game's complexity (Travassos et al., 2018). Therefore, it has been suggested that futsal has a great potential to promote diversification in contexts (e.g., ball, surface, number of players, or dimension) within the “football” sport, especially in earlier phases of sport formation. Additionally, it can be used as an alternative training methodology in soccer, similar to small-sided games. Interestingly, recent research with male youth soccer players, found that the use of small sided-games in soccer practice, such as 2x2 up to 4x4 activities, during early adolescence was positively associated with the development of offensive tactical decision-making skills (Machado et al. 2020). Therefore, considering our results during the early adolescence period, it suggests that a greater prevalence of participation in structured activities in soccer and futsal in this period of sport development may favor the development of decision-making skills in female soccer players.

Considering the late adolescence period, we found just one difference among both groups: the HS group showed a lower percentage of time spent in play soccer activities (average of 22.3%) than the LS group (average of 39.2%). The results found for the HS group show a more likely pattern excepted for this phase of sport formation, known as the investment phase. High amounts of deliberate practice in the primary sport are expected, and low amounts of deliberate play (Côté et al., 2007). In other words, we found that the involvement of the HS group was mainly focused on practice activities in soccer (~ 80% on average) and almost four times less on play activities in soccer (~ 20% on average). On the other hand, although the LS group showed a prevalence of involvement in practice activities in soccer (~ 60% on average), this amount is not even twice as much time their involvement in play activities in soccer (~ 40% on average). In other words, this percentual shown by the LS group in late adolescence looks very similar to the pattern found by the HS group during its early adolescence (see table 1).

Moreover, the pattern showed by the HS group in this period, which was around four times more time spent on practice activities compared to play activities, was much more similar to the pattern found by Ford et al. (2020) with female adult soccer players from senior national teams. In this study, the players from their national squads showed during their late adolescence almost six

times more times (on average) spent on practice activities compared to play activities in soccer. These results indicate that a greater prevalence of involvement in practice activities in soccer during late adolescence is associated with higher performance levels on soccer, such as reaching a national squad and are linked to the development of decision-making skills.

Regarding the development of decision-making skills, we will discuss which pathway, especially in childhood (6-12 years), best characterize the sports formation of professional female soccer players from Brazil with higher decision-making skills. We found that players with higher decision-making skills during their childhood participated in a diversity of contexts related to “football” games, such as play and practice in soccer and practice in futsal. In contrast, we found that in terms of engagement of other sports, there was no diversification, once the players participated on average in only 1.1 other sports apart from soccer. Moreover, they engaged in great amounts of play activities in soccer (~ 1,000h on average) and practice activities in both soccer (~ 550h on average) and futsal (~ 550h on average). It means they were involved in similar amounts of play activities (~ 1,000h on average) and practice activities when we couple soccer and futsal (~ 1,100h on average).

Therefore, the specialized diversification pathway, proposed by Sieghartsleitner et al. (2018), is the one that best characterizes the sports involvement during the childhood of professional female soccer players from Brazil with higher decision-making skills. This result suggests that the diversification of sports contexts in the primary sport during childhood may favor the development of decision-making skills of soccer players. Moreover, our findings partially support the early engagement pathway proposed by Ford et al. (2009) once we found a balanced involvement in play (~ 55% on average) and practice (~ 45% on average) activities in soccer during childhood. However, this pathway does not consider participation in similar sports apart from soccer (e.g., futsal) as we found in our study. In general, our results indicated that being engaged in a balanced percentual time in both practice and play during childhood enhances the probability of developing better decision-making skills in adulthood and keeping engaged on greater percentual time in practice during adolescence.

Other important finds of our study are related to the early adolescence period (13-15 years), known as specializing years by the DMSP (Côté, 1999). The players with higher decision-making skills still participated in various contexts related to “football” games, such as play and practice in soccer and practice in futsal. However, during this phase, we found a shift in the prevalence of

activities they participated in soccer compared to childhood as expected by the DMSP. It means that participation was focused more on structured activities, such as practice activities in soccer (~ 650h on average) and futsal (~ 500h on average). In other words, it means a prevalence of practice activities considering both soccer and futsal (~ 1,100h on average), compared to play activities (~ 500h on average). These results highlight the importance to enhance the volume of practice activities during early adolescence, coupled with a considerable amount of play activities, to favor the development of decision-making skills, as found in previous research (Baker and Côté 2003; Berry et al. 2008; Machado et al. 2020; Roca et al. 2012).

An exciting find in our study is that the proportion of percentage time of player's participation in soccer activities, considering play and practice, was the one that differentiated both groups of high and low decision-making skills in every developmental phase. Furthermore, we highlight that this variable was the one that showed a larger effect size among all variables assessed (large effect) to differentiate both HS and LS groups during early adolescence (13-15 years). Therefore, it shows a potential of such a variable for future research focused on developmental studies in sport. In this research field, it is more common to compare the total amount of accumulated hours in different activities, such as practice and play (Erikstad et al. 2018; Ford et al. 2020; Forsman et al. 2016; Haugaasen et al. 2014; Hendry et al. 2019; Machado et al. 2020; Roca and Ford 2021), instead of the proportion of them (Hendry & Hodges, 2018; Hendry et al., 2018).

Moreover, sports institutions could use this metric to enhance the learning and development of talented young female players as a low-cost assessment method. However, we recognize that it is needed to build more scientific knowledge considering different sports contexts, such as continents, countries, ages, gender, and competitive levels. Additionally, it would be interesting to investigate other aspects of decision-making skills in future studies, such as decision time and perceptual-motor skills, once literature indicates that cognitive and motor skills may develop in different manners during sports development (González-Víllora et al., 2013; Williams et al., 2020). In turn, a potential limitation with the method employed in our study was the unavailability to assess the quality of training sessions/programs during players' sports development. This limitation could be addressed in future studies using video/training analysis to characterize the nature of the practice, jointly with the employment of questionnaires.

In summary, to the best of our knowledge, our study was the first to study the development of decision-making skills considering the analysis of soccer activities during childhood and

adolescence of professional female soccer players. Another novelty of research with female soccer players was assessing decision-making skills based on an objective test that assesses both offensive and defensive skills based on collective tactical aspects (TacticUP®). It provides a broader profile of players' decision-making skills instead of tests that assesses only offensive situations with the ball or those focused on just individual actions. Moreover, our findings show a potential to be used by governing bodies and soccer stakeholders, such as the Brazilian Soccer Confederation (CBF), CONMEBOL, and Federation Internationale de Football Association (FIFA). It might subsidize the construction of an “equity and equality” structured curriculum that favors the development of decision-making skills throughout sports development education during the childhood and adolescence of female soccer players. We also suggest future studies to replicate this methodological approach with different youth female samples, such as U-21, -19, -17, and -15 female soccer players.

Conclusions

It is concluded that previous types and amounts of soccer activities performed during all formation stages (from 6 years to 18 years old) differentiate Brazilian professional female soccer players with different levels of decision-making skills. We found differences in every period that was assessed (childhood and early and late adolescence). In every period set, players with better decision-making skills accumulated more percentage time of their participation in soccer activities in practice than players with lower decision-making skills. Moreover, during early adolescence (13-15 years), the group with high decision-making skills accumulated more hours on practice in futsal and total practice (i.e., considers the accumulated practice time in soccer and futsal) compared to players with low decision-making skills. Therefore, it seems beneficial that young female players practice these two sports during their sports education, as there is a positive transfer between them, and that later on, the players decide which sport to continue their involvement.

Moreover, the sport developmental pathway during childhood that best characterizes players with high decision-making skills was the specialized diversification pathway. It means that the diversification of sports contexts in the primary sport, such as involvement in practice and play in soccer plus practice in futsal during childhood, may contribute to the development of decision-making skills of female soccer players in adulthood.

Practical Applications

- During childhood (6-12 years), involvement in a variety of contexts on the primary sport, such as play activities in soccer (~ 1,000h on average), practice in soccer (~ 650h on average), and practice in futsal (~ 500h on average) are related to better decision-making skills in adulthood. It means involvement in similar amounts of play activities (~ 1,000h on average) and practice activities when we couple soccer and futsal (~ 1,100h on average).
- During early adolescence (13-15 years), a prevalence of practice activities in soccer (~ 650h on average) and futsal (~ 500h on average) compared to play activities (~ 500h on average) are related to better decision-making skills in adulthood. It means more than twice the time spent in practice activities than play activities when we couple soccer and futsal (~ 1,100h on average).
- Our findings show a potential to be used by governing bodies and soccer stakeholders, such as CBF, CONMEBOL, and FIFA, to subsidize the construction of a structured curriculum throughout sports development education that contributes to the development of female soccer players with better decision-making skills.

Disclosure statement

No potential conflict of interest was reported by the authors.

Data availability statement

Due to the nature of this research, participants of this study did not agree for their data to be shared publicly, so supporting data is not available.

References

- Andrade, M. O. C., Costa, V. T., García-Calvo, T., Figueiredo, A., & Teoldo, I. (2021). Peripheral perception as discriminant factor of tactical behaviour efficiency of young soccer players. *International Journal of Sport and Exercise Psychology*, 19(6), 1034–1045. <https://doi.org/10.1080/1612197X.2021.1948588>
- Baker, J., & Côté, J. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, 15(1), 12–25.

<https://doi.org/10.1080/10413200390180035>

- Barquero-Ruiz, C., Arias-Estero, J. L., & Kirk, D. (2020). Assessment for tactical learning in games: A systematic review. *European Physical Education Review*, 26(4), 827–847. <https://doi.org/10.1177/1356336X19889649>
- Berry, J., Abernethy, B., & Côté, J. (2008). The contribution of structured activity and deliberate play to the development of expert perceptual and decision-making skill. *Journal of Sport and Exercise Psychology*, 30(6), 685–708. <https://doi.org/10.1123/jsep.30.6.685>
- Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. *Psychology of Sport and Exercise*, 13(2), 152–161. <https://doi.org/10.1016/j.psychsport.2011.10.005>
- Cardoso, F., González-Víllora, S., Guilherme, J., & Teoldo, I. (2019). Young soccer players with higher tactical knowledge display lower cognitive effort. *Perceptual & Motor Skills*, 126(3), 499–514. <https://doi.org/https://doi.org/10.1177/0031512519826437>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd Edition). Lawrence Erlbaum Associates. <https://doi.org/10.4324/9780203771587>
- Côté, J. (1999). The Influence of the family in the development of talent in sport. *The Sport Psychologist*, 13(4), 395–417. <https://doi.org/10.1123/tsp.13.4.395>
- Côté, J., Baker, J., & Abernethy, B. (2007). Practice and play in the development of sport expertise. In R. Eklund & G. Tenenbaum (Eds.), *Handbook of Sport Psychology* (3rd ed., pp. 184–202). John Wiley & Sons.
- Côté, J., & Erickson, K. (2015). Diversification and deliberate play during the sampling years. In Joseph Baker & D. Farrow (Eds.), *Routledge Handbook of Sport Expertise* (pp. 305–316). Routledge.
- Côté, J., & Vierimaa. (2014). The developmental model of sport participation: 15 years after its first conceptualization. *Science & Sports*, 29S(SUP), S63–S69. <https://doi.org/http://dx.doi.org/10.1016/j.scispo.2014.08.133>

- Ericsson, A. K., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363–406. <https://doi.org/10.1037/0033-295X.100.3.363>
- Erikstad, M. K., Høigaard, R., Johansen, B. T., Kandala, N. B., & Haugen, T. (2018). Childhood football play and practice in relation to self-regulation and national team selection; a study of Norwegian elite youth players. *Journal of Sports Sciences*, 36(20), 2304–2310. <https://doi.org/10.1080/02640414.2018.1449563>
- Ford, P. Low, J., McRobert, A., & Williams, A. (2010). Developmental activities that contribute to high or low performance by elite cricket batters when recognizing type of delivery from bowlers' advanced postural cues. *Journal of Sport & Exercise Psychology*, 32, 638–654. <https://doi.org/10.1123/jsep.32.5.638>
- Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., Stenling, A., Moreno, J., Gall, F. Le, Holmström, S., Salmela, J., & Williams, A. M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, 30(15), 1653–1663. <https://doi.org/10.1080/02640414.2012.701762>
- Ford, P. R., Hodges, N. J., Broadbent, D., O'Connor, D., Scott, D., Datson, N., Andersson, H. A., & Williams, A. M. (2020). The developmental and professional activities of female international soccer players from five high-performing nations. *Journal of Sports Sciences*, 38(11–12), 1432–1440. <https://doi.org/10.1080/02640414.2020.1789384>
- Ford, P. R., Ward, P., Hodges, N. J., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. *High Ability Studies*, 20(1), 65–75. <https://doi.org/10.1080/13598130902860721>
- Ford, & Williams, A. (2012). The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. *Psychology of Sport and Exercise*, 13(May), 349–352. <https://doi.org/10.1016/j.psychsport.2011.09.004>
- Forsman, H., Blomqvist, M., Davids, K., Konttinen, N., & Liukkonen, J. (2016). The role of sport-specific play and practice during childhood in the development of adolescent Finnish team

- sport athletes. *International Journal of Sports Science and Coaching*, 11(1), 69–77. <https://doi.org/10.1177/1747954115624816>
- Fritz, C., Morris, P., & Richler, J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, 141(1), 2–18. <https://doi.org/10.1037/a0024338>
- Godbout, P., & Gréhaigne, J. F. (2020). Revisiting the Tactical-Decision Learning Model. *Quest*, 72(4), 430–447. <https://doi.org/10.1080/00336297.2020.1792953>
- Gonçalves, E., Noce, F., Barbosa, M. A. M., Figueiredo, A. J., Hackfort, D., & Teoldo, I. (2020). Correlation of the peripheral perception with the maturation and the effect of the peripheral perception on the tactical behaviour of soccer players. *International Journal of Sport and Exercise Psychology*, 18(5), 687–699. <https://doi.org/10.1080/1612197X.2017.1329222>
- González-Víllora, S., García-López, L. M., Gutiérrez-Díaz, D., & Pastor-Vicedo, J. C. (2013). Tactical awareness, decision making and skill in youth soccer players (under-14 years). *Journal of Human Sport and Exercise*, 8(2), 412–426. <https://doi.org/10.4100/jhse.2012.82.09>
- Haugaasen, M., Toering, T., & Jordet, G. (2014). From childhood to senior professional football: A multi-level approach to elite youth football players' engagement in football-specific activities. *Psychology of Sport and Exercise*, 15(4), 336–344. <https://doi.org/10.1016/j.psychsport.2014.02.007>
- Helsen, W., Starkes, J., & Hodges, N. (1998). Team sports and theory of deliberate practice. *Journal of Sport & Exercise Psychology*, 20, 12–34. <https://doi.org/10.1123/jsep.20.1.12>
- Hendry, D. T., Crocker, P. R. E., Williams, M., & Hodges, N. J. (2019). Tracking and comparing self-determined motivation in elite youth soccer: Influence of developmental activities, age, and skill. *Frontiers in Psychology*, 10(MAR), 1–10. <https://doi.org/10.3389/fpsyg.2019.00304>
- Hendry, D. T., & Hodges, N. J. (2018). Early majority engagement pathway best defines transitions from youth to adult elite men's soccer in the UK: A three time-point retrospective and prospective study. *Psychology of Sport and Exercise*, 36(May), 81–89.

<https://doi.org/10.1016/j.psychsport.2018.01.009>

- Hendry, D. T., Williams, A. M., & Hodges, N. J. (2018). Coach ratings of skills and their relations to practice, play and successful transitions from youth-elite to adult-professional status in soccer. *Journal of Sports Sciences*, 36(17), 2009–2017. <https://doi.org/10.1080/02640414.2018.1432236>
- Ivarsson, A., Kilhage-Persson, A., Martindale, R., Priestley, D., Huijgen, B., Ardern, C., & McCall, A. (2020). Psychological factors and future performance of football players: A systematic review with meta-analysis. *Journal of Science and Medicine in Sport*, 23(4), 415–420. <https://doi.org/10.1016/j.jsams.2019.10.021>
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Machado, G., & Teoldo, I. (2020). TacticUP Video Test for soccer: Development and validation. *Frontiers in Psychology*, 11(1690), 1–12. <https://doi.org/10.3389/fpsyg.2020.01690>
- Macmahon, C., & Mcpherson, S. U. E. L. (2009). Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! *International Journal of Sport Psychology*, 40(4), 565–579.
- McPherson, S. L., & Kernodle, M. (2003). Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: advances in research on sport expertise* (pp. 137–167). Human Kinetics. [internal-pdf://228.60.152.31/2003 - Starkes & Ericsson - Expert Performance.pdf](https://doi.org/10.1016/j.psychsport.2018.01.009)
- Murata, A., Goldman, D. E., Martin, L. J., Turnnidge, J., Bruner, M. W., & Côté, J. (2021). Sampling between sports and athlete development: a scoping review. *International Journal of Sport and Exercise Psychology*, 0(0), 1–25. <https://doi.org/10.1080/1612197X.2021.1995021>
- O'Brien-Smith, J., Bennett, K. J. M., Fransen, J., & Smith, M. R. (2020). Same or different? A

- comparison of anthropometry, physical fitness and perceptual motor characteristics in male and female youth soccer players. *Science and Medicine in Football*, 4(1), 37–44. <https://doi.org/10.1080/24733938.2019.1650197>
- Oppici, L., Panchuk, D., Serpiello, F. R., & Farrow, D. (2019). Futsal task constraints promote the development of soccer passing skill: evidence and implications for talent development research and practice. *Science and Medicine in Football*, 3(3), 259–262. <https://doi.org/10.1080/24733938.2019.1609068>
- Roca, A., & Ford, P. R. (2021). Developmental activities in the acquisition of creativity in soccer players. *Thinking Skills and Creativity*, 41(April), 100850. <https://doi.org/10.1016/j.tsc.2021.100850>
- Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, 30(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>
- Scharfen, H.-E., & Memmert, D. (2019). Measurement of cognitive functions in experts and elite athletes: A meta-analytic review. *Applied Cognitive Psychology*, 33(5), 843–860. <https://doi.org/10.1002/acp.3526>
- Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2018). “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. *Frontiers in Psychology*, 9(FEB), 1–12. <https://doi.org/10.3389/fpsyg.2018.00188>
- Teoldo, I., Guilherme, J., & Garganta, J. (2021). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Travassos, B., Araújo, D., & Davids, K. (2018). Is futsal a donor sport for football?: exploiting complementarity for early diversification in talent development. *Science and Medicine in Football*, 2(1), 66–70. <https://doi.org/10.1080/24733938.2017.1390322>
- Turnnidge, J., Côté, J., & Hancock, D. (2014). Positive youth development from sport to life: Explicit or implicit transfer? *Quest*, 66(2), 203–217. <https://doi.org/10.1080/00336297.2013.867275>

- Williams, A. M., Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.1766647>
- Williams, M., Ward, P., Bell-Walker, J., & Ford, P. (2012). Perceptual-cognitive expertise, practice history profiles and recall performance in soccer. *British Journal of Psychology*, 103(3), 393–411. <https://doi.org/10.1111/j.2044-8295.2011.02081.x>
- Yiannaki, C., Carling, C., & Collins, D. (2018). Futsal as a potential talent development modality for soccer—a quantitative assessment of high-level soccer coach and player perceptions. *Science and Medicine in Football*, 2(4), 299–308. <https://doi.org/10.1080/24733938.2018.1483079>

Capítulo III

Estudo 3: Artigo original dois

Este capítulo foi submetido como artigo original para a revista:

Psychology of Sport and Exercise

Estudo 3: The relationship between deliberate practice, play, and futsal in childhood and adolescence and the development of different decision-making skills in professional female soccer players

Guilherme Machado; Sixto González-Víllora; Israel Teoldo

Abstract: The importance of soccer players' ability to make efficient and quick decisions has increased due to changes in the dynamics of the sport in the last few years. Therefore, this study aimed to examine the relationship between the engagement in previous developmental activities in soccer and futsal with the quality and speed of decision-making skills in different phases of sport development of elite female soccer players. The sample comprised 77 elite Brazilian professional female soccer players. Players' decision-making skills were assessed based on an objective video-based test – TacticUP®. We used a retrospective questionnaire to collect information about previous participation in different developmental activities. The results showed that engagement in deliberate practice in soccer and futsal, especially during childhood and early adolescence, is related to a better quality of offensive decision-making skills. In turn, engaging in deliberate play in soccer, mainly in childhood and early adolescence, is related to quicker offensive and defensive decision-making skills. To the best of our knowledge, it was the first study to measure the relationship of decision-making time with developmental activities in soccer. It is concluded that deliberate practice in soccer and futsal and deliberate play in soccer are associated with different dimensions of decision-making skills.

Keywords: female football; engagement; game reading; deliberate practice/play and futsal; tactical awareness; perceptual-cognitive skills.

Resumo: A importância da habilidade de jogadores de futebol em tomarem decisões rápidas e eficientes aumentou devido às mudanças na dinâmica do esporte nos últimos anos. Portanto, este estudo teve como objetivo verificar a relação entre a vivência prévia em atividades relacionadas ao futebol e futsal com a qualidade e velocidade da tomada de decisão em diferentes fases do desenvolvimento esportivo de jogadoras de futebol profissional de elite. A amostra foi composta por 77 jogadoras brasileiras de futebol profissional de elite. A tomada de decisão das jogadoras foi avaliada através de um teste de vídeo objetivo - TacticUP. Foi utilizado um questionário retrospectivo para coletar informações sobre a vivência prévia em em diferentes atividades de desenvolvimento no esporte. Os resultados mostraram que o envolvimento na prática deliberada no futebol e no futsal, especialmente durante a infância e início da adolescência, está relacionado a uma melhor qualidade da tomada de decisão ofensiva. Por outro lado, o envolvimento em atividades de jogo deliberado no futebol, principalmente na infância e no início da adolescência, está relacionado a uma capacidade de tomada de decisão mais rápida nas fases ofensiva e defensiva. Até onde sabemos, este foi o primeiro estudo a avaliar a relação entre o tempo de tomada de decisão e a vivência prévia em atividades relacionadas ao futebol. Conclui-se que a prática deliberada no futebol e no futsal e o jogo deliberado no futebol estão associados a diferentes dimensões da tomada de decisão.

Palavras-chave: futebol feminino; engajamento; leitura do jogo; prática deliberada/jogo e futsal; consciência tática; habilidades perceptivo-cognitivas.

Introduction

The importance of soccer players' ability to make efficient and quick decisions has increased due to changes in the dynamics of the sport. The game has evolved in the last few years, and players' demands to make decisions with less time and space have increased compared to a few decades ago (Link & Hoernig, 2017). Therefore, it is increasingly important to develop this aspect of performance in soccer players to allow them to timely respond to the problems of the game. In this regard, decision-making skills can be divided into perceptual-cognitive and perceptual-motor skills, both contributing to the development of sport expertise (McPherson & Kernodle, 2003; Williams et al., 2020). Perceptual-cognitive skills can be described as what one perceives and understands, while perceptual-motor skills refer to what one perceives and responds to through movement (Materniuk, 1976; Starkes et al., 2004). In this context, decision-making can be defined as a choice of action and as an outcome identified through a motor or verbal response (Bruce et al., 2012; Macmahon & Mcpherson, 2009). In the last few years, the study of perceptual-cognitive skills has drawn increasing attention in the field of talent identification and development in soccer (Ehmann et al., 2022; Sarmiento et al., 2018), as many studies have shown the association of such components with game performance (Cardoso et al., 2019; Hartigh et al., 2018; Kunrath et al., 2018).

Research carried out in talent identification and selection has shown that perceptual-cognitive decision-making skills are essential for players to be selected for training programs and to continue their sport's development in soccer (Cardoso et al., 2019, 2020; Hartigh et al., 2018). The study conducted by Cardoso and collaborators (2020) showed that elite male youth soccer players (age 16.7 ± 3.1 years) who possessed faster perceptual-cognitive decision-making skills, when compared to their less fast peers, possessed: i) better game reading ability by using more efficient visual search strategies; ii) and showed a less cognitive effort to make decisions (Cardoso et al., 2020). In line with these findings, another study found that young male soccer players (age 10.9 ± 0.43 years) selected to continue in a talent development program possessed better game reading skills than non-selected players. The selected players could better structure and integrate information from the game (e.g., teammates, opponents, and the field of play) (Hartigh et al., 2018). Therefore, it highlights the importance of developing such skills throughout athletes' careers. All of these studies were conducted on samples of male players, as the scientific field has traditionally neglected women's soccer. However, it is our responsibility as scientists to equally investigate sports participation in a gender-sensitive manner to promote equal opportunities in sports, mainly because recent research showed differences among sex in cognitive processes recruited for the same task (Rominger et al., 2020).

In this context, the development of decision-making in soccer depends on different factors, such as individuals' previous experience in the sport, the quality of the experiences they have had during their sports education, and the phase of sport development depending on their age (Williams et al., 2020). Regarding the phases of sport development, the theoretical model proposed by Côté and collaborators (1999; 2007), known as the Development Model of Sport Participation (DMSP), has been widely used in the world to understand the process of sport education in different sports, including several studies in soccer (Ford, Hodges, et al., 2020; Roca et al., 2012). In addition, this model has been used in research that seeks to optimize and direct public investment policies to qualify sports training systems in different countries (Côté & Vierimaa, 2014).

This theoretical model divides sports education into different stages, which are classified as: i) sampling years (6-12 years old); ii) specialization years (13-15 years old); iii) investment years (from 16 years old to adulthood); iv) early specialization (from 6 years old to adulthood); and v) recreational years (from 13 years old to adulthood). These different stages are characterized by the type of activities involved in the practice of the sport(s). It also considers the age of the individuals and the number of sports practiced. The types of activities are called deliberate practice and deliberate play. The deliberate practice is characterized by activities performed with the purpose of improving performance (and not necessarily to generate satisfaction) and require a high cognitive and/or physical effort, besides being positively associated with the development of specific abilities (e.g., systematized training with the team led by the coach) (Ericsson et al., 1993). On the other hand, deliberate play is characterized by a form of intrinsically motivating sports activity that provides immediate gratification and is specifically designed to maximize satisfaction in the activity (e.g., playing football in the park with friends) (Côté, 1999).

In addition to those two types of activities, recent research suggests the potential of engagement in futsal practice to contribute to talent development in soccer (Oppici et al., 2019; Travassos et al., 2018; Yiannaki et al., 2018). Futsal is an indoor version of soccer, composed of teams of four outfield players and a goalkeeper that plays in a court of 20x40m. There is empirical evidence that futsal practice promotes the transfer of tactical-technical skills (e.g. passing skills) to soccer due to similarities between perceptual-cognitive and perceptual-motor skills of both sports (Oppici et al., 2019). Therefore, research about talent development could assess players' previous futsal participation to understand further its association with the acquisition of decision-making skills (Machado et al., 2020; Sweeney et al., 2021). These findings have been demonstrated in the

practice of soccer and futsal in the male category, but does the same occur in the female category? Unfortunately, from scientific data, we do not have a clear answer, as there seems to be a clear gap in the literature in this regard.

Based on the proposal of the DMSP model, in recent years, researchers from different countries proposed to investigate which sports trajectory was associated with the development of decision-making skills in soccer, considering especially the initial years of sport participation (6-12 years) (Machado et al., 2020; Roca et al., 2012). Some studies have shown that the interaction of both types of activities (deliberate play and practice) is essential for developing decision-making in athletes. However, there is no consensus on the ideal period or age to focus on the accumulation of these different types of activities (Machado et al., 2020; Roca et al., 2012; Sieghartsleitner et al., 2018). Another issue on this topic is that research focuses on understanding only how developmental activities contribute to developing the decision-making quality but not the decision-making speed of soccer players. Although the ability to make quick decisions has gained greater importance in soccer, to the best of our knowledge, we found no study investigating how developmental activities are associated with such a skill.

After analyzing recent reviews and meta-analyses on this topic (Robles et al., 2020; Silva et al., 2020, 2021), we found that research on decision-making in soccer has mainly focused on the assessment of decision-making accuracy in situations that only involved the player in possession during attacking plays. It represents a severe limitation on this research topic as empirical evidence has already shown that: 1) during matches, players spend between 97% and 99% of the time performing movements without the ball, either in attack or defense (Di Salvo et al., 2007); and 2) it is important to develop the ability to make quick decisions for achieving sport expertise (Mann et al., 2007).

We highlight that we have not found any research addressing decision-making skills in situations without the ball, and only one study assessed decision time on talent selection (Bennett et al., 2020). Therefore, those aspects must be addressed to subsidize the construction of a structured curriculum that favors the development of decision-making skills throughout sports development education. Therefore, this study aimed to examine the relationship between the engagement in previous developmental activities in soccer and futsal with the quality and speed of decision-making skills in different phases of sport development of elite female soccer players. Although previous studies on this topic with soccer players are scarce and carried out only with

male samples, we hypothesize that there will be a positive relationship between the accumulated experience in deliberate play and practice during childhood (6-12 years) and early adolescence (13-15 years) with decision-making skills (Machado et al., 2020; Roca et al., 2012).

Materials and Methods

Study Design

In this study, we used a retrospective design. We examine the relationship between soccer developmental activities with different decision-making skills (response accuracy and response time of offensive and defensive situations) of female Brazilian professional soccer players. Players' decision-making skills were assessed based on an objective video-based test – TacticUP® (Machado and Teoldo 2020). We used a retrospective questionnaire (Ford, Low, et al., 2010; Haugaasen et al., 2014) to collect information about previous participation in different soccer activities.

Participants

The sample comprised 77 elite Brazilian professional female soccer players ($M = 23.4 \pm 4.2$ years of age) from six soccer teams of three different states in Brazil. Participants should be competing on the professional national league in Brazil for inclusion criteria. Data collection was carried out with previous approval from club officials and athletes. The present study was approved by the Ethics Committee for Research with Human Beings from the leading institution (Approval number: 4.924.597) and is in accordance with the norms established by the National Health Council (466/2012), and by the Declaration of Helsinki (2013) for research with human beings. Participants provided signed and informed consent.

Measures and Procedures for Data Collection

Developmental Activities: Participation History Questionnaire (PHQ)

The Participation History Questionnaire (PHQ), used in several studies (Ford, Low, et al., 2010; Ford & Williams, 2012; Machado et al., 2020; Roca et al., 2012), was used to measure the soccer activities undertaken by players. The test-retest reliability and the concurrent validity of the PHQ were shown in Ford et al. (2010). This questionnaire provided information about the engagement in different soccer developmental activities (e.g. participation in soccer practice or play). Furthermore, four variables related to developmental sports activities were assessed (see

chart 1). All variables have been included in previous studies. We also calculated the number of hours per week spent playing and practicing soccer, considering a 40-week sports season.

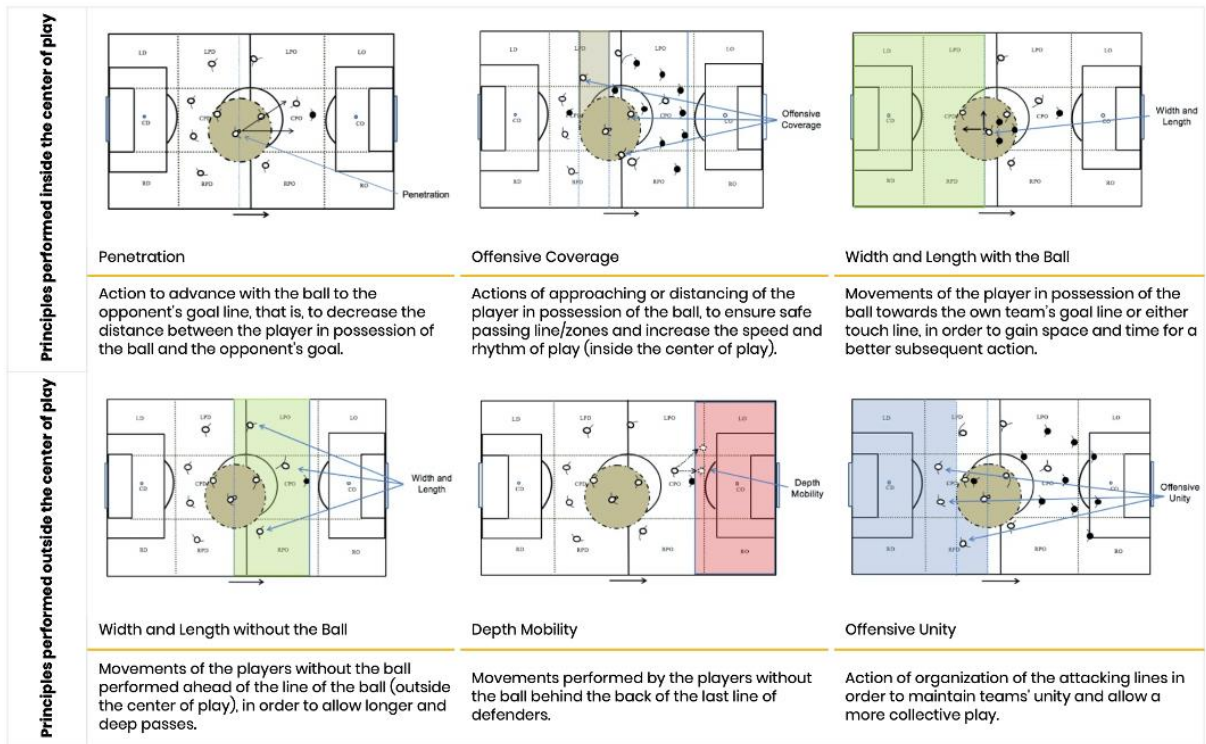
Chart 1. Variables assessed with the Participation History Questionnaire.

Variables	Explanation
Play in soccer	Play activities (i.e., deliberate play) in soccer are related to play-type games with specific rules created and supervised by participants, in which the primary goal is enjoyment (e.g., playing a soccer game with friends in the park).
Practice in soccer	Practice in soccer was related to soccer activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team).
The percentage of time in play	The “percentage time in play” was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer.
Practice in futsal	Practice in futsal was related to futsal activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team).

In order to complete the questionnaire, participants should provide the number of hours per week and the number of months per year they spent in those soccer activities since they started participating in soccer. They also provided information about the number of weeks from each year they were injured and unable to participate in soccer activities. This information was given retrospectively, from the present season, going backward in a one-year interval up to 5 years of age, or the age they started participation in soccer activities. The calculation of the accumulated hours in soccer activities was performed by multiplying hours reported per week by weeks per year, minus weeks per year that players reported injuries that prevented them from participating in soccer activities.

This retrospective questionnaire was applied online, using a mobile phone, tablet, or computer with internet access, where the researcher in charge explained how to fill out the questionnaire. After the initial explanation, the participants answered the questionnaire, while the researcher was available to answer any questions that arose during the completion of the form. The application took approximately 60 minutes per player during a specific session in the day they were not training.

a) Offensive Principles



b) Defensive Principles

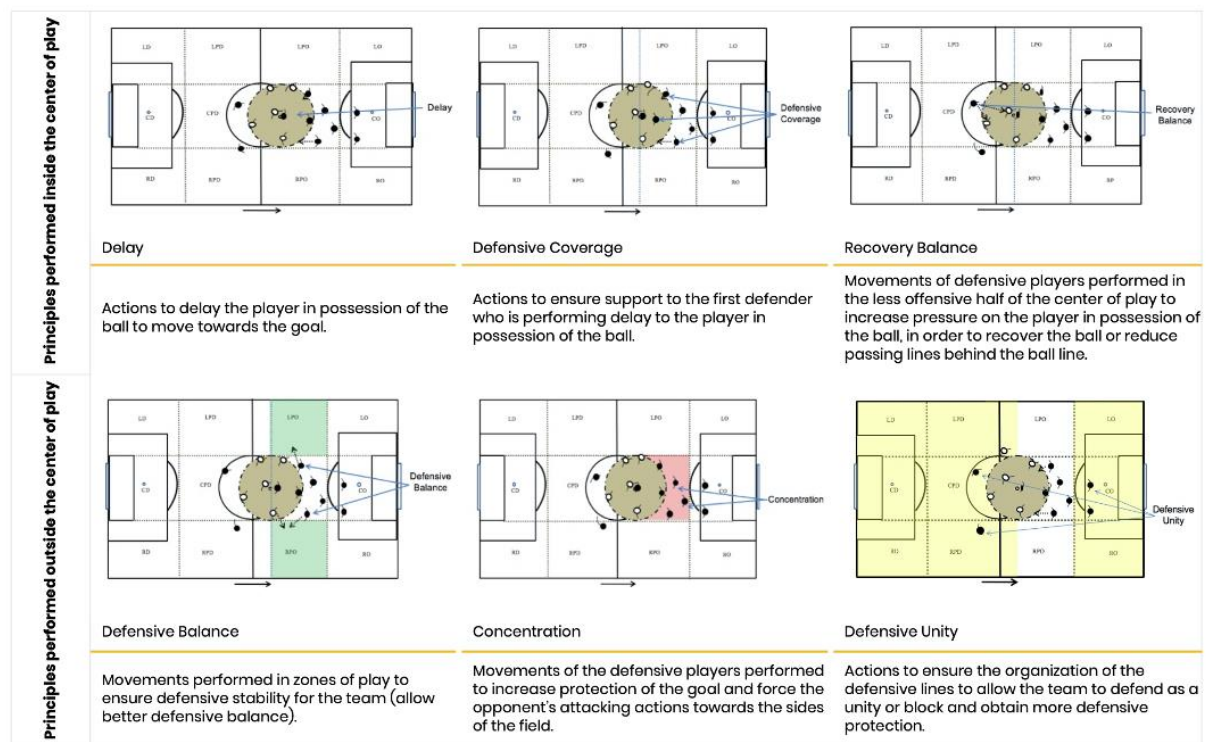


Figure 1. Description of the core tactical principles assessed by the TacticUP® test: a) offensive; b) defensive (Source: Teoldo et al., 2022).

Decision-making skills (TacticUP®)

TacticUP® is an online platform (www.tacticup.com.br) that assesses players' decision-making skills (Machado and Teoldo 2020). It is a video-based test using a temporal occlusion paradigm. Participants had to respond as quickly as possible, “what the observed player should do?” and choose the most appropriate solution from four possible scenarios at the end of each scene. This decision-making test was developed based on tactical aspects of the game grounded on tactical principles (Teoldo et al., 2022). Therefore, it allows the assessment of response accuracy and response time of decision-making in offensive and defensive actions in situations with and without the ball (see figure 1). The validity and reliability of the test were shown in Machado and Teoldo (2020).

Before the start of the test, the online platform displays instructions to participants regarding the test structure and procedures, and three trial scenes are exhibited to familiarize the subjects with the assessment, thus excluding the possibility of low performance due to lack of comprehension of the task. These three trial scenes include: two offensive sequences (one in which the player being observed is in possession of the ball, and another in which he is not in possession) and one defensive sequence (the player being observed is in the defensive phase of play). These three conditions enable participants to familiarize themselves with the characteristics of the video sequences they were about to watch. The test was carried out using laptop computers with internet, to enable the access to the tests in the TacticUP® platform. The test took around 20 minutes per player. The variables generated by the TacticUP® platform were categorized into different offensive and defensive as showed in Chart 2.

Statistical Analysis

Data distribution was checked with a Kolmogorov-Smirnov test followed by a Spearman's correlation test. Correlations were analyzed for three age periods: 1) 6–12 years of age (i.e. childhood); 2) 13–15 years of age (i.e. early adolescence); and 3) 16–18 years of age (i.e. late adolescence) to match the developmental stages outlined by Côté (1999). The level of significance was set as $p < .05$. For statistical procedures was utilized the software Statistical Package for Social Sciences 25.0.

Chart 2. Variables assessed with the decision-making test (TacticUP®).

Variables	Explanation*
<u>Offensives</u>	
Inside the center of play	Composed by the principles of: i) penetration; ii) offensive coverage; and iii) width and length with the ball.
Outside the center of play	Composed by the principles of: i) width and length without the ball; ii) mobility; and iii) offensive unity.
With the ball	Composed by the principles of: i) penetration; ii) width and length with the ball.
Without the ball	Composed by the principles of: i) offensive coverage; ii) width and length without the ball; iii) mobility; and iv) offensive unity.
Offensive	Composed by all offensive principles: i) penetration; ii) offensive coverage; iii) width and length with the ball; iv) width and length without the ball; v) mobility; and vi) offensive unity.
<u>Defensives</u>	
Inside the center of play	Composed by the principles of: i) delay; ii) defensive coverage; and iii) recovery balance.
Outside the center of play	Composed by the principles of: i) defensive balance; ii) concentration; and iii) defensive unity.
Defensive	Composed by all defensive principles: i) delay; ii) defensive coverage; iii) recovery balance; iv) defensive balance; v) concentration; and vi) defensive unity.
*This categorization was performed due to the spatial relations between these principles and the center of play, as well as their hierarchical relation within the teaching-learning process. The tactical principles performed inside the center of play display less complexity regarding their execution, when compared to those performed outside the center of play (Machado and Teoldo 2020; Teoldo, Guilherme, and Garganta 2022). According to Teoldo, Guilherme, and Garganta (2022) the center of play is a dynamic spatial reference employed to characterize where the game is played more intensely/quickly. Its radius is 9.15 meters from the ball.	

Results

We found positive correlations between the accumulated hours of practice in soccer with the decision-making quality during childhood, early adolescence, and late adolescence. In childhood, practice in soccer positively correlated with decision-making quality in situations: 1) offensive with the ball, $r(75) = .23$, $p = .049$; and 2) offensive, $r(75) = .24$, $p = .032$. During early adolescence, practice in soccer showed positive correlations with decision-making quality in situations: 1) offensive with the ball, $r(75) = .23$, $p = .044$; and 2) offensive, $r(75) = .29$, $p = .011$. In late adolescence practice in soccer positively correlated with decision-making quality in situations outside the center of play, $r(75) = .23$, $p = .049$. We also found negative correlations between practice in soccer with the decision-making time during late adolescence in situations: 1) offensive inside the center of play, $r(75) = .266$, $p = .020$; 2) offensive with the ball, $r(75) = .26$, $p = .022$; and 3) offensive, $r(75) = .24$, $p = .033$. It means that players that accumulated more hours in practice were quicker in their decision-making.

Negative correlations were found between the accumulated hours of play in soccer, with the decision-making time during childhood, early adolescence, and late adolescence. In other words, players that accumulated more hours in play decide quickly. During childhood, play in soccer negatively correlated with decision-making time in situations: 1) offensive inside the center of play, $r(75) = -.42$, $p < .001$; 2) offensive outside the center of play, $r(75) = -.36$, $p = .001$; 3) offensive with the ball, $r(75) = -.41$, $p < .001$; 4) offensive without the ball, $r(75) = -.36$, $p = .001$; 5) offensive, $r(75) = -.39$, $p < .001$; 6) defensive inside the center of play, $r(75) = -.36$, $p = .001$; 7) defensive outside the center of play, $r(75) = -.30$, $p = .008$; and 8) defensive, $r(75) = -.27$, $p = .018$. In early adolescence, play in soccer negatively correlated with decision-making time in situations: 1) offensive inside the center of play, $r(75) = -.40$, $p < .001$; 2) offensive outside the center of play, $r(75) = -.33$, $p = .004$; 3) offensive with the ball, $r(75) = -.40$, $p < .001$; 4) offensive without the ball, $r(75) = -.34$, $p = .002$; 5) offensive, $r(75) = -.37$, $p = .001$; 6) defensive inside the center of play, $r(75) = -.37$, $p = .001$; 7) defensive outside the center of play, $r(75) = -.33$, $p = .004$; and 8) defensive, $r(75) = -.30$, $p = .008$. During late adolescence, play in soccer negatively correlated with decision-making time in situations: 1) offensive inside the center of play, $r(75) = -.26$, $p = .024$; and 2) offensive with the ball, $r(75) = -.25$, $p = .028$. We also found negative correlations between practice in soccer with the decision-making quality during early adolescence and late adolescence. In early adolescence it was negatively correlated with offensive situations inside the center of play, $r(75) = -.24$, $p = .037$, and during late adolescence it was negatively correlated considering situations: 1) offensive without the ball, $r(75) = -.25$, $p = .028$; and 2) defensive, $r(75) = -.26$, $p = .022$.

The percentual time in play showed negative correlations with the decision-making quality during childhood, early adolescence, and late adolescence. It means that players who accumulated a greater percentage of play, considering both play and practice in soccer, had lower values in their decision-making quality. In childhood, percentual time in play negatively correlated with situations: 1) offensive inside the center of play, $r(75) = -.33$, $p = .009$; 2) offensive with the ball, $r(75) = -.35$, $p = .006$; and 3) offensive, $r(75) = -.34$, $p = .007$. During early adolescence, it showed negative correlations with situations: 1) offensive inside the center of play, $r(75) = -.36$, $p = .003$; 2) offensive with the ball, $r(75) = -.36$, $p = .002$; and 3) offensive, $r(75) = -.30$, $p = .012$. In late adolescence it was found negative correlations with situations: 1) offensive with the ball, $r(75) = -.34$, $p = .003$; 2) offensive, $r(75) = -.24$, $p = .036$; and 3) defensive, $r(75) = -.27$, $p = .019$. We also

found negative correlations between percentual time in play with the decision-making time during childhood and early adolescence. It means that players who accumulated a greater percentage of play, considering play and practice in soccer, were quicker in their decision-making time. In childhood, it negatively correlated with situations: 1) offensive with the ball, $r(75) = -.29$, $p = .025$; 2) defensive inside the center of play, $r(75) = .30$, $p = .017$; and 3) defensive outside the center of play, $r(75) = .26$, $p = .038$. During early adolescence, it showed negative correlations with situations: 1) offensive inside the center of play, $r(75) = -.26$, $p = .030$; 2) offensive with the ball, $r(75) = -.28$, $p = .020$; 3) offensive, $r(75) = .25$, $p = .036$; and 4) defensive inside the center of play, $r(75) = .25$, $p = .036$.

The accumulated hours in practice in futsal showed positive correlations with the decision-making quality during childhood and early adolescence. During childhood, practice in futsal positively correlated with decision-making quality in situations: 1) offensive inside the center of play, $r(75) = .26$, $p = .023$; 2) offensive with the ball, $r(75) = .24$, $p = .038$; and 3) offensive, $r(75) = .23$, $p = .043$. In early adolescence, practice in futsal showed positive correlations with decision-making quality in situations: 1) offensive inside the center of play, $r(75) = .300$, $p = .009$; and 2) offensive with the ball, $r(75) = .27$, $p = .019$.

Table 1. Spearman correlation between decision-making skills and accumulated hours in developmental activities in different stages.

Indexes	Childhood (6-12 years)				Early adolescence (13-15 years)				Late adolescence (16-18 years)			
	Practice in soccer (h)	Play in soccer (h)	% time in play ⁷	Practice in futsal (h)	Practice in soccer (h)	Play in soccer (h)	% time in play ⁷	Practice in futsal (h)	Practice in soccer (h)	Play in soccer (h)	% time in play ⁷	Practice in futsal (h)
DECISION-MAKING QUALITY (a.u.)												
<u>Offensives</u>												
Inside the center of play ¹	.11	-.18	-.33**	.26*	.20	-.24*	-.36**	.30**	.06	-.17	-.19	.10
Outside the center of play ²	.20	.08	-.07	.08	.12	.08	.02	-.00	.23*	-.05	-.12	-.02
With the ball ³	.23*	-.15	-.35**	.24*	.23*	-.19	-.36**	.27*	.18	-.18	-.34**	.09
Without the ball ⁴	.11	.002	-.11	.14	.12	-.03	-.03	.06	.13	-.25*	-.05	.01
Offensive	.24*	-.10	-.34**	.23*	.29*	-.13	-.30*	.20	.19	-.05	-.24*	.05
<u>Defensives</u>												
Inside the center of play ⁵	-.10	-.10	-.09	-.15	-.12	-.08	-.06	.01	.03	-.16	-.14	-.12
Outside the center of play ⁶	-.13	-.15	-.03	-.08	-.19	-.05	.00	.09	-.10	-.18	-.10	.07
Defensive	-.01	-.14	-.19	-.03	-.05	-.13	-.16	.11	-.04	-.26*	-.27*	.01
DECISION-MAKING TIME (s)												
<u>Offensives</u>												
Inside the center of play ¹	-.08	-.42**	-.25	.08	-.06	-.40**	-.26*	.18	-.27*	-.26*	-.19	.04
Outside the center of play ²	-.02	-.36**	-.23	.10	.02	-.33**	-.22	.18	-.22	-.16	-.10	.09
With the ball ³	-.03	-.41**	-.29*	.05	-.03	-.40**	-.28*	.14	-.26*	-.25*	-.19	.04
Without the ball ⁴	-.05	-.36**	-.21	.13	-.01	-.34**	-.22	.22	-.22	-.19	-.13	.11
Offensive	-.04	-.39**	-.24	.11	-.01	-.37**	-.25*	.21	-.24*	-.22	-.16	.09
<u>Defensives</u>												
Inside the center of play ⁵	-.00	-.36**	-.30*	.10	-.03	-.37**	-.25*	.20	-.22	-.22	-.18	.07
Outside the center of play ⁶	.01	-.30**	-.26*	.11	-.03	-.33**	-.21	.21	-.22	-.22	-.18	.08
Defensive	.04	-.27*	-.24	.11	.01	-.30**	-.20	.21	-.20	-.19	-.16	.09

¹principles of penetration, offensive coverage and width, and length with the ball; ²principles of width and length without the ball, mobility, and offensive unity; ³principles of penetration and offensive coverage; ⁴principles of offensive coverage, width and length without the ball, mobility, and offensive unity; ⁵principles of delay, defensive coverage, and recovery balance; ⁶principles of defensive balance, concentration, and defensive unity.; ⁷The “percentage time in play” was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer.

*p < 0.05; **p < 0.01

Discussion

This study aimed to examine the relationship between the engagement in previous developmental activities in soccer and futsal with the quality and speed of decision-making skills in different phases of sport development of elite female soccer players. In general, the results showed that engagement in deliberate practice in soccer and futsal, especially during childhood and early adolescence, is related to a better quality of offensive decision-making skills. In turn, engaging in deliberate play in soccer, mainly in childhood and early adolescence, is related to quicker offensive and defensive decision-making skills.

We also found that during late adolescence: 1) engagement in deliberate practice in futsal had no relationship with any decision-making skills; 2) engagement in deliberate play showed a smaller number of relationships with the decision-making time and negative relationship with decision-making quality; and 3) engagement in deliberate practice in soccer is related with better decision-making quality and quicker decision-making skills. To the best of our knowledge, it was the first study to measure the relationship of decision-making time with developmental activities in soccer.

The accumulated hours in deliberate practice in soccer, mainly in childhood and early adolescence, were related to a better quality of offensive decision-making skills. Our findings support previous research with male youth players from Brazil (~14.9 years), showing that players who possessed better decision-making skills accumulated more hours of practice in soccer during their sport formation compared to players with lower decision-making skills (Machado et al., 2020). Additionally, another study in soccer with male samples found that a greater percentage of time spent in practice in childhood was positively associated with higher ratings of creative and tactical skills (Hendry et al., 2018).

The involvement with structured activities that has its primary aim to develop performance looks to be an important aspect for athletes to develop their decision-making quality through their sport formation (Mann et al., 2007). This context usually provides athletes with exercises focusing on performance improvement with valuable feedback from the coaching staff (Hendry et al., 2019; Roca & Ford, 2020). Moreover, a recent study found that practice in soccer has been changing throughout the last 15 years to provide players nowadays with higher opportunities to make decisions (Roca & Ford, 2020) compared to practice prior to 2010 (Ford, Yates, et al., 2010). Such a practice characteristic has been associated with the acquisition of better decision-making quality in soccer (Machado et al., 2020).

Regarding the engagement in deliberate play in soccer, we found that it is related to quicker offensive and defensive decision-making skills. These results were found

predominantly in childhood and early adolescence. To the best of our knowledge, we found no previous research that assessed the association between developmental activities with decision-making time in soccer, although the ability to decide quickly in sport has been shown that is an important advantage developed by expert players (Ivarsson et al., 2020; Cardoso et al., 2021). A meta-analysis about perceptual-cognitive expertise that assessed players from invasion sports (including soccer) found that expert players were 37% quicker on average compared to lower-level players (Mann et al., 2007).

One explanation for the association between deliberate play with quicker decision-making skills is its nature, which usually couples perceptual-cognitive and perceptual-motor skills in unstructured activities (Berry et al., 2008). Those activities usually can be characterized by 1) mimicking game-like sub-phases situations (e.g., 2x2, 3x3); 2) providing modified tasks and environmental constraints (e.g., smaller and irregular playing fields); and 3) having variability of practice in uncertain contexts (e.g., require many soccer skills to be executed in a random format). Such practice characteristics induce athletes to provide quick solutions for game problems and have provided an adequate environment for skill transfer to the formal game (Uehara et al., 2018).

A recent study with youth soccer players also showed that deliberate play, in comparison with deliberate practice, provides more 1x1 situations, ball touches, dribbling frequency in games, more activity time (68% vs. 56%), children spend more time playing against each other (92% vs. 36%), and most of the time there are games or finishing on goal (Nybakken & Falco, 2022). It indicates that deliberate play provides a stimulus for players to decide quickly on game problems and develop skills related to creative and intelligent decision-making (Roca & Ford, 2021). Moreover, this ability to make quicker decisions is gaining even more importance due to changes in soccer game dynamics. The game has evolved in the last few years, and players' demands to make decisions with less time and space have increased compared to a few decades ago. Therefore, sports education programs should encourage the development of this ability so that young players feel competent and want to continue practicing and learning sports (Estevan et al., 2021).

In terms of involvement in deliberate practice in futsal, especially during childhood and early adolescence, it was found to have a positive relationship with the quality of offensive decision-making skills in situations with the ball and near the ball. These results align with empirical evidence showing that futsal practice promotes the transfer of tactical-technical skills (e.g., passing skills) to soccer (Oppici et al., 2019). This potential for positive transfer between futsal skills to soccer skills has been attributed to similarities between perceptual-cognitive and

perceptual-motor skills of both sports (Teoldo et al., 2022). Furthermore, due to the characteristics of futsal, such as fewer players and dimensions compared to soccer, it may contribute to a wide range of technical and tactical abilities and decrease the game's complexity (Travassos et al., 2018). Therefore, it has been suggested that futsal has a great potential to promote diversification in contexts (e.g., ball, surface, number of players, or dimension) within the "football" sport, especially in earlier phases of sport formation (Oppici et al., 2018).

Additionally, it can be used as an alternative training methodology in soccer, like small-sided games. Interestingly, recent research with male youth soccer players found that the use of small sided-games in soccer practice, such as 2x2 up to 4x4 activities, during early adolescence was positively associated with the development of offensive tactical decision-making skills (Machado et al., 2020). Therefore, considering our results during childhood and early adolescence, these suggest that greater participation in structured activities in futsal in this period of sport development may be associated with better decision-making skills in female soccer players at older ages. Moreover, these results add to previous research showing that futsal practice is integrated within the sport formation structure of elite soccer players in Brazil in childhood and early adolescence, not just for males but also for female athletes (Ford et al., 2012; Williams & Wigmore, 2021).

Overall, our findings provide support for Sieghartsleitner et al. (2018), who showed through the specialized sampling pathway, that diversification of contexts (e.g., practice and play in soccer and practice in futsal) in the primary sport since childhood may contribute to the attainment of expert performance in the sport and may favor the attainment of better decision-making skills of soccer players at older ages. Moreover, our findings partially support the early engagement pathway proposed by Ford et al. (2009) once we found that both play and practice activities in soccer during childhood are important to contribute to different decision-making skills. However, this pathway does not consider participation in similar sports apart from soccer (e.g., futsal) as we found in our study. In general, our results indicated that engaging in both practice and play during childhood and early adolescence enhances the probability of Brazilian female elite soccer players possessing better and quicker decision-making skills in adulthood. This study adds to the literature on sports psychology that deliberate practice and play are related to different dimensions of decision-making skills. In this regard, it is important to carry out a sports management that guarantees respect for the Principle of Equality of women and men and allows continuing to build a more egalitarian and fairer sports (and soccer) environment.

In future studies would be interesting to investigate other aspects of decision-making skills related to developmental activities, such as perceptual-motor skills, once the literature indicates that cognitive and motor skills may develop in different manners during sports development (González-Víllora et al., 2013; Machado et al., 2020; Williams et al., 2020).

We also acknowledge that some limitations of this study should be noted. First, the possible memory inference related to self-reported data on remembering what was being practiced several years ago (e.g., recall bias, retrospection effect) needs to be considered when interpreting the results. Second, we used a retrospective study design, and only longitudinal studies would allow for comparing (as a matter of fact) hours spent playing soccer in earlier years. These limitations could be addressed in future studies using more longitudinal designs to avoid memory error and inference and video/training analysis to characterize the nature of the practice, jointly with the employment of questionnaires.

Conclusions

It is concluded that the decision-making quality was positively associated with the engagement in deliberate practice in soccer and futsal, especially during childhood (6-12 years) and early adolescence (13-15 years). Moreover, decision-making time was negatively correlated with engaging in deliberate play in soccer, mainly in childhood and early adolescence. In other words, players with quicker decision-making skills accumulate more hours of deliberate play during these stages of sport formation. Therefore, deliberate practice in soccer and futsal and deliberate play in soccer are associated with different dimensions of decision-making skills. Finally, this type of study is necessary to promote inclusion and equality in sports, specifically in soccer. This work aims to have scientific and practical repercussions to facilitate the development of talented players and facilitate the promotion of the international professionalization of women's soccer.

Declaration of competing interest

The authors have no conflicts of interests to declare.

Funding

This study was supported by the Sports incentive law of the Government of Minas Gerais, by the Academy & Soccer Program of the Ministry of Citizenship, through the National Secretariat of Football and Defense of Fans' Rights; the SEESP-MG, FAPEMIG, CNPq,

Funarbe, the Dean's Office for Graduate and Research Studies and the Centre of Life and Health Sciences from the leading institution. This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance Code 001.

Acknowledgements

The authors would like to thank all the professional female football players who participated in this study, as they have certainly contributed to making it easier for girls and young women who want to play football in the future.

References

- Baker, J., & Côté, J. (2003). Sport-specific practice and the development of expert decision-making in team ball sports. *Journal of Applied Sport Psychology*, 15(1), 12–25. <https://doi.org/10.1080/10413200390180035>
- Baker, J., Côté, J., & Abernethy, B. (2003). Learning from the experts: Practice activities of expert decision makers in sport. *Research Quarterly for Exercise and Sport*, 74(3), 342–347. <https://doi.org/10.1080/02701367.2003.10609101>
- Bennett, K. J. M., Novak, A. R., Pluss, M. A., Coutts, A. J., & Fransen, J. (2020). A multifactorial comparison of Australian youth soccer players' performance characteristics. *International Journal of Sports Science and Coaching*, 15(1), 17–25. <https://doi.org/10.1177/1747954119893174>
- Bergkamp, T. L. G., Frencken, W. G. P., Niessen, A. S. M., Meijer, R. R., & den Hartigh, R. J. R. (2021). How soccer scouts identify talented players. *European Journal of Sport Science*. <https://doi.org/10.1080/17461391.2021.1916081>
- Berry, J., Abernethy, B., & Côté, J. (2008). The contribution of structured activity and deliberate play to the development of expert perceptual and decision-making skill. *Journal of Sport and Exercise Psychology*, 30(6), 685–708. <https://doi.org/10.1123/jsep.30.6.685>
- Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. *Psychology of Sport and Exercise*, 13(2), 152–161. <https://doi.org/10.1016/j.psychsport.2011.10.005>
- Cardoso, F., González-Víllora, S., Guilherme, J., & Teoldo, I. (2019). Young soccer players

with higher tactical knowledge display lower cognitive effort. *Perceptual & Motor Skills*, 126(3), 499–514. <https://doi.org/https://doi.org/10.1177/0031512519826437>

Cardoso, F., Neves, J., Roca, A., & Teoldo, I. (2020). The association between perceptual-cognitive processes and response time in decision making in young soccer players. *Journal of Sports Sciences*, 39(8), 926–935. <https://doi.org/10.1080/02640414.2020.1851901>

Côté, J. (1999). The Influence of the family in the development of talent in sport. *The Sport Psychologist*, 13(4), 395–417. <https://doi.org/10.1123/tsp.13.4.395>

Côté, J., Baker, J., & Abernethy, B. (2007). Practice and play in the development of sport expertise. In R. Eklund & G. Tenenbaum (Eds.), *Handbook of Sport Psychology* (3rd ed., pp. 184–202). John Wiley & Sons.

Côté, J., & Erickson, K. (2015). Diversification and deliberate play during the sampling years. In Joseph Baker & D. Farrow (Eds.), *Routledge Handbook of Sport Expertise* (pp. 305–316). Routledge.

Côté, J., & Vierimaa. (2014). The developmental model of sport participation: 15 years after its first conceptualization. *Science & Sports*, 29S(SUP), S63–S69. <https://doi.org/http://dx.doi.org/10.1016/j.scispo.2014.08.133>

Di Salvo, V., Baron, R., Tschan, H., Calderon-Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, 28, 222–227. <https://doi.org/10.1055/s-2006-924294>

Ehmann, P., Beavan, A., Spielmann, J., Mayer, J., Altmann, S., Ruf, L., Rohrmann, S., Irmer, J. P., & Englert, C. (2022). Perceptual-cognitive performance of youth soccer players in a 360°-environment – Differences between age groups and performance levels. *Psychology of Sport and Exercise*, 59(April), 102120. <https://doi.org/10.1016/j.psychsport.2021.102120>

Ericsson, A. K., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363–406. <https://doi.org/10.1037/0033-295X.100.3.363>

Estevan, I., Bardid, F., Utesch, T., Menescardi, C., Barnett, L. M., & Castillo, I. (2021). Examining early adolescents' motivation for physical education: associations with actual

- and perceived motor competence. *Physical Education and Sport Pedagogy*, 26(4), 359–374. <https://doi.org/10.1080/17408989.2020.1806995>
- Ford, Low, J., McRobert, A., & Williams, A. (2010). Developmental activities that contribute to high or low performance by elite cricket batters when recognizing type of delivery from bowlers' advanced postural cues. *Journal of Sport & Exercise Psychology*, 32(5), 638–654. <https://doi.org/10.1123/jsep.32.5.638>
- Ford, P. R., Bordonau, J. L. D., Bonanno, D., Tavares, J., Groenendijk, C., Fink, C., Gualtieri, D., Gregson, W., Varley, M. C., Weston, M., Lolli, L., Platt, D., & Di Salvo, V. (2020). A survey of talent identification and development processes in the youth academies of professional soccer clubs from around the world. *Journal of Sports Sciences*, 38(11–12), 1269–1278. <https://doi.org/10.1080/02640414.2020.1752440>
- Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., Stenling, A., Moreno, J., Gall, F. Le, Holmström, S., Salmela, J., & Williams, A. M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, 30(15), 1653–1663. <https://doi.org/10.1080/02640414.2012.701762>
- Ford, P. R., Hodges, N. J., Broadbent, D., O'Connor, D., Scott, D., Datson, N., Andersson, H. A., & Williams, A. M. (2020). The developmental and professional activities of female international soccer players from five high-performing nations. *Journal of Sports Sciences*, 38(11–12), 1432–1440. <https://doi.org/10.1080/02640414.2020.1789384>
- Ford, P. R., Ward, P., Hodges, N. J., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. *High Ability Studies*, 20(1), 65–75. <https://doi.org/10.1080/13598130902860721>
- Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. *Journal of Sports Sciences*, 28(5), 483–495. <https://doi.org/10.1080/02640410903582750>
- Ford, & Williams, A. (2012). The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. *Psychology of Sport and Exercise*, 13(May), 349–352.

<https://doi.org/10.1016/j.psychsport.2011.09.004>

- Gledhill, A., Harwood, C., & Forsdyke, D. (2017). Psychosocial factors associated with talent development in football: A systematic review. *Psychology of Sport and Exercise*, 31(July), 93–112. <https://doi.org/10.1016/j.psychsport.2017.04.002>
- González-Víllora, S., García-López, L. M., Gutiérrez-Díaz, D., & Pastor-Vicedo, J. C. (2013). Tactical awareness, decision making and skill in youth soccer players (under-14 years). *Journal of Human Sport and Exercise*, 8(2), 412–426. <https://doi.org/10.4100/jhse.2012.82.09>
- Hartigh, R., Steen, S., Hakvoort, B., Frencken, W., & Lemmink, K. (2018). Differences in game reading between selected and non-selected youth soccer players. *Journal of Sports Sciences*, 36(4), 422–428. <https://doi.org/10.1080/02640414.2017.1313442>
- Haugaasen, M., Toering, T., & Jordet, G. (2014). From childhood to senior professional football: A multi-level approach to elite youth football players' engagement in football-specific activities. *Psychology of Sport and Exercise*, 15(4), 336–344. <https://doi.org/10.1016/j.psychsport.2014.02.007>
- Hendry, D. T., & Hodges, N. J. (2018). Early majority engagement pathway best defines transitions from youth to adult elite men's soccer in the UK: A three time-point retrospective and prospective study. *Psychology of Sport and Exercise*, 36(May), 81–89. <https://doi.org/10.1016/j.psychsport.2018.01.009>
- Hendry, D. T., Williams, A. M., Ford, P. R., & Hodges, N. J. (2019). Developmental activities and perceptions of challenge for National and Varsity women soccer players in Canada. *Psychology of Sport and Exercise*, 43(February), 210–218. <https://doi.org/10.1016/j.psychsport.2019.02.008>
- Hendry, D. T., Williams, A. M., & Hodges, N. J. (2018). Coach ratings of skills and their relations to practice, play and successful transitions from youth-elite to adult-professional status in soccer. *Journal of Sports Sciences*, 36(17), 2009–2017. <https://doi.org/10.1080/02640414.2018.1432236>
- Höner, O., Murr, D., Larkin, P., Schreiner, R., & Leyhr, D. (2021). Nationwide subjective and objective assessments of potential talent predictors in elite youth soccer: An investigation of prognostic validity in a prospective study. *Frontiers in Sports and Active Living*,

- 3(May), 1–16. <https://doi.org/10.3389/fspor.2021.638227>
- Horning, M., Aust, F., & Güllich, A. (2016). Practice and play in the development of German top-level professional football players. *European Journal of Sport Science*, 16(1), 16–105. <https://doi.org/10.1080/17461391.2014.982204>
- Horrocks, D. E., McKenna, J., Whitehead, A. E., Taylor, P. J., Morley, A. M., & Lawrence, I. (2016). Preparation, structured deliberate practice and decision making in elite level football: The case study of Gary Neville (Manchester United FC and England). *International Journal of Sports Science and Coaching*, 11(5), 673–682. <https://doi.org/10.1177/1747954116667105>
- Ivarsson, A., Kilhage-Persson, A., Martindale, R., Priestley, D., Huijgen, B., Ardern, C., & McCall, A. (2020). Psychological factors and future performance of football players: A systematic review with meta-analysis. *Journal of Science and Medicine in Sport*, 23(4), 415–420. <https://doi.org/10.1016/j.jsams.2019.10.021>
- Konarski, J. M., Krzykała, M., Skrzypczak, M., Nowakowska, M., Coelho-E-Silva, M. J., Cumming, S. P., & Malina, R. M. (2021). Characteristics of select and non-select U15 male soccer players. *Biology of Sport*, 38(4), 535–544. <https://doi.org/10.5114/biolSport.2021.101126>
- Kunrath, C. A., Cardoso, F., Nakamura, F., & Teoldo, I. (2018). Mental fatigue as a conditioner of the tactical and physical response in soccer players: a pilot study. *Human Movement*, 19(3), 16–22. <https://doi.org/10.5114/hm.2018.76075>
- Larkin, P., & O'Connor, D. (2017). Talent identification and recruitment in youth soccer: Recruiter's perceptions of the key attributes for player recruitment. *PLoS ONE*, 12(4), 1–15. <https://doi.org/10.1371/journal.pone.0175716>
- Lath, F., Koopmann, T., Faber, I., Baker, J., & Schorer, J. (2021). Focusing on the coach's eye; towards a working model of coach decision-making in talent selection. *Psychology of Sport and Exercise*, 56(July), 102011. <https://doi.org/10.1016/j.psychsport.2021.102011>
- Link, D., & Hoernig, M. (2017). Individual ball possession in soccer. *PLoS ONE*, 12(7), 1–15. <https://doi.org/10.1371/journal.pone.0179953>
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical

- decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Machado, G., & Teoldo, I. (2020). TacticUP Video Test for soccer: Development and validation. *Frontiers in Psychology*, 11(1690), 1–12. <https://doi.org/10.3389/fpsyg.2020.01690>
- Macmahon, C., & Mcpherson, S. U. E. L. (2009). Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! *International Journal of Sport Psychology*, 40(4), 565–579.
- Mann, D. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457–478. <https://doi.org/10.1123/jsep.29.4.457>
- Materniuk, R. (1976). *Information Processing in Motor Skills*. Holt, Rinehart, and Winston.
- McPherson, S. L., & Kernodle, M. (2003). Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: advances in research on sport expertise* (pp. 137–167). Human Kinetics.
- Murr, D., Feichtinger, P., Larkin, P., O'Connor, D., & Höner, O. (2018). Psychological talent predictors in youth soccer: A systematic review of the prognostic relevance of psychomotor, perceptual-cognitive and personality-related factors. *PLoS ONE*, 13(10), 1–24. <https://doi.org/10.1371/journal.pone.0205337>
- Nybakken, T., & Falco, C. (2022). Activity level and nature of practice and play in children's football. *International Journal of Environmental Research and Public Health*, 19(8). <https://doi.org/10.3390/ijerph19084598>
- Oppici, L., Panchuk, D., Serpiello, F. R., & Farrow, D. (2018). Futsal task constraints promote transfer of passing skill to soccer task constraints. *European Journal of Sport Science*, 18(7), 947–954. <https://doi.org/10.1080/17461391.2018.1467490>
- Oppici, L., Panchuk, D., Serpiello, F. R., & Farrow, D. (2019). Futsal task constraints promote

the development of soccer passing skill: evidence and implications for talent development research and practice. *Science and Medicine in Football*, 3(3), 259–262. <https://doi.org/10.1080/24733938.2019.1609068>

Robles, M. T. A., Collado-Mateo, D., Fernández-Espínola, C., Viera, E. C., & Fuentes-Guerra, F. J. G. (2020). Effects of teaching games on decision making and skill execution: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 17(2), 1–13. <https://doi.org/10.3390/ijerph17020505>

Roca, A., & Ford, P. R. (2020). Decision-making practice during coaching sessions in elite youth football across European countries. *Science and Medicine in Football*, 4(4), 263–268. <https://doi.org/10.1080/24733938.2020.1755051>

Roca, A., & Ford, P. R. (2021). Developmental activities in the acquisition of creativity in soccer players. *Thinking Skills and Creativity*, 41. <https://doi.org/10.1016/j.tsc.2021.100850>

Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, 30(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>

Rominger, C., Memmert, D., Papousek, I., Perchtold-Stefan, C. M., Weiss, E. M., Benedek, M., Schwerdtfeger, A. R., & Fink, A. (2020). Female and male soccer players recruited different cognitive processes when generating creative soccer moves. *Psychology of Sport and Exercise*, 50(June), 101748. <https://doi.org/10.1016/j.psychsport.2020.101748>

Sarmiento, H., Anguera, M., Pereira, A., & Araújo, D. (2018). Talent identification and development in male football: A systematic review. *Sports Medicine*, 48(4), 907–931. <https://doi.org/10.1007/s40279-017-0851-7>

Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2018). “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. *Frontiers in Psychology*, 9(FEB), 1–12. <https://doi.org/10.3389/fpsyg.2018.00188>

Silva, A. F., Conte, D., & Clemente, F. M. (2020). Decision-making in youth team-sports players: A systematic review. *International Journal of Environmental Research and Public Health*, 17(11), 1–33. <https://doi.org/10.3390/ijerph17113803>

- Silva, A. F., Ramirez-Campillo, R., Sarmiento, H., Afonso, J., & Clemente, F. M. (2021). Effects of training programs on decision-making in youth team sports players: A systematic review and meta-analysis. *Frontiers in Psychology*, 12(May), 663867. <https://doi.org/10.3389/fpsyg.2021.663867>
- Starkes, J., Cullen, J., & MacMahon, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In N. Hodges & M. Williams (Eds.), *Skill acquisition in sport: Research, theory and practice*. Routledge.
- Sweeney, L., Horan, D., & MacNamara, Á. (2021). Premature professionalisation or early engagement? examining practise in football player pathways. *Frontiers in Sports and Active Living*, 3(June), 1–9. <https://doi.org/10.3389/fspor.2021.660167>
- Teoldo, I., Guilherme, J., & Garganta, J. (2022). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Travassos, B., Araújo, D., & Davids, K. (2018). Is futsal a donor sport for football?: exploiting complementarity for early diversification in talent development. *Science and Medicine in Football*, 2(1), 66–70. <https://doi.org/10.1080/24733938.2017.1390322>
- Uehara, L., Button, C., Araújo, D., Renshaw, I., Davids, K., & Falcous, M. (2018). The role of informal, unstructured practice in developing football expertise: The case of Brazilian Pelada. *Journal of Expertise*, 1(3), 162–180.
- Williams, A. M., Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.1766647>
- Williams, M., & Wigmore, T. (2021). *The Best: How elite athletes are made*. Nicholas Brealey Publishing.
- Yiannaki, C., Carling, C., & Collins, D. (2018). Futsal as a potential talent development modality for soccer—a quantitative assessment of high-level soccer coach and player perceptions. *Science and Medicine in Football*, 2(4), 299–308. <https://doi.org/10.1080/24733938.2018.1483079>

Capítulo IV

Estudo 4: Artigo original três

Estudo 4: Este capítulo foi submetido como artigo original para a revista:

Journal of Teaching in Physical Education

Estudo 4: Developing cognitive and motor decision-making skills through 25 sessions of tactical principles and small-sided games in youth soccer

Guilherme Machado; Sixto González-Víllora; André Roca; Israel Teoldo

Abstract: We aimed to verify the influence of 25 training sessions based on tactical principles and small-sided and conditioned games (SSCG) in developing cognitive and motor decision-making skills of U-12 soccer players. Participants were 25 U-12 Brazilian elite male soccer players (12.0 ± 0.2 years). Perceptual-cognitive decision-making skills (quality and response time) were assessed with TacticUP[®]. Perceptual-motor decision-making skills (tactical efficiency) were assessed with FUT-SAT. Both instruments were developed based on the same theoretical background (core tactical principles of soccer). The 25 training sessions were organized based on tactical principles and SSCG. Results of the within-group comparison among pre- and post-test showed improvements in: 1) perceptual-cognitive decision-making skills related to the decision-making time for both offensive and defensive actions; and 2) perceptual-motor skills for defensive actions. We concluded that 25 training sessions based on core tactical principles and SSCG improved perceptual-cognitive related to decision time and perceptual-motor decision-making skills.

Keywords: Learning; Game-Based Approach; sport pedagogy; football; children.

Resumo: O objetivo deste estudo foi verificar a influência de 25 sessões de treinamento baseadas em princípios táticos e jogos reduzidos e condicionados (JRC) no desenvolvimento da capacidade de tomada de decisão cognitiva e motora de jogadores de futebol sub-12. Os participantes foram 25 jogadores de futebol masculinos de elite brasileira sub-12 ($12,0 \pm 0,2$ anos). A tomada de decisão perceptivo-cognitiva (qualidade e tempo de resposta) foram avaliadas com o TacticUP®. A tomada de decisão perceptivo-motora (eficiência tática) foi avaliadas através do FUT-SAT. Ambos os instrumentos foram desenvolvidos com base na mesma base teórica (princípios táticos fundamentais do futebol). As 25 sessões de treinamento foram organizadas com base nos princípios táticos e em JRC. Os resultados da comparação entre o pré e o pós-teste mostraram melhorias nas: 1) tomada de decisão perceptivo-cognitiva relacionadas ao tempo de tomada de decisão tanto para ações ofensivas quanto defensivas; e 2) tomada de decisão perceptivo-motora para ações defensivas. Concluimos que 25 sessões de treinamento baseadas nos princípios táticos fundamentais e em JRC melhoraram as habilidades perceptivo-cognitivas relacionadas ao tempo de tomada de decisão e às habilidades perceptivo-motoras de tomada de decisão.

Palavras-chave: Aprendizagem; abordagem baseada em jogos; pedagogia esportiva; futebol; crianças.

Introduction

Making efficient decisions is an essential feature for both youth and professional players to achieve superior performance in sports (Gréhaigne et al., 2001; O'Connor et al., 2017; Roca et al., 2013). Moreover, decision-making skills might be divided into perceptual-cognitive and perceptual-motor skills, where both contribute to the development of expertise in sport (McPherson & Kernodle, 2003; Williams et al., 2020). Perceptual-cognitive skills can be considered to be what one is able to perceive and understand, while perceptual-motor skills refers to what one is able to perceive and do through movement (Materniuk, 1976; Starkes et al., 2004). In this context, decision-making can be defined as an action choice, and it is an outcome that can be observed as a motor or verbal response (Bruce et al., 2012; Macmahon & Mcpherson, 2009). The decision-making skill is also based on players' game reading skill, which can be defined in soccer as the players' ability to notice and integrate the moving information on the field, including the ball, teammates, opponents, as well as the actions they perform (Hartigh et al., 2018; Teoldo et al., 2022; Williams & Reilly, 2000). In the context of soccer, the game reading and decision-making skills seem to be associated with players' sport development and the achievement of superior performance (Keller et al., 2018; Williams & Reilly, 2000).

Research carried out in the area of sports development have shown that the abilities of game reading, and perceptual-cognitive, and perceptual-motor decision-making skills are essential factors for players to keep selected in high-quality training programs and to continue their sport's development in soccer (Cardoso et al., 2019, 2020; Hartigh et al., 2018). The study conducted by Cardoso and collaborators (2020) showed that youth soccer players (age 16.7 ± 3.1 years) who possessed faster perceptual-cognitive decision-making skills, when compared to their less fast peers, possessed: i) better game reading ability, by using more efficient visual search strategies; ii) and showed a less cognitive effort to make decisions (Cardoso et al., 2020). In line with these findings, another study found that young soccer players (age 10.9 ± 0.43 years) selected to continue in a sport development program possessed better game reading skills than non-selected players. The selected players could better structure and integrate information from the game (e.g., teammates, opponents, and the field of play) (Hartigh et al., 2018). Moreover, in the study carried out by O'Connor, Larkin, and Williams (2016), decision-making skill was the most important among 11 perceptual-cognitive and developmental variables, for distinguishing selected and non-

selected U-15 players for a sport development program. Again, findings indicated that superior performance in soccer was associated with higher decision-making skills.

Therefore, considering these results presented above as a whole, it is observed that both the ability to read the game and the decision-making skills play an essential role throughout the sport's development process of soccer players, from early ages until the end of the sports education. In this way, it is highlighted the need to evaluate during the whole process of sport's development in soccer, both perceptual-cognitive and perceptual-motor skills, which are complementary components of decision-making capacity (Cardoso et al., 2019, 2020). However, despite the importance and complementarity of these abilities (perceptual-motor and perceptual-cognitive) for sport's development, there is still a need for greater understanding and empirical studies on the relationship between the development of both of them (Machado & Teoldo, 2020).

Regarding the development of decision-making skills, the literature highlights the importance of players experiencing a great amount of structured sport practice (e.g., team training) throughout their development process (Berry et al., 2008). Besides, much of this time focused on structured practice must include activities that enable the interaction of perceptual-cognitive and technical skills, as through the utilization of methodological approaches that favor such environment. In this line, research in sport pedagogy has demonstrated that small-sided and conditioned games (SSCG), which are adjusted and smaller versions of formal games, are commonly used to augment the perceptions of the players for a given tactical problem, thus promoting adjustments in targeted behaviors (Davids et al., 2013). Moreover, its utilization emphasizes the learner-centered teaching and coaching practice in which the game sets the base and framework for developing creative, intelligent, and skillful players (Clemente et al., 2020). The use of SSCG also stands out as an alternative to traditional models based on the reproduction of sport technique and, therefore, provides a rich environment to foster the players' game reading, decision-making, and tactical skills (Davids et al., 2013; González-Víllora et al., 2020; Machado et al., 2020).

This approach coupled with questioning and guided-discovery situations educate the recognition and attention of players' through tasks that facilitate information-movement coupling, such as perceptual-cognitive and perceptual-motor skills (Ford et al., 2010; Roca & Ford, 2020). In this context, the coach has the role of facilitator providing a rich environment to foster the players' game reading and decision-making skills (Harvey & Jarrett, 2014; Machado et al., 2017;

O'Connor & Larkin, 2016). Moreover, such learning strategies are usually related to developing tactical aspects in team sports (Clemente et al., 2020; Kinnerk et al., 2018).

In this regard, the tactical dimension of soccer has a straight connection to the development of decision-making skills and the formation of effective problem solvers soccer players, since every action in the game has a tactical purpose (Teoldo et al., 2022). Therefore, the teaching-learning of tactics must be based on the theoretical construction regarding the logic of the game, which allows systematization of training through contents in a contextualized way. In addition, this systematization contributes to the development of athletes' decision-making throughout the training process (González-Víllora et al., 2015; Teoldo et al., 2022). Hence, it is important to develop players' decision-making skill according to the tactical contents recommended for each stage during their sport formation. Literature indicates that around age 11 onwards, it is necessary to develop tactical content related to the core tactical principles (Teoldo et al., 2022).

In this context, few studies focused on evaluating the effectiveness of soccer interventions based on the game's core tactical principles (Lima et al., 2015; Souza et al., 2014). In both studies, carried out with U-13 (Lima et al., 2015) and U-14 (Souza et al., 2014) players, authors sought to verify the effectiveness of 20 training sessions based on the core tactical principles on the development of perceptual-motor decision-making skills, assessed through the tactical performance. They observed that training organization led to an overall improvement of the tactical performance of players from both age groups. However, although these studies indicated that training organizations based on this content could improve players' tactical performance, none addressed the assessment of perceptual-cognitive decision-making skills and their interaction with perceptual-motor skills. Therefore, it is necessary to verify whether a similar training organization might influence both types of decision-making skills (i.e., perceptual-cognitive and perceptual-motor).

Furthermore, it is necessary to resort to instruments that enable the assessment of players' decision-making skills based on the core tactical principles to ensure the coherence of the teaching and training processes. Such instruments must assess the decision-making skills considering both offensive and defensive situations (Machado & Teoldo, 2020). Currently, there is the availability of such instruments that allow the evaluation of decision making from this same theoretical basis (core tactical principles of soccer), which assess: i) perceptual-motor decision making, through the System of Tactical Assessment in Soccer (FUT-SAT) (Teoldo et al., 2011); and ii) perceptual-

cognitive decision making through the TacticUP® video test (Machado & Teoldo, 2020). In this way, the use of both instruments allows evaluating the athletes' decision-making skills in offensive and defensive game situations through their perceptual-cognitive and perceptual-motor skills, which are complementary components of the decision-making ability.

To the best of our knowledge, this study is the first to assess the effectiveness of an intervention based on core tactical principles and SSCG on both perceptual-cognitive and perceptual-motor decision-making skills in soccer. Therefore, we propose scientific advances by aligning teaching contents and assessment instruments based on complementary aspects of decision-making skills. This type of approach might contribute to methodological advances in this research area, contributing to professionals who work with soccer education (e.g., physical education teachers, coaches, methodological coordinators, etc.) by allowing them to qualify their intervention and directly impact soccer players. Thus, this study aims to verify the influence of 25 training sessions based on tactical principles and SSCG in developing cognitive and motor decision-making skills of U-12 soccer players.

Materials and Methods

Participants

In this study, 25 U-12 elite male soccer players (aged 12.0 ± 0.2 years) from a Brazilian first division national club were evaluated. Players had training experience in soccer of 5.4 ± 1.9 years and trained in the club for 1.9 ± 1.1 years. For inclusion criteria, participants had to be a regular academy player, training four times a week, 2 hours per session.

Data collection was performed with previous authorization from club's representatives and players' legal guardians. The present study was approved by the Ethics Committee for Research with Human Beings from the leading institution (Approval number: 4.924.597) and is in accordance with the norms established by the National Health Council (466/2012) and by the Declaration of Helsinki (2013) for research with human beings. An informed consent was signed by participants' legal guardians.

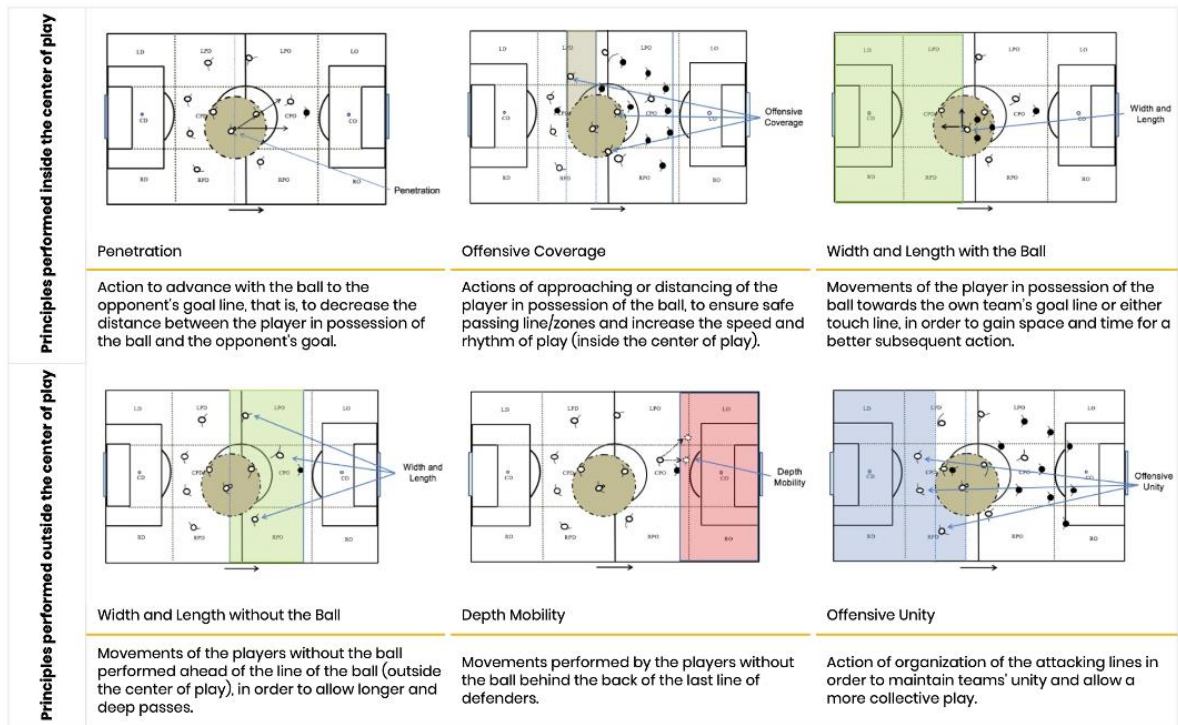
Measures and Procedures for Data Collection

Perceptual-Cognitive Decision-making skills (TacticUP®)

TacticUP® is an online platform (www.tacticup.com.br) that allows the assessment of decision-making skills of players (Machado & Teoldo, 2020). In addition, this platform allows

evaluating the quality of decision-making and response time of players' decision-making skills, based on the core tactical principles of the offensive and defensive phases, in situations with and without the ball (see figure 1) (Teoldo et al., 2022). The validity and reliability of the test were shown in Machado and Teoldo (2020). Before the start of the test, the online platform displays instructions to participants regarding the test structure and procedures, and three trial scenes are exhibited to familiarize the participants with the assessment, thus excluding the possibility of low performance due to lack of comprehension of the task. The test was carried out using laptop computers with internet, to enable the access to the tests in the TacticUP® platform. The test took around 20 minutes per player. After finishing the test, measures of the quality of decision-making and the decision-making time are generated for each tactical principle (further details are available in (Machado & Teoldo, 2020)).

a) Offensive Principles



b) Defensive Principles

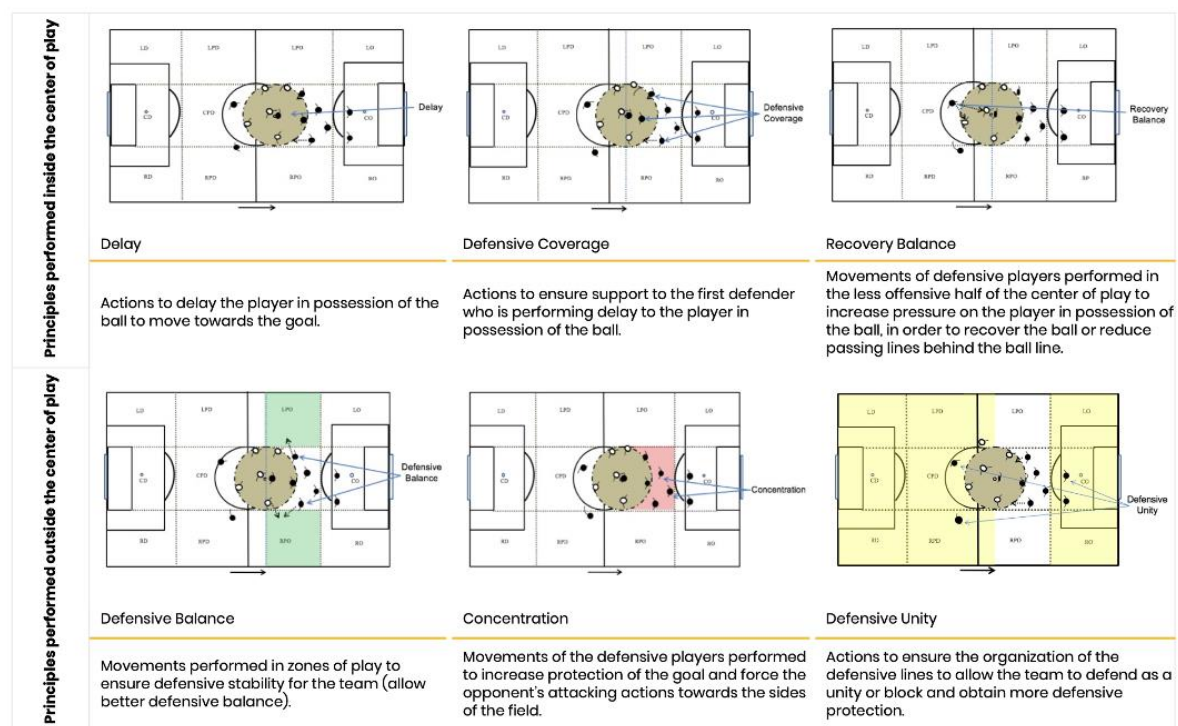


Figure 1. Description of the core tactical principles of soccer: a) offensive; and b) defensive (Source: Teoldo, Guilherme & Garganta, 2021).

Perceptual-Motor Decision-making skills – Tactical behavior efficiency (FUT-SAT)

The instrument used to assess the perceptual-motor skills through tactical behavior was the System of Tactical Assessment in Soccer (FUT-SAT) (Teoldo et al., 2011). In FUT-SAT, tactical actions related to the core tactical principles of soccer are observed and assessed. This system enables the identification and assessment of tactical actions performed by the players, through spatial references in the playing field, taking into account the tactical principle performed, the quality of the principle performed, the player's location in the field at the moment he/she performs and the action outcome (Teoldo et al., 2011). Actions such as throw-ins, free kicks, and corner kicks are not considered for analysis. Tactical behavior was measured through the *tactical behavior efficiency*, defined by the *number of correct actions*, divided by the *total number of actions* of each principle performed by the players.

The FUT-SAT field test was carried out with one small-sided game with a 4vs.4 configuration (goalkeeper + 3 outfield players vs. 3 outfield players + goalkeeper), in an area of 36 meters long by 27 meters wide for 4 minutes. The players were instructed to play in accordance with the official rules of soccer, including the offside rule. Prior to each game, players were provided with 30 seconds to familiarize with the test. In order to facilitate their identification during video analysis, players wore numbered vests, and each team was provided with vests of a particular color.

Organization of the 25 sessions

Following the first athletes' assessment through TacticUP® and FUT-SAT, 25 training sessions based on SSCG were designed considering the individual needs of improvement or maintenance of decision-making skills, related to the core tactical principles of soccer. These sessions were weekly planned (four sessions a week) taking into account players' development in previous training sessions and competitions, as observed by the coaching staff. Players were ranked and sorted in three performance groups, according to the quality of decision-making assessed by the TacticUP® test for each tactical principle, which were categorized as: i) high (score > 75); ii) regular (score ≤ 75 and > 50); and iii) low (score ≤ 50).

The 25 training sessions were designed based on SSCG by the coaching staff with support of the main researcher. Each session was structured in three parts: i) warm-up phase; ii) practice phase; and iii) conclusion phase (Pill, 2016). First, the warm-up phase started with a discussion to focus the sessions' learning intention, followed by closed to open drills related to that session's

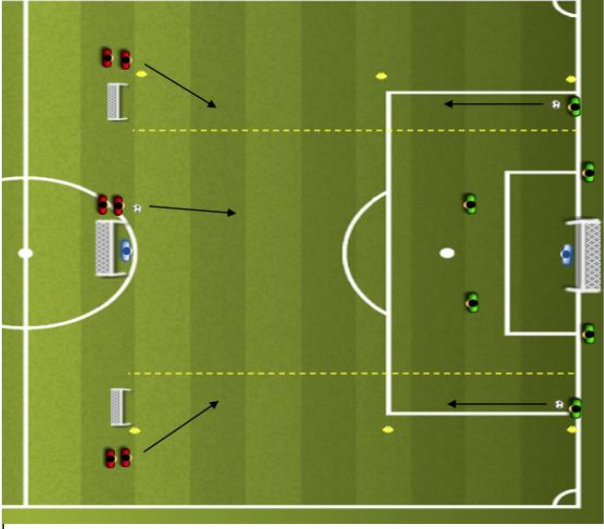
objectives. Secondly, the practice phase was characterized by the use of SSCG and the use of questioning and freeze play strategies. This phase was usually structured with a main activity followed by variations. Lastly, the conclusion phase was designed with the last game related to the training objectives and a final discussion about the session's learning intentions. We highlight that the practice phase was focused on the core tactical principles of soccer, with the purpose of improving players' decision-making skills. This phase was composed by activities with an average duration of 36.7 ± 7.6 minutes (minimum time = 28 minutes; maximum time = 50 minutes) per session.

The coaching staff and the main researcher discussed the aims of the training sessions in planning meetings held at the start of each week. In such meetings, they selected the coaches responsible for supervising each activity and defined the questioning provided to the players. Those questioning strategies focused on the performance indicators related to the tactical principles on which the activities were focused in each training session (see figure 2). The inquiry strategies occurred during training sessions, post-training (group talk showing the tactical board) and on the day after training, individually, in case of need.

The interactions within the activities were organized according to the athletes' performance levels according to the quality of decision-making assessed by the TacticUP® test (e.g., an athlete with high performance in relation to the offensive principle of penetration, against an athlete with high performance in relation to the defensive principle of delay). These interactions could be modified according to the context of a given proposed activity.

At the end of each training session, coaches and the technical coordinators held meetings to provide feedback about how each group performed the exercises, in addition to perform adjustments regarding the structure of the activities proposed for the next training sessions.

CONTENTS AND PURPOSES			
Type of Principle	Principle 1	Principle 2	Principle 3
Principle	Penetration	Delay	-
Performance Indicator	Enable shot or dribbling	Prevent progression and shot at goal	-
Purpose	Directly attack the opponent or the goal	Limit the space of the player in possession for offensive actions	-

ACTIVITY 1	
	Number of Players
	14 (in each area)
	Time (min)
	30
	Dimensions
	Length: 50m / Width: 40m
Description	Series x Duration
	2 x 15
	The aim of the attacking players (in red) is to quickly progress throughout the opponent's area, with the purpose of shooting at goal, thus taking advantage of numerical superiority. After the end of each bout, the athletes near the side corridors have to quickly change their attitude and perform a delay action towards the opposing players who will be in possession of the ball, performing the principle of penetration.
Variations	-
	-
	-

ORGANIZATION OF ACTIVITY INTERACTIONS	
Part 1 (Athletes with high performance in penetration x athletes with high performance in delay). Part 2 (Athletes with regular performance in penetration x athletes with regular performance in delay). Part 3 (Athletes with low performance in penetration x athletes with low performance in delay).	

PLAYERS FEEDBACK			
Performance Group	High Performance	Regular Performance	Low Performance
Feedback	Adjustments, for both high and regular performance groups, on the utilization of the arms to provide support when challenging an opponent; stimuli to encourage aggressiveness and speed when performing penetrations were also provided.	Adjustments, for both high and regular performance groups, on the utilization of the arms to provide support when challenging an opponent; stimuli to encourage aggressiveness and speed when performing penetrations were also provided.	In this group, some athletes had difficulties in defensive actions of limiting the space of the player in possession. Adjustments were made in this respect.

Figure 2. Exemplar planning and organization of a training activity based on the core tactical principles.

Time control regarding the training contents taught during the 25 training sessions was carried out per player according to the groups of tactical principles, which were categorized as follows: 1) offensive principles inside the center of play (OICP) - penetration, offensive coverage and width and length with the ball (training time of 478.6 ± 140.4 minutes per player); 2) offensive

principles outside the center of play (OOCp) - width and length without the ball, mobility and offensive unity (training time of 223.5 ± 76.8 minutes per player); 3) defensive principles inside the center of play (DICP) - delay, defensive coverage and recovery balance (training time of 630.7 ± 192.3 minutes per player); and 4) defensive principles outside the center of play (DOCP) - defensive balance, concentration and defensive unity (training time of 190.6 ± 83.8 minutes per player). This categorization was performed due to the spatial relations between these principles and the center of play, as well as their hierarchical relation within the teaching-learning process. The tactical principles performed inside the center of play display less complexity regarding their execution, when compared to those performed outside the center of play (Machado and Teoldo 2020; Teoldo, Guilherme, and Garganta 2022).

According to Teoldo, Guilherme, and Garganta (2022) the center of play is a dynamic spatial reference employed to characterize where the game is played more intensely/quickly. Its radius is 9.15 meters from the epicenter of play. With respect to this space, it is assumed that ball transmission between teammates is facilitated when they are located inside the center of play and/or when opponents are located farther than the distance of the radius and the player in possession needs to pass the ball to a teammate outside the center of play. In the case of the players located inside the center of play, ball transmission is facilitated, as the distance between the player in possession and the potential receiver is lower, thus allowing for more efficient technical actions and increased ball transmission speed.

As the activities and their interactions are planned according to the players' individual needs, the amount of training time for each principle was not similar for all players, taking the 25 training sessions into account. The training time of each player, for each tactical principle is displayed in table 1 and the contents taught in each training session are displayed in chart 1.

As the activities and their interactions are planned according to the players' individual needs, the amount of training time for each principle was not similar for all players, taking the 25 training sessions into account. The contents taught in each training session are displayed in chart 1, and the training time of each player, for each tactical principle is displayed in table 1.

Chart 1. Tactical principles taught, and training time per session.

Session	Tactical principles taught	Time (min)
1	Penetration; Delay	48
2	Mobility; Delay	28
3	Defensive Coverage; Offensive Coverage	36
4	Width and length without the ball; Defensive Balance	36
5	Width and length without the ball; Defensive Balance	36
6	Mobility; Delay; Defensive Balance	40
7	Defensive Balance, Width and length without the ball; Delay	40
8	Offensive Coverage; Delay	50
9	Defensive Coverage; Delay	48
10	Defensive Balance; Recovery Balance	40
11	Defensive Unity; Offensive Unity	45
12	Defensive Balance, Delay; Width and length without the ball	30
13	Offensive Coverage; Delay; Defensive Coverage	30
14	Offensive Coverage; Delay; Defensive Coverage	40
15	Mobility; Defensive Balance; Recovery Balance	45
16	Width and length without the ball; Defensive Coverage; Width and length with the ball	30
17	Width and length without the ball; Penetration; Concentration	28
18	Width and length without the ball; Offensive Coverage; Defensive Coverage	40
19	Penetration; Width and length with the ball; Delay	30
20	Offensive Coverage; Delay	40
21	Offensive Coverage; Delay	40
22	Offensive Coverage; Mobility; Defensive Balance	45
23	Penetration; Delay	30
24	Defensive Coverage; Delay; Penetration	30
25	Defensive Coverage; Width and length without the ball; Delay	40

Statistical Analysis

Outcomes of quality of decision-making, decision-making time, and tactical behaviour efficiency are presented as means $\pm$ standard deviations (SD). In addition, percentage change was calculated for all variables from the pre- to the post-test. We verified the within-groups differences among pre- and post-test through a paired sample t-test or Wilcoxon test, considering the data distribution. Distributions were checked with a Shapiro-Wilk test. (1999). The level of significance was set as $p < .05$. The effect size used for the independent t-test was Cohens's d (Cohen, 1988), and for Wilcoxon tests was calculated through the formula described by Fritz, Morris, and Richler (2012) as $(r = Z/\sqrt{n})$. The interpretation of the effect size value was made as follows Cohen (1988): small effect (.1 - .29); medium effect (.3 - .49); and large effect ($> .5$).

Cohen's Kappa test was used for assessing the reliability of FUT-SAT analyses, whereas 57 tactical actions were reassessed, corresponding to 12.2% of the overall sample, which is greater than the reference value (10%) suggested by literature (Tabachnick & Fidell, 2013). Two trained evaluators participated in this procedure and presented inter-evaluator reliability values of 0.911 (SE = 0.027). As for intra-evaluator reliability value was 0.953 (SE = 0.014). For statistical procedures was utilized the software SPSS 22.0.

Results

In terms of the quality of decision-making we found unexpected results. The defensive principles outside the center of play (DOCP) showed a negative variation (-9.6 % change), once we found lower values of post intervention ($M = 73.0$, $SD = 8.6$) compared to the pre intervention ($M = 66.0$, $SD = 11.5$), $t(24) = 3.421$, $p = .002$, $d = -.690$, *large effect* (see table 2).

Table 1. Descriptive statistics and pairwise comparisons in analyses of quality of decision-making, decision-making time and tactical efficiency.

Indexes	Quality of decision-making (a.u.)			Decision-making time (s)			Tactical Efficiency (%)		
	Pre Intervention	Post Intervention	P	Pre Intervention	Post Intervention	P	Pre Intervention	Post Intervention	P
Offensive									
Inside the center of play	74.4 ± 8.9	75.9 ± 8.0	0.641	11.9 ± 4.6	9.6 ± 3.2	0.004*	93.8 ± 6.7	90.1 ± 8.3	0.076
Outside the center of play	66.6 ± 14.9	65.5 ± 12.7	0.726	11.8 ± 5.1	10.0 ± 3.2	0.103	93.4 ± 10.2	95.1 ± 11.1	0.309
Defensive									
Inside the center of play	66.3 ± 12.4	62.3 ± 11.6	0.189	8.8 ± 2.1	7.9 ± 2.3	0.042*	61.4 ± 18.3	73.6 ± 20.1	0.031*
Outside the center of play	73.0 ± 8.6	66.0 ± 11.5	0.002*	8.7 ± 2.7	6.9 ± 2.3	0.004*	97.2 ± 4.4	96.0 ± 30.4	0.717

* $p < 0.050$; a.u. - arbitrary units

Considering the decision-making time, we found an improvement in three out of four variables, once the time decreased for all those three. In terms of offensive indexes, only the offensive principles inside the center of play (OICP) showed main effects with a negative variation (-19.3 % change), once we found lower values of post intervention ($M = 9.6$, $SD = 3.2$) compared to the pre intervention ($M = 11.9$, $SD = 4.6$), $T = 56$, $p = .004$, $r = -0.577$, *large effect* (see table 2). For the defensive indexes, the defensive principles inside the center of play (DICP) showed a negative variation (-10.0 % change), and we found lower values of post intervention ($M = 7.9$, $SD = 2.3$) compared to the pre intervention ($M = 8.8$, $SD = 2.1$), $t(24) = 2.144$, $p = .042$, $d = -.360$, *medium effect* (see table 2). Moreover, the defensive principles outside the center of play (DOCP) showed a negative variation (-20.7 % change), once we found lower values of post intervention ($M = 6.9$, $SD = 2.3$) compared to the pre intervention ($M = 8.7$, $SD = 2.7$), $T = 53$, $p = .004$, $r = -0.571$, *large effect* (see table 2).

In terms of the tactical efficiency we found improvements for the defensive principles inside the center of play (DICP), with a positive variation (20.0 % change), and higher values of post intervention ($M = 73.6$, $SD = 20.1$) compared to the pre intervention ($M = 61.4$, $SD = 18.3$), $t(24) = -2.296$, $p = .031$, $d = -.635$, *large effect* (see table 2).

Discussion

The purpose of this study was to verify the influence of 25 training sessions based on tactical principles and SSCG in developing cognitive and motor decision-making skills of U-12 soccer players. To the best of our knowledge, it was the first study to use complementary instruments to

assess both perceptual-cognitive (TacticUP[®]) and perceptual-motor (FUT-SAT) decision-making skills based in the same theoretical background (core tactical principles) as suggested by previous research (Machado & Teoldo, 2020). We highlight that it was the first study because one of the instruments (TacticUP[®]) used in our research was recently developed and validated (Machado & Teoldo, 2020). Moreover, it was also the first study to investigate the effect of an on-field intervention on perceptual-cognitive and perceptual-motor skills in soccer players. Recent systematic reviews published in this research area (Robles et al., 2020; A. F. Silva et al., 2020, 2021) have shown that studies with on-field intervention have their assessment focused only on perceptual-motor skills, neglecting the assessment of perceptual-cognitive skills. Due to the multidimensional characteristic of soccer, in terms of the combination of cognitive and motor skills that contribute to on-field performance, we believe it is an important advance in this research field. This type of approach may contribute to a further understanding of how sport pedagogy and training methodologies may impact in both perceptual-cognitive and perceptual-motor skills, and its interaction.

As a result, we found improvements in perceptual-cognitive decision-making skills related to the decision-making time for both offensive and defensive actions performed inside the center of play (actions with the ball and near the ball) and defensive actions performed outside the center of play (actions far from the ball). Moreover, we also found improvement in perceptual-motor skills (tactical efficiency) for defensive actions performed inside the center of play (actions near the ball). Although, surprisingly, we found a decrement in perceptual-cognitive skills related to the quality of decision-making in actions outside the center of play (actions far from the ball). In general, we found the most quantity of improvements in decision-making skills related to the decision-making time.

In soccer, the decision-making time is related to the time that an individual needs to perceive a game situation, process that information, and provide a solution. In other words, it is an objective measure of the elapsed time between stimulus onset and the overt production of a response (Mann et al., 2007). This ability is related to player's development along sport formation, where older players (e.g. U-17) usually possess quicker decision-making responses compared to youngers (e.g. U-14) as showed in previously research (D. Silva et al., 2021).

Moreover, this ability to make quicker decisions is gaining even more importance due to changes in the soccer game dynamics. The game and training methodologies used in sports

formation have evolved in the last few years, and players' demands to make decisions with less time and space have increased compared to a few decades ago. Therefore, sports education programs should encourage the development of this ability so that young players feel competent and want to continue practicing and learning sports (Estevan et al., 2021). In other words, it may enhance the likelihood of their adherence to the practice of physical activity and sports in a healthy way (Morales-Belando et al., 2018). However, although the decision-making time has been shown to represent an important aspect of players' sports formation, very little research has assessed the effectiveness of an intervention to improve such ability.

The few studies found on literature were carried out on badminton (Romeas et al., 2019), American football (Sanger et al., 2019), handball (Hohmann et al., 2016), rugby (Serpell et al., 2011), and soccer (Nimmerichter et al., 2016). All those five studies assessed the effect of virtual training on decision-making time and found improvements after the intervention period. Moreover, two of them (Nimmerichter et al., 2016; Serpell et al., 2011) showed that improvements in perceptual-cognitive decision-making time also reflected faster decisions in on-field assessments. These results provide interesting insights into the trainability of decision-making time and how the improvement of perceptual-cognitive skills has a positive transfer into a behavioral level based on on-field tests.

Moreover, results from our study add to the literature the possibility of improvements on decision-time through on-field interventions for both offensive and defensive skills. It is an important advance in the scientific field of sport pedagogy, once offensive and defensive decision-making skills must be developed throughout the sport formation from childhood up to adulthood (Teoldo et al., 2022). However, both offensive and defensive skills apparently develop in different paces (González-Víllora et al., 2010; Machado & Teoldo, 2020), and different activities contribute for its development during sport's formation (Machado et al., 2020; Roca et al., 2012).

In terms of the perceptual-motor decision-making skills, we found improvements (~20% in tactical efficiency) for the defensive principles inside the center of play. These principles are related to defensive actions performed near to the ball, such as: 1) actions of opposition by the “first” defensive player to the player in possession (delay); 2) supporting actions of a player “on the back” of the first defender - delay - in order to strengthen defensive marking (defensive coverage); and 3) defensive movements to increase pressure, performed in the “back” of the player in possession of the ball (recovery balance). In this regard, Teoldo, Guilherme, and Garganta (2022) highlight

that the core tactical principles of soccer demand abstract thinking and hypothesis testing to enable space occupation and movement throughout the playing field. Therefore, it is suggested that they should be the target of the training of the tactical component by around 11 years, focusing initially on principles less complex such as principles performed inside the center of play. Gradually, the teaching process might be focusing on more complex principles, such as those performed outside the center of play, when the child's cognitive development stage is already (or close to becoming) fully mature (Américo et al., 2016; Teoldo et al., 2022).

Therefore, it is interestingly to highlight that due to the age of the players in our sample (around 12 years), the defensive principles performed inside the center of play were the ones with more training volume (~ 700 minutes - see table 1) during the 25 sessions compared to the other categories of principles. It shows an adequate focus of training on contents that might be targeted at this phase of sport's formation. Moreover, it might suggest that improvements at a behavioral level, as we found for the tactical efficiency, might take longer training volumes than the players had on the other categories of tactical principles, which varied between ~500 to ~200 minutes (see table 1). Another interesting aspect is that we also found an improvement in this category of principle in terms of perceptual-cognitive skills, related to the decision-making time, but not for the quality of decision-making. It suggests that improvements in the capacity to read the game quickly and make faster decisions positively impact players' on-game tactical skills.

This view is supported by a recent study that found that players with better perceptual-motor decision-making skills assessed through tactical efficiency also possessed a better capacity to read the game (Assis et al., 2020). The results showed that more tactically efficient players also employed more efficient visual search strategies. Although this study did not use the same perceptual-cognitive metrics we assessed, it showed a positive association between perceptual-cognitive and perceptual-motor skills. Moreover, the perceptual-motor skills assessed by Assis et al. (2020) used the same instrument (FUT-SAT) and metric (tactical efficiency) that we used in our study, which reinforces our claim of association among both skills: cognitive and motor. It highlights the important role of physical education teachers and coaches to focus their teaching process on fostering motor and cognitive skills, such as using game-based approaches.

Considering the perceptual-cognitive skills related to the quality of decision-making, we found unexpected results. We observed a decrease in decision-making quality related to the offensive principles performed outside the center of play. Although surprisingly, it was the

category of principle with less training volume (~ 200 minutes - see table 1) during the 25 sessions compared to the other categories of principles. This result might indicate that higher training volumes might be necessary to keep and improve the quality of decision-making related to this category of principles. Interestingly, previous research on sport supports the idea that the quality of decision-making takes longer to develop than decision-making time (Hohmann et al., 2016; Romeas et al., 2019; Sanger et al., 2019). In these studies, an improvement was observed in decision-making time for all interventions based on virtual training. However, there was no change in the quality of decision-making in two of them (Hohmann et al., 2016; Sanger et al., 2019), and in Romeas et al. (2019), a decrease was observed in the quality of decision-making, similar to our findings. The authors suggested that this negative effect could be related to a speed-accuracy tradeoff in that reaction time was improved while the quality of decision-making declined.

In general, our results add to the literature of sports pedagogy on how an intervention based on SSCG and tactical principles may contribute to the development of decision-making skills. Additionally, we showed the importance of individualizing the stimuli provided through the training process for players' individual needs, as structured in the present study. This strategy may improve the quality of interventions based on SSCG and game-based approaches to teaching and coaching (e.g., TGfU, Tactical Games Model, Play Practice, and Ball School) that consider the teacher's and coach's roles as a facilitator of the learning process (Kinnerk et al., 2018; Light & Harvey, 2017; Pill et al., 2021). For example, in addition to adjusting the activities' interactions according to the students' performance level, the questioning strategy can also be optimized. This strategy can be done by asking questions in a more individualized way consistent with the players' level of performance. The questioning can direct players' attention to more general or specific behaviors of a given game situation, depending on what they need to improve in the planned tasks.

Moreover, this individualization strategy must be following the content proposed for the players' development phase, which is related to the core tactical principles of soccer, regarding the tactical component for U-12 soccer players (Teoldo et al., 2022). In addition, these results indicate that an on-field intervention based on core tactical principles can develop perceptual-cognitive skills related to the decision-making time and perceptual-motor decision-making skills related to tactical efficiency. It contributes to developing more competent players capable of quickly and effectively solving problems that arise from the game.

One limitation of our study is the fact that we have not used a control group. Therefore, we suggest for future studies the inclusion of control groups with similar age and experience. In addition, we suggest that further research could assess intervention with different training volumes (e.g., number of sessions) based on the core tactical principles. Activities with tactical contents outside the center of play could also be emphasized to investigate the effect of a greater volume of stimuli of these contents on this age group. We also suggest that a similar intervention protocol be developed in other age groups or competitive levels (e.g., soccer schools), and different team sports. Lastly, we suggest assessing and controlling the players' previous developmental activities in soccer, as different sport contexts beyond practice look to contribute to the development of decision-making skills in soccer (Machado et al., 2020; Roca et al., 2012).

Conclusions

We concluded that 25 training sessions based on core tactical principles and SSCG improved perceptual-cognitive and perceptual-motor decision-making skills. It was found improvements in perceptual-cognitive decision-making skills related to the decision-making time for both offensive and defensive actions performed inside the center of play (actions with the ball and near the ball) and defensive actions performed outside the center of play (actions far from the ball). Moreover, we also found improvement in perceptual-motor skills (tactical efficiency) for defensive actions performed inside the center of play (actions near the ball). Our results also indicated that in terms of perceptual-cognitive skills, decision-making time develops quicker than the quality of decision-making. Finally, to the best of our knowledge our study was the first to: 1) use complementary instruments to assess both perceptual-cognitive (TacticUP®) and perceptual-motor (FUT-SAT) decision-making skills based in the same theoretical background (core tactical principles); and 2) provide empirical evidence that an on-field intervention contributes for the development of perceptual-cognitive and perceptual-motor decision-making skills in soccer players.

Practical Applications

- 25 training sessions based on core tactical principles contributes to developing decision-making time (offensive and defensive skills) and tactical efficiency (defensive skills) of U-12 soccer players.

- Improvement of decision-making time apparently is related to improvement in tactical efficiency of U-12 soccer players.
- In terms of perceptual-cognitive skills, focus on the development of decision-making time might be a good strategy for the teaching process, once it develops quickly compared to the quality of decision-making in U-12 soccer players.
- It is advisable to design programs with around 25 sessions to deepen tactical learning, emphasizing learning tactical principles based on SSCG.

Funding

This study was supported by the Sports incentive law of the Government of Minas Gerais, by the Academy & Soccer Program of the Ministry of Citizenship, through the National Secretariat of Football and Defense of Fans' Rights; the SEESP-MG, FAPEMIG, CNPq, Funarbe, the Dean's Office for Graduate and Research Studies and the Centre of Life and Health Sciences from Universidade Federal de Viçosa, Brazil. This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

References

- Américo, H. B., Cardoso, F. da S. L., Machado, G. F., Andrade, M. O. C., Resende, E. R., & Teoldo, I. C. (2016). Analysis of the tactical behavior of youth academy soccer players. *Journal of Physical Education*, 27(1), e-2710. <https://doi.org/10.4025/jphyseduc.v27i1.2710>
- Assis, J., González-Víllora, S., Clemente, F., Cardoso, F., & Teoldo, I. (2020). Do youth soccer players with different tactical behaviour also perform differently in decision-making and visual search strategies? *International Journal of Performance Analysis in Sport*, 20(6), 1143–1156. <https://doi.org/10.1080/24748668.2020.1838784>
- Berry, J., Abernethy, B., & Côté, J. (2008). The contribution of structured activity and deliberate play to the development of expert perceptual and decision-making skill. *Journal of Sport and Exercise Psychology*, 30(6), 685–708. <https://doi.org/10.1123/jsep.30.6.685>

- Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. *Psychology of Sport and Exercise*, 13(2), 152–161. <https://doi.org/10.1016/j.psychsport.2011.10.005>
- Cardoso, F., González-Víllora, S., Guilherme, J., & Teoldo, I. (2019). Young soccer players with higher tactical knowledge display lower cognitive effort. *Perceptual & Motor Skills*, 126(3), 499–514. <https://doi.org/https://doi.org/10.1177/0031512519826437>
- Cardoso, F., Neves, J., Roca, A., & Teoldo, I. (2020). The association between perceptual-cognitive processes and response time in decision making in young soccer players. *Journal of Sports Sciences*, 39(8), 926–935. <https://doi.org/10.1080/02640414.2020.1851901>
- Clemente, F. M., Afonso, J., Castillo, D., Arcos, A. L., Silva, A. F., & Sarmiento, H. (2020). The effects of small-sided soccer games on tactical behavior and collective dynamics: A systematic review. *Chaos, Solitons and Fractals*, 134, 109710. <https://doi.org/10.1016/j.chaos.2020.109710>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates. <https://doi.org/10.4324/9780203771587>
- Davids, K., Araújo, D., Correia, V., & Vilar, L. (2013). How small-sided and conditioned games enhance acquisition of movement and decision-making skills. *Exercise and Sport Sciences Reviews*, 41(3), 154–161. <https://doi.org/10.1097/JES.0b013e318292f3ec>
- Estevan, I., Bardid, F., Utesch, T., Menescardi, C., Barnett, L. M., & Castillo, I. (2021). Examining early adolescents' motivation for physical education: associations with actual and perceived motor competence. *Physical Education and Sport Pedagogy*, 26(4), 359–374. <https://doi.org/10.1080/17408989.2020.1806995>
- Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. *Journal of Sports Sciences*, 28(5), 483–495. <https://doi.org/10.1080/02640410903582750>
- Fritz, C., Morris, P., & Richler, J. (2012). Effect size estimates: Current use, calculations, and

- interpretation. *Journal of Experimental Psychology: General*, 141(1), 2–18. <https://doi.org/10.1037/a0024338>
- González-Víllora, S., Fernandez-Rio, J., Guijarro-Jareño, E., & Sierra-Díaz, M. (2020). *The game-centred approach to sport literacy*. Routledge.
- González-Víllora, S., García-López, L. M., Gutiérrez-Díaz, D. C., & Contreras-jordán, O. R. (2010). Estudio descriptivo sobre el desarrollo táctico y la toma de decisiones en jóvenes jugadores de fútbol (12 años). *Infancia Y Aprendizaje*, 33(4), 489–501. <https://doi.org/10.1174/021037010793139644>
- González-Víllora, S., Serra-Olivares, J., Pastor-Vicedo, J., & Teoldo, I. (2015). Review of the tactical evaluation tools for youth players, assessing the tactics in team sports: football. *Springerplus*, 4(663), 1–17. <https://doi.org/https://doi.org/10.1186/s40064-015-1462-0>
- Gréhaigne, J. F., Godbout, P., & Bouthier, D. (2001). The teaching and learning of decision making in team sports. *Quest*, 53(1), 59–76. <https://doi.org/http://dx.doi.org/10.1080/00336297.2001.10491730>
- Hartigh, R., Steen, S., Hakvoort, B., Frencken, W., & Lemmink, K. (2018). Differences in game reading between selected and non-selected youth soccer players. *Journal of Sports Sciences*, 36(4), 422–428. <https://doi.org/10.1080/02640414.2017.1313442>
- Harvey, S., & Jarrett, K. (2014). A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy*, 19(3), 278–300. <https://doi.org/10.1080/17408989.2012.754005>
- Hohmann, T., Obelöer, H., Schlapkohl, N., & Raab, M. (2016). Does training with 3D videos improve decision-making in team invasion sports? *Journal of Sports Sciences*, 34(8), 746–755. <https://doi.org/10.1080/02640414.2015.1069380>
- Keller, B. S., Raynor, A. J., Iredale, F., & Bruce, L. (2018). Tactical skill in Australian youth soccer: Does it discriminate age-match skill levels? *International Journal of Sports Science and Coaching*, 13(6), 1057–1063. <https://doi.org/10.1177/1747954118760778>
- Kinnerk, P., Harvey, S., MacDonncha, C., & Lyons, M. (2018). A review of the game-based

- approaches to coaching literature in competitive team sport settings. *Quest*, 70(4), 401–418. <https://doi.org/10.1080/00336297.2018.1439390>
- Light, R. L., & Harvey, S. (2017). Positive Pedagogy for sport coaching. *Sport, Education and Society*, 22(2), 271–287. <https://doi.org/10.1080/13573322.2015.1015977>
- Lima, R. C., Cardoso, F. S. L., Vecchi, P., Teoldo, I. C., & Paoli, P. B. (2015). A organização do treino baseado nos princípios fundamentais do jogo de futebol e sua relação com o desempenho tático de jogadores da categoria sub 13. *Revista Brasileira de Futebol*, 8(1), 30–42.
- Machado, G., Cardoso, F., & Teoldo, I. (2017). Visual search strategy of soccer players according to different age groups. *Motriz*, 23(3), e101748. <https://doi.org/10.1590/S1980-6574201700030022>
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Machado, G., & Teoldo, I. (2020). TacticUP Video Test for soccer: Development and validation. *Frontiers in Psychology*, 11(1690), 1–12. <https://doi.org/10.3389/fpsyg.2020.01690>
- Macmahon, C., & Mcpherson, S. U. E. L. (2009). Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! *International Journal of Sport Psychology*, 40(4), 565–579.
- Mann, D. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457–478. <https://doi.org/10.1123/jsep.29.4.457>
- Materniuk, R. (1976). *Information Processing in Motor Skills*. Holt, Rinehart, and Winston.
- McPherson, S. L., & Kernodle, M. (2003). Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.),

- Expert performance in sports: advances in research on sport expertise* (pp. 137–167). Human Kinetics. internal-pdf://228.60.152.31/2003 - Starks & Ericsson - Expert Performance.pdf
- Morales-Belando, M. T., Calderón, A., & Arias-Estero, J. L. (2018). Improvement in game performance and adherence after an aligned TGfU floorball unit in physical education. *Physical Education and Sport Pedagogy*, 23(6), 657–671. <https://doi.org/10.1080/17408989.2018.1530747>
- Nimmerichter, A., Weber, N. J. R., Wirth, K., & Haller, A. (2016). Effects of video-based visual training on decision-making and reactive agility in adolescent football players. *Sports*, 4(1), 1–9. <https://doi.org/10.3390/sports4010001>
- O'Connor, D., & Larkin, P. (2016). Decision making and tactical knowledge: An Australian perspective in the development of youth football players. In T. Favero, B. Drust, & B. Dawson (Eds.), *International Research in Science and Soccer II* (pp. 204–214). Routledge. internal-pdf://195.27.215.181/2016 - O'Connor & Larkin - Decision making and.pdf
- O'Connor, D., Larkin, P., & Mark Williams, A. (2016). Talent identification and selection in elite youth football: An Australian context. *European Journal of Sport Science*, 16(7), 837–844. <https://doi.org/10.1080/17461391.2016.1151945>
- O'Connor, D., Larkin, P., & Williams, A. M. (2017). What learning environments help improve decision-making? *Physical Education and Sport Pedagogy*, 22(6), 647–660. <https://doi.org/10.1080/17408989.2017.1294678>
- Pill, S. (2016). *Play with purpose: Game sense to sport literacy* (3rd ed.). ACHPER.
- Pill, S., Evans, J. R., Williams, J., Davies, M. J., & Kirk, M. A. (2021). Conceptualising games and sport teaching in physical education as a culturally responsive curriculum and pedagogy. *Sport, Education and Society*, 0(0), 1–15. <https://doi.org/10.1080/13573322.2021.1964461>
- Robles, M. T. A., Collado-Mateo, D., Fernández-Espínola, C., Viera, E. C., & Fuentes-Guerra, F. J. G. (2020). Effects of teaching games on decision making and skill execution: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 17(2), 1–13. <https://doi.org/10.3390/ijerph17020505>

- Roca, A., & Ford, P. R. (2020). Decision-making practice during coaching sessions in elite youth football across European countries. *Science and Medicine in Football*, 4(4), 263–268. <https://doi.org/10.1080/24733938.2020.1755051>
- Roca, A., Ford, P. R., McRobert, A. P., & Williams, A. M. (2013). Perceptual-cognitive skills and their interaction as a function of task constraints in soccer. *Journal of Sport & Exercise Psychology*, 35, 144–155. <https://doi.org/10.1123/jsep.35.2.144>
- Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, 30(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>
- Romeas, T., Chaumillon, R., Labbé, D., & Faubert, J. (2019). Combining 3D-MOT with sport decision-making for perceptual-cognitive training in virtual reality. *Perceptual and Motor Skills*, 126(5), 922–948. <https://doi.org/10.1177/0031512519860286>
- Sanger, M. A., Buns, M. T., & Thomas, K. T. (2019). The effect of virtual training on speed and accuracy of decision making in sport. *Journal of Human Kinetics*, 70(1), 261–273. <https://doi.org/10.2478/hukin-2019-0041>
- Serpell, B. E., Young, W. A., & Ford, M. A. (2011). Are the perceptual and decision-making components of agility trainable? A preliminary investigation. *The Journal of Strength and Conditioning Research*, 25(5), 1240–1248. <https://doi.org/10.1519/JSC.0b013e3181d682e6>
- Silva, A. F., Conte, D., & Clemente, F. M. (2020). Decision-making in youth team-sports players: A systematic review. *International Journal of Environmental Research and Public Health*, 17(11), 1–33. <https://doi.org/10.3390/ijerph17113803>
- Silva, A. F., Ramirez-Campillo, R., Sarmiento, H., Afonso, J., & Clemente, F. M. (2021). Effects of training programs on decision-making in youth team sports players: A systematic review and meta-analysis. *Frontiers in Psychology*, 12(May), 663867. <https://doi.org/10.3389/fpsyg.2021.663867>
- Silva, D., Moreira, W., Vasconcellos, F., Machado, G., Petiot, G., Mota-Júnior, R., Lavorato, V., & Teoldo, I. (2021). Comparison of decision-making skills between Under-14 , Under-16 ,

- and Under-17 soccer players. *Journal of Physical Education & Sport*, 21(6), 3298–3304. <https://doi.org/10.7752/jpes.2021.s6448>
- Souza, C., Muller, E., Teoldo, I., & Graça, A. (2014). Quais comportamentos táticos de jogadores de futebol da categoria sub-14 podem melhorar após 20 sessões de treino? *Revista Brasileira de Ciências Do Esporte*, 36(1), 71–86. [internal-pdf://121.226.169.207/173-2014-Quais-comportamentos-taticos-de-joga.pdf](https://doi.org/10.1226.169.207/173-2014-Quais-comportamentos-taticos-de-joga.pdf)
- Starkes, J., Cullen, J., & MacMahon, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In N. Hodges & M. Williams (Eds.), *Skill acquisition in sport: Research, theory and practice*. Routledge.
- Tabachnick, B., & Fidell, L. (2013). *Using Multivariate Statistics* (6th ed.). Pearson.
- Teoldo, I., Garganta, J., Greco, P., Mesquita, I., & Maia, J. (2011). System of tactical assessment in soccer (FUT-SAT): Development and preliminary validation. *Motricidade*, 7(1), 69–83. [https://doi.org/10.6063/motricidade.7\(1\).121](https://doi.org/10.6063/motricidade.7(1).121)
- Teoldo, I., Guilherme, J., & Garganta, J. (2022). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Williams, A. Mark, Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.1766647>
- Williams, A M, & Reilly, T. (2000). Talent identification and development in soccer. *Journal of Sports Sciences*, 18(9), 657–667. <https://doi.org/10.1080/02640410050120041>

Capítulo V

Estudo 5: Artigo original quatro

Este capítulo foi submetido como artigo original para a revista:

International Journal of Performance Analysis in Sport

Estudo 5: Selected soccer players are quicker and better decision-makers in elite Brazilian youth academies

Guilherme Machado; Sixto González-Víllora; Israel Teoldo

Abstract: The ability of soccer players to decide efficiently and quickly is gaining even more importance due to changes in the soccer game dynamics over time. Studies in talent identification and selection showed that more talented players usually possessed better decision-making skills. Nevertheless, studies on this topic have not yet been carried out: 1) with South American samples; 2) neither assessed both decision-making time and quality based on offensive and defensive skills among selected and deselected youth soccer players. This study aimed to compare the decision-making skills among selected and deselected players from Brazilian elite youth soccer academies. The sample comprised 317 Brazilian youth elite male soccer players (U-14, U-15, U-16, and U-17) from teams of the first national division in Brazil. At the end of that competition season, players continued in the club (selected) or were released (deselected). Players' decision-making skills (quality and response time) were assessed with an objective video-based test (TacticUP®). Results showed that selected players, compared to those deselected, possessed advantages ($p < 0.05$) in every age group assessed on: 1) the decision-making time (U-16 and U-17); 2) the quality of decision-making (U-15); or 3) in both decision-making time and quality (U-14). Those advantages were related to offensive skills for the U-16, defensive skills for the U-15, and offensive and defensive skills for the U-14 and U-17. Moreover, among all variables assessed ($n = 72$), the deselected players did not show any advantage compared to the selected ones. It is concluded that selected players by youth elite soccer academies in Brazil possess superior decision-making skills related to decision time and quality compared to those deselected.

Keywords: Talent identification; Talent development; decision-making; perceptual-cognitive skills; football.

Resumo: A capacidade de jogadores de futebol decidirem com eficiência e rapidez está ganhando cada vez mais importância devido às mudanças na dinâmica do jogo de futebol ao longo do tempo. Estudos sobre identificação e seleção de talentos tem mostrado que jogadores mais talentosos geralmente possuem melhores habilidades para tomarem decisões. Entretanto, estudos sobre este tópico ainda não foram realizados: 1) com amostras sul-americanas; 2) nem avaliaram conjuntamente o tempo e a qualidade da tomada de decisão ofensivas e defensivas em jovens jogadores de futebol selecionados e não selecionados. O objetivo deste estudo foi comparar a habilidade de tomada de decisão entre jogadores selecionados e não selecionados de clubes de futebol de base de elite no Brasil. A amostra incluiu 317 jogadores brasileiros de futebol masculino de elite (sub-14, sub-15, sub-16 e sub-17) de equipes da primeira divisão nacional no Brasil. No final dessa temporada competitiva, os jogadores ou continuaram no clube (selecionados) ou foram liberados (não selecionados). A tomada de decisão dos jogadores (qualidade e tempo de resposta) foi avaliada através de um teste de vídeo objetivo (TacticUP®). Os resultados mostraram que jogadores selecionados, comparados com não selecionados, possuíam vantagens ($p < 0,05$) em todas as faixas etárias avaliadas: 1) no tempo de tomada de decisão (sub-16 e sub-17); 2) na qualidade da tomada de decisão (sub-15); ou 3) tanto no tempo quanto na qualidade de tomada de decisão (sub-14). Essas vantagens estavam relacionadas às habilidades ofensivas para o sub-16, defensivas para o sub-15, e ofensivas e defensivas para o sub-14 e sub-17. Além disso, entre todas as variáveis avaliadas ($n = 72$), os jogadores não selecionados não apresentaram nenhuma vantagem em comparação com os selecionados. Conclui-se que os jogadores selecionados pelos clubes de futebol de elite no Brasil possuem melhores habilidades de tomada de decisão em relação ao tempo e qualidade que decidem em comparação com os não selecionados.

Palavras-chave: Identificação de talentos; desenvolvimento de talentos; tomada de decisões; habilidades perceptivo-cognitivas; futebol.

Introduction

Identifying talents in multidimensional sports such as soccer has been challenging since it involves many aspects that contribute to performance (Johnston et al., 2018; Lath et al., 2021). In this context, many models of talent identification and development in sport have been proposed in recent years as frameworks for researchers and professionals (Bennet et al., 2019; Hendry & Hodges, 2019; O'Connor et al., 2016; Vaeyens et al., 2008). A recent review paper by Williams, Ford, and Drust (2020) proposed the organization of a model including key aspects related to talent identification, selection, and development in soccer. This model defines talent identification as the process of identifying individuals with the potential to reach high-performance development programs consisting of a systematic combination of coaching, support, training, and match play designed for developing players. Other key aspects of this model are related to talent selection and deselection. On the one hand, talent selection refers to the ongoing process of choosing players within a development program who display suitable attributes for progressing towards a squad or team, such as to the subsequent age group squad at a youth academy or national team. On the other hand, talent deselection refers to the process of cutting of players from the development program, who no longer display the attributes to participate in, or to be selected for, subsequent squads.

The processes of talent identification, selection, and deselection are closely linked to the process of talent development (Teoldo & Cardoso, 2021), as players need to: 1) be identified by recruiters or scouts as talented individuals to participate in high-level structured training programs at youth academies; 2) stay at youth academies and keep progressing towards high-level coaching and sports facilities; and 3) avoid being deselected, as it may imply on losing access to high-quality coaching and sports facilities. However, the processes of identification, selection, and deselection occur relatively frequently in elite youth academies worldwide (Ford, Bordonau, et al., 2020; Reeves & Roberts, 2020). Previous research has identified key physical and physiological (Kelly & Williams, 2020), technical and tactical (Sarmiento et al., 2018), psychological (Ivarsson et al., 2020), and sociological (Ford et al., 2020) aspects that contribute to reaching high-performance levels in the sport and to positively influence the processes of talent identification and selection.

Among these attributes, we highlight the importance of soccer players' ability to make efficient and quick decisions, since this topic has attained even greater relevance due to changes in the dynamics of the sport. The game has evolved in the last few years, and players' demands to make decisions with less time and space have increased compared to a few decades ago.

Therefore, it is increasingly important to develop this aspect of performance in soccer players to allow them to timely respond to the problems from the game. In this regard, decision-making skills can be divided into perceptual-cognitive and perceptual-motor skills, both contributing to the development of sport expertise (McPherson & Kernodle, 2003; Williams et al., 2020). Perceptual-cognitive skills can be described as what one perceives and understands, while perceptual-motor skills refer to what one perceives and responds to through movement (Materniuk, 1976; Starkes et al., 2004). In this context, decision-making can be defined as choice of action, and as an outcome identified through a motor or verbal response (Bruce et al., 2012; Macmahon & Mcpherson, 2009). In the last few years, the study of perceptual-cognitive skills has drawn increasing attention in the field of talent identification and development in soccer (Ehmann et al., 2022; Sarmiento et al., 2018), as many studies have shown the association of such components with game performance (Cardoso et al., 2019; Hartigh et al., 2018; Kunrath et al., 2018).

Recent studies on the topic of talent identification and selection that assessed youth soccer players' decision-making skills have been carried out in different countries, such as Australia (Bennett et al., 2020), Poland (Konarski et al., 2021), Scotland (Dugdale et al., 2021), Netherlands (Hartigh et al., 2018; Joode et al., 2021), Spain (Pastor-Vicedo et al., 2020), and Germany (Höner et al., 2021; Murr et al., 2021). Overall, those studies have shown that players identified as currently talented or as future prospects, or those selected to continue in youth soccer programs possessed better decision-making skills than their "less talented" or deselected counterparts. Surprisingly, studies in this research line were not carried out with South American players, despite soccer's popularity in the continent and its success in international tournaments.

In terms of collective success in soccer, measured by the number of champions in the FIFA World Cup, South America has nine titles, secured by three different countries (Brazil = 5; Argentina = 2; and Uruguay = 2) in 21 tournaments played from 1930 to 2018. Moreover, a report published by FIFA (2021) analyzing international transfers from 2011 to 2020 showed that the top two countries with more international player transfers are Brazil ($n = 15,128$) and Argentina ($n = 7,444$), followed by the United Kingdom ($n = 5,523$). Therefore, these data show how South America is an important talent pool in soccer at an international level. Considering the important role played by Brazil as the country with more professional soccer players at an international level in the last ten years, we highlight the need to gather scientific information about its context related to the processes of talent identification, selection, and development.

This view is shared by a recent review on this topic (Williams et al., 2020) that emphasized the need to broaden the scope of research on talent selection, identification and development in order to include South American soccer players.

After analyzing recent reviews and meta-analyses on this topic (Gledhill et al., 2017; Ivarsson et al., 2020; Murr et al., 2018; Sarmento et al., 2018; Williams et al., 2020), we found that research on talent selection in soccer has mainly focused on the assessment of decision-making accuracy, in situations which only involved the player in possession during attacking plays. It represents a severe limitation on this research topic as empirical evidence has already showed that: 1) during matches, players spend between 97% and 99% of the time performing movements without the ball, either in attack or defense (Di Salvo et al., 2007); and 2) it is important to develop the ability to make quick decisions for achieving sport expertise (Mann et al., 2007). We highlight that we have not found any research addressing decision-making skills in situations without the ball and only one study that assessed decision time on talent selection (Bennett et al., 2020). Therefore, those aspects must be addressed to provide a deeper understanding on how decision-making skills impact talent selection.

Therefore, through this study we propose the assessment of decision-making skills among selected and deselected soccer players from elite Brazilian youth academies. We believe that it might contribute to the field of performance analysis, particularly with respect to talent identification, selection, and development once it adds scientific information considering the assessment of: 1) South American players; 2) both offensive and defensive situations without the ball; and 3) decision-making time. Furthermore, we consider that soccer professionals involved in talent identification and development programs in elite youth academies may benefit from our study, as it can provide information about talented players based on empirical data that may be included in the ongoing talent identification processes at Brazilian and South American clubs. Moreover, it can inform about players' advantages regarding their decision-making skills, whose development by youth soccer coaches and sport analysts may be relevant for retaining soccer players in talent development programs. Thus, the aim of this study is to compare decision-making skills between selected and deselected players from elite Brazilian youth soccer academies.

Materials and Methods

Participants

The sample comprised a total of 317 Brazilian youth elite male soccer players recruited from four soccer teams that played at the first national division in Brazil (i.e. U-14, U-15, U-16, and U-17). Those four clubs were from four different states in the country. Players should be participating in national or international competitions for their age group for inclusion criteria. Any player who could not participate in the assessment activity at the time of testing was excluded from the study. All players were evaluated in the middle of the competition season (around June and July), which is from 1st January to 31st December in Brazil. At the end of that competition season, players were invited to continue in the club for the next season (selected) or were released by the club (deselected). Participants were from U-14 (selected = 70; 14.1 ± 0.4 years; deselected = 31; 14.4 ± 0.4 years), U-15 (selected = 41; 15.1 ± 0.4 years; deselected = 39; 15.3 ± 0.4 years), U-16 (selected = 10; 16.2 ± 0.3 years; deselected = 22; 16.5 ± 0.4 years), and U-17 (selected = 68; 16.6 ± 0.7 years; deselected = 37; 17.1 ± 0.7 years) age groups.

Data collection was carried out with previous approval from club officials and players' legal guardians. The present study was approved by the Ethics Committee for Research with Human Beings from the leading institution (Approval number: 4.924.597) and is in accordance with the norms established by the Declaration of Helsinki (2013) for research with human beings. Participants and their legal guardians provided signed and informed consent.

Measures and Procedures for Data Collection

Decision-making skills (TacticUP®)

TacticUP® is an online platform (www.tacticup.com.br) that allows the assessment of players' decision-making skills. The validity and reliability of the TacticUP® test were shown in Machado and Teoldo (2020). In addition, this platform allows evaluating the quality and time of players decision-making skills, based on the core tactical principles of the offensive and defensive phases, in situations with and without the ball (see Figure 1) (Teoldo, Guilherme, & Garganta, 2022).

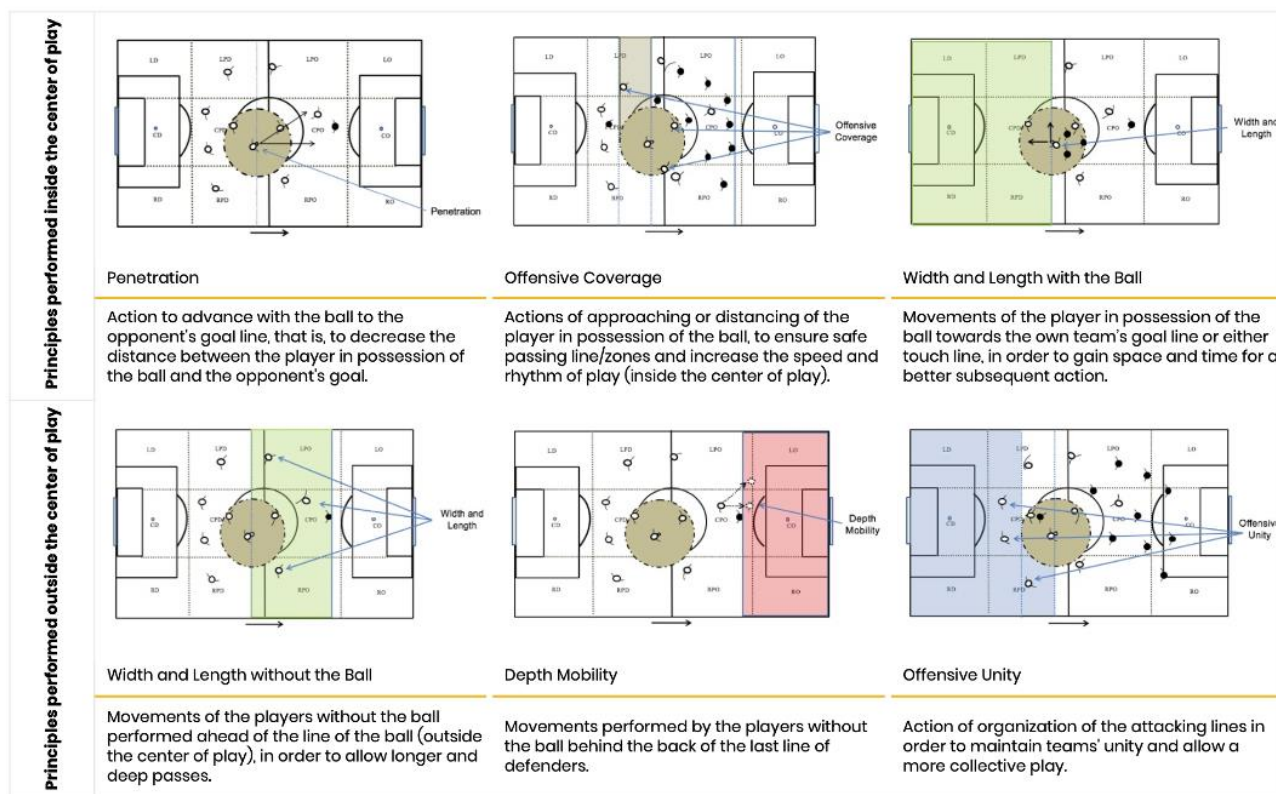
Before starting the test, the online platform displays instructions to participants regarding the test structure and procedures, and three trial scenes are exhibited to familiarize the subjects with the assessment, thus excluding the possibility of low performance due to a

lack of comprehension of the task. These three trial scenes include two offensive sequences (one in which the player being observed has the ball, and another in which he is not in possession) and one defensive sequence (the player being observed is in the defensive phase of play). These three conditions enable participants to familiarize themselves with the characteristics of the video sequences they were about to watch. The test was carried out using laptop computers with internet access to perform tests in the TacticUP® platform. The test took around 20 minutes per player and was carried out in a quiet room. The measure used in this study was the general decision-making index, comprised of the average of the offensive and defensive indexes (further details are available in Machado & Teoldo, 2020).

The variables measured by the TacticUP® were grouped in some categories as done in previous studies (Andrade, Machado, Gonçalves, & Teoldo, 2021; Machado, González-Víllora, Sarmento, & Teoldo, 2020). Those categories are: 1) offensive principles inside the center of play (OICP) - penetration, offensive coverage and width and length with the ball; 2) offensive principles outside the center of play (OOCp) - width and length without the ball, mobility and offensive unity; 3) offensive phase - all the offensive principles; 4) defensive principles inside the center of play (DICP) - delay, defensive coverage and recovery balance; 5) defensive principles outside the center of play (DOCP) - defensive balance, concentration and defensive unity; 6) defensive phase – all the defensive principles; and 7) general – all the offensive and defensive principles. This categorization was performed due to the phases of the game (attack and defense) and the spatial relations between these principles and the center of play, as well as their hierarchical relationships within the teaching-learning process. The tactical principles performed inside the center of play display less complexity regarding their execution when compared to those performed outside the center of play (Machado & Teoldo, 2020; Teoldo et al., 2022).

According to Teoldo, Guilherme, and Garganta (2022), the center of play is a dynamic spatial reference employed to characterize where the game is played more intensely/quickly. Its radius is 9.15 meters from the ball. With respect to this space, it is assumed that ball transmission between teammates is facilitated when they are located inside the center of play and/or when opponents are located farther than the distance of the radius and the player in possession needs to pass the ball to a teammate outside the center of play. In the case of the players located inside the center of play, ball transmission is facilitated, as the distance between the player in possession and the potential receiver is lower, thus allowing for more efficient technical actions and increased ball transmission speed.

a) Offensive Principles



b) Defensive Principles

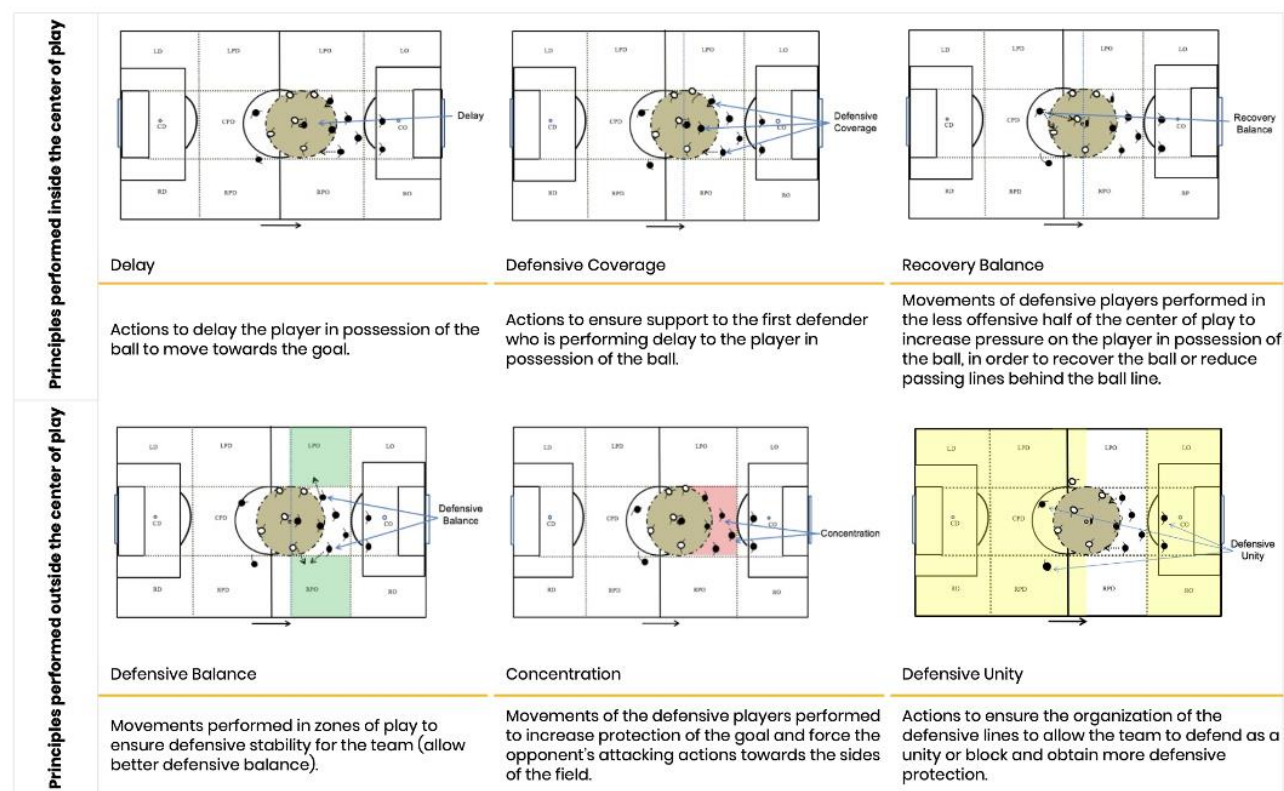


Figure 1. Description of the core tactical principles of soccer: a) offensive; and b) defensive. (Source: Teoldo, Guilherme & Garganta, 2021).

0.347, *medium effect*), DICP ($U = 772.0$, $z = -2.305$, $p = 0.032$, $r = -0.229$, *small effect*), DOCP ($U = 737.5$, $z = -2.559$, $p = 0.011$, $r = -0.254$, *small effect*), defensive ($U = 812.0$, $z = -2.010$, $p = 0.044$, $r = -0.200$, *small effect*), and general ($U = 712.0$, $z = -2.746$, $p = 0.006$, $r = -0.273$, *small effect*).

Moreover, selected U-16 players were faster than deselected in principles with the ball [$t(30) = -2.388$, $p = 0.023$, $d = 0.989$, *large effect*], principles without the ball ($U = 53.0$, $z = -2.317$, $p = 0.020$, $r = -0.410$, *medium effect*), offensive ($U = 48.0$, $z = -2.521$, $p = 0.011$, $r = -0.446$, *medium effect*), and general ($U = 56.0$, $z = -2.195$, $p = 0.028$, $r = -0.388$, *medium effect*).

Lastly, the U-17 players were faster than deselected in OOC (U = 879.5, $z = -2.444$, $p = 0.015$, $r = -0.240$, *small effect*), principles without the ball ($U = 891.5$, $z = -2.363$, $p = 0.018$, $r = -0.232$, *small effect*), offensive ($U = 923.0$, $z = -2.149$, $p = 0.032$, $r = -0.211$, *small effect*), DICP ($U = 907.5$, $z = -2.254$, $p = 0.024$, $r = -0.221$, *small effect*), DOCP ($U = 835.0$, $z = -2.746$, $p = 0.006$, $r = -0.269$, *small effect*), defensive ($U = 879.0$, $z = -2.448$, $p = 0.014$, $r = -0.240$, *small effect*), and general ($U = 883.5$, $z = -2.417$, $p = 0.016$, $r = -0.237$, *small effect*).

Table 1. Descriptive statistics and pairwise comparisons analyses of quality of decision-making and decision-making time for each age group.

Indexes	U-14				U-15				U-16				U-17			
	Selected (n = 70)	Deselected (n = 31)	p	Effect Size	Selected (n = 41)	Deselected (n = 39)	p	Effect Size	Selected (n = 10)	Deselected (n = 22)	p	Effect Size	Selected (n = 67)	Deselected (n = 37)	p	Effect Size
QUALITY OF DECISION-MAKING (a.u.)																
Offensives																
Inside the center of play ¹	75.8 ± 10.3	77.1 ± 6.5	0.991	-	76.4 ± 8.5	74.0 ± 7.9	0.205	-	75.5 ± 5.9	76.1 ± 7.7	0.920	-	75.9 ± 8.2	77.9 ± 8.4	0.336	-
Outside the center of play ²	67.9 ± 9.5	64.3 ± 7.6	0.045*	-0.199	64.4 ± 9.1	65.1 ± 9.6	0.761	-	70.6 ± 9.7	64.2 ± 10.9	0.123	-	66.8 ± 9.5	67.7 ± 8.2	0.336	-
With the ball ³	78.4 ± 13.2	80.2 ± 9.5	0.828	-	79.9 ± 10.0	75.7 ± 9.8	0.106	-	76.7 ± 7.2	78.3 ± 11.6	0.699	-	79.3 ± 10.7	82.2 ± 8.5	0.302	-
Without the ball ⁴	68.6 ± 7.9	66.0 ± 7.5	0.088	-	65.7 ± 7.2	66.5 ± 8.4	0.654	-	71.2 ± 8.1	66.1 ± 9.7	0.235	-	67.4 ± 8.0	68.1 ± 7.3	0.263	-
Offensive	71.8 ± 6.3	70.6 ± 4.5	0.340	-	70.3 ± 5.4	69.5 ± 6.3	0.52	-	73.1 ± 5.3	70.1 ± 8.0	0.305	-	71.3 ± 5.9	72.7 ± 5.9	0.240	-
Defensives																
Inside the center of play ⁵	64.8 ± 12.7	64.7 ± 10.5	0.848	-	67.3 ± 10.2	62.6 ± 10.2	0.044*	-0.009	65.2 ± 11.0	62.6 ± 9.4	0.509	-	65.3 ± 9.7	65.4 ± 11.5	0.510	-
Outside the center of play ⁶	64.6 ± 13.7	67.6 ± 10.5	0.512	-	67.7 ± 11.0	66.1 ± 9.8	0.481	-	65.2 ± 12.7	62.6 ± 12.3	0.579	-	66.7 ± 9.8	69.8 ± 12.2	0.170	-
Defensive	66.5 ± 8.9	67.5 ± 6.8	0.576	-	68.2 ± 6.1	65.5 ± 7.3	0.072	-	67.2 ± 9.1	65.9 ± 7.1	0.664	-	67.4 ± 6.9	69.6 ± 7.3	0.141	-
General																
General	69.2 ± 5.7	69.0 ± 4.3	0.685	-	69.2 ± 4.3	67.4 ± 5.6	0.113	-	70.1 ± 5.0	68.0 ± 5.9	0.337	-	69.4 ± 4.0	71.1 ± 5.2	0.056	-
DECISION-MAKING TIME (s)																
Offensives																
Inside the center of play ¹	10.3 ± 6.8	13.3 ± 5.7	0.003*	-0.297	10.0 ± 5.3	10.6 ± 5.3	0.544	-	10.0 ± 4.1	14.5 ± 5.6	0.330	-	10.5 ± 8.9	11.7 ± 6.2	0.080	-
Outside the center of play ²	9.4 ± 6.0	13.4 ± 6.0	<0.001*	-0.357	9.2 ± 5.8	9.7 ± 4.8	0.366	-	14.4 ± 20.5	13.9 ± 5.1	0.937	-	9.8 ± 7.8	13.1 ± 8.1	0.015*	-0.240
With the ball ³	10.9 ± 7.5	13.8 ± 7.0	0.008*	-0.262	10.4 ± 5.6	11.1 ± 6.1	0.59	-	10.1 ± 4.1	14.8 ± 5.4	0.023*	0.989	11.0 ± 10.4	11.8 ± 6.1	0.098	-
Without the ball ⁴	9.4 ± 5.8	13.1 ± 5.6	<0.001*	-0.376	9.2 ± 5.3	9.7 ± 4.6	0.427	-	13.2 ± 16.0	13.9 ± 5.2	0.020*	-0.410	9.7 ± 7.5	12.7 ± 7.6	0.018*	-0.232
Offensive	9.7 ± 6.2	13.0 ± 5.2	<0.001*	-0.347	9.7 ± 5.2	10.0 ± 4.9	0.799	-	12.2 ± 11.8	14.2 ± 5.1	0.011*	-0.446	10.1 ± 8.2	12.3 ± 7.0	0.032*	-0.211
Defensives																
Inside the center of play ⁵	9.9 ± 6.9	12.6 ± 8.9	0.021*	-0.229	10.8 ± 5.9	10.8 ± 5.6	0.821	-	10.6 ± 5.3	15.5 ± 8.9	0.204	-	9.4 ± 7.7	13.9 ± 12.3	0.024*	-0.221
Outside the center of play ⁶	10.9 ± 7.5	13.8 ± 7.0	0.011*	-0.254	11.0 ± 6.2	10.9 ± 5.8	0.931	-	10.7 ± 5.1	15.3 ± 9.2	0.176	-	9.3 ± 8.1	14.1 ± 12.1	0.006*	-0.269
Defensive	8.9 ± 4.9	11.0 ± 6.7	0.044*	-0.200	10.0 ± 5.4	9.8 ± 4.3	0.784	-	10.4 ± 6.3	14.0 ± 7.1	0.129	-	8.7 ± 6.6	12.4 ± 8.4	0.014*	-0.240
General																
General	9.3 ± 5.3	12.0 ± 5.8	0.006*	-0.273	9.9 ± 5.1	9.9 ± 4.5	0.682	-	11.3 ± 8.9	14.1 ± 5.8	0.028*	-0.388	9.4 ± 7.3	12.3 ± 7.0	0.016*	-0.237

¹principles of penetration, offensive coverage and width and length with the ball; ²principles of width and length without the ball, depth mobility and offensive unity; ³principles of penetration and width and length with the ball;

⁴principles of offensive coverage, width and length without the ball, depth mobility and offensive unity; ⁵principles of delay, defensive coverage and recovery balance; ⁶principles of defensive balance, concentration and defensive

*p < 0.05; a.u. - arbitrary units

Discussion

This study aimed to compare decision-making skills between selected and deselected players from elite Brazilian youth soccer academies. To the best of our knowledge, it was the first study: 1) to assess both decision-making time and quality based on offensive and defensive skills among selected and deselected youth soccer players; and 2) to assess differences in decision-making skills among selected and deselected youth elite soccer players with a South American sample. Overall, we found that selected players, compared to their counterpart deselected, possessed advantages in every age group assessed on: 1) the decision-making time (U-16 and U-17 age groups); 2) the quality of decision-making (U-15 age group); or 3) in both decision-making time and quality (U-14 age group). Moreover, those advantages were related to offensive skills for the U-16 group, defensive skills for the U-15 group, and offensive and defensive skills for the U-14 and U-17 groups.

Considering the quality of decision-making, a recent study found that youth soccer players selected to play in the German youth national team were better decision-makers than those not-selected players (Murr et al., 2021). Moreover, other recent studies found that U-14 and U-15 selected players possessed superior decision-making and tactical skills assessed subjectively by their coaches (Höner et al., 2021; Konarski et al., 2021) and superior decision-making skills assessed with a video-based test (O'Connor et al., 2016), compared to those deselected. In turn, Bennet et al. (2020) found no differences among soccer players (aged 14 years old) that played on different levels based on their decision-making skills. However, in this previous study, the decision-making skill was assessed considering only the carrier of the ball in attacking situations. Nevertheless, these results support our findings, as the U-14 and U-15 Brazilian selected players were the ones who showed superior decision-making quality compared to the deselected ones, but not in situations with the ball.

We also found that different skills differentiate players from these different age groups (U-14 and U-15). On the one hand, U-14 selected players showed superior offensive skills in situations performed far from the ball, such as in movements performed in the back of the last defensive line of the opposite team (i.e. principle of mobility) or movements to create passing lines performed ahead of the player in possession of the ball (i.e. principle of width and length without the ball).

On the other hand, the U-15 selected players possessed superior defensive skills in situations near to the ball, such as in actions of direct opposition of the player in possession (i.e. principle of delay), or supporting movements performed in the back of the first defender (i.e. principle of defensive coverage). Those results highlight the importance to assess decision-making skills in: 1) situations different than just the player in possession of the ball; 2) situations on attack and defense; and 3) situations that can be transferred for training contents, such as the core tactical principles (Teoldo et al., 2022). Therefore, not including the assessment of situations without the ball represents a severe limitation on understanding players' characteristics regarding their decision-making skills, related to both quality and decision time, once players spend between 97% and 99% of the time performing movements without the ball (Di Salvo et al., 2007).

Considering the results related to decision-making time, it was the variable that showed the greatest number of differences in our study, with effect sizes varying between large, medium, and small. It was found that the U-14 selected players were faster decision-makers compared to those deselected in all the nine variables assessed (offensives, defensives, and general). In addition, the U-16 selected players also made faster decisions than the deselected ones, on offensive skills with and without the ball, and in general. Finally, the U-17 selected players were faster decision-makers than those deselected in offensive skills without and far from the ball and defensive skills near and far from the ball, and in general. In this regard, the ability to decide quickly in sport has been shown that is an advantage developed by expert players. A meta-analysis about perceptual-cognitive expertise that assessed players from invasion sports (including soccer) found that expert players were 37% quicker on average compared to players from lower levels (Mann et al., 2007).

Although the literature has indicated the importance to develop the capacity to make quick decisions for the attainment of expert performance in sport, very few studies were found in this subject about talent identification and development in soccer after analyzing recent reviews and meta-analysis in this topic (Gledhill et al., 2017; Ivarsson et al., 2020; Murr et al., 2018; Sarmiento et al., 2018; Williams et al., 2020). We found only one study in this area, which was carried out with youth Australian soccer players (Bennett et al., 2020). This study showed no differences in decision-making time between Australian players in the top national league of their age group (~14 years old) and players from the second national league. The authors suggested that these findings might be related to a higher propensity for youth soccer recruiters and coaches in Australia to

overestimate physical competencies on talent identification and selection processes than decision-making skills, as reported by previous work (Sarmiento et al., 2018). Moreover, we highlight that this study assessed only the decision-making time of the ball carrier in attacking situations. This methodology approach could have hidden differences among both groups on decision-making skills in attacking situations without the ball and in defensive situations.

In terms of the advantages found in our study for selected players compared to those deselected, considering their decision time, it can be explained based on the interaction of perceptual-cognitive and perceptual-motor skills. Previous studies have found that players who are faster on perceptual-cognitive skills also are faster on agility tests on the field (Altmann et al., 2021; Vääntinen et al., 2010). Therefore, it implies that such cognitive advantages positively impact performance at a behavioral level on the field. This argument has been supported by recent findings showing positive associations between tactical performance on game situations with perceptual-cognitive skills related to: 1) anticipation (Assis et al., 2021); 2) peripheral perception (Gonçalves et al., 2020); 3) visual search strategies (Assis et al., 2020, 2021); and 4) attention (Andrade et al., 2020; Gonçalves et al., 2021). Moreover, a recent study conducted by Cardoso et al. (2020) showed that elite youth soccer players (age 16.7 ± 3.1 years) who possessed faster decision-making skills, when compared to their less fast peers, possessed: 1) better game reading ability, by using more efficient visual search strategies; 2) and showed a less cognitive effort to make decisions.

Summarizing the results above, it is observed that the perceptual-cognitive skills to read the game and decide quickly are positively associated with the tactical performance of players assessed in game situations. Those advantages in decision-making skills impact at a behavioural level on tactical performance on the field and can be observed by important stakeholders involved in the process of talent selection in soccer. Thus, it probably influences those practitioners to identify players as talents and select them to continue or enter their youth academies. This view is supported by previous research on youth soccer showing that decision-making and tactical skills have been pointed out as one of the most important skills for talent development and selection by coaches (Höner et al., 2021; Konarski et al., 2021; Lath et al., 2021), recruiters (Bergkamp et al., 2021; Larkin & O'Connor, 2017), researchers (Sarmiento et al., 2018), and academy directors (Ford, Bordonau, et al., 2020).

Overall, our results showed that differences among selected and deselected youth soccer players from Brazil's highest competitive level are related to both the quality and the time of decision-making skills. On the one hand, the quality of decision-making differentiated players from the youngest groups assessed in our study, which were U-14 and U-15 players. On the other hand, the assessment of decision-making time showed that selected players are quicker decision-makers since the youngest (U-14) up to the oldest (U-17) age groups, except by the U-15s. Therefore, based on our results and the view of important stakeholders in soccer, as mentioned above, we highly suggest soccer clubs incorporate this type of assessment in their talent identification and selection processes.

The use of objective assessment of players' offensive and defensive decision-making skills related to decision time and quality may help clubs enhance the effectiveness of correct choices on keeping and selecting talented players for their academies. Moreover, it could help coaches, recruiters, and academy directors to reduce arbitrariness in this process and provide a more evidence-based decision-making process. This type of objective assessment could be incorporated into existing protocols within those academies, jointly with subjective evaluations and other multidimensional assessments. Such an approach showed to be a more robust method to implement on talent identification and selection processes than using only one of those methods (Sieghartsleitner et al., 2019).

Recent research conducted by Bergkamp et al. (2021) found that European scouts reported that they assess attributes of players in a structured manner. However, they ultimately based their decision (i.e. final score) on an intuitive integration of different performance attributes, which is a suboptimal strategy according to existing literature. Therefore, the results of our study provide valuable information to make scouting evaluation more optimal and more effective. Moreover, the use of both objective and subjective evaluations may contribute to bridging the gap between science and practice to provide clubs with more assertive processes on talent identification and selection.

Improvement in such processes could provide a direct financial return for clubs at a medium-term by providing a more sensitive method to identify and keep talents that: 1) may integrate the professional squad of the club, avoiding expenses of hiring new players and with cheaper salaries during the beginning of their careers; 2) can participate on national and international transfers that provide a financial return for clubs. Therefore, youth academies of

countries with higher rates of international transfers, such as Brazil, Argentina, UK, France, and Colombia (i.e. top five countries with international transfers among 2011-2020) (FIFA, 2021) can potentially benefit from those returns. On the other hand, emerging nations on soccer can potentialize talent selection and development processes in youth academies by using more qualified protocols to nurture their limited talent pool in soccer.

Our findings provide interesting insights into the selection process among players already participating in talent development within youth academies. The assessment of offensive and defensive decision-making time showed to be relevant during the whole sport formation, especially for the youngest (U-14) and oldest (U-17) groups. Regarding assessing the quality of decision-making skills, it looks to have more applications up to the U-15 group. However, it would be interesting to carry out future studies in this research area focusing on the process of identification of talents. In other words, it means to compare the decision-making skills of players already selected with those trying to enter elite youth academies or players from different competitive levels. It could provide a bigger picture of how incorporating objective assessment of decision-making skills could benefit different processes already implemented on youth soccer academies.

We acknowledge that our results may translate for other invasion sports, such as handball, basketball, hockey, rugby, and American football, as they share similarities in terms of the need to couple perceptual-cognitive and perceptual-motor skills for higher performance achievement (Ashford et al., 2021). Therefore, it indicates that decision-making quality and time might be an important aspect to be assessed during talent identification, selection, and development in representative situations in such sports, considering offensive and defensive skills. Future studies in such sports could substantiate this hypothesis and provide more robust scientific knowledge to implement better processes to identify and nurture talent in invasion sports.

It is interesting to note that among all variables assessed in our study ($n = 72$), considering both decision-making time and quality for every age group, the deselected players did not show any advantage compared to the selected ones. It shows how important decision-making skills are to contribute to the permanence of soccer players in elite youth academies in Brazil during their sport formation. Moreover, our results indicated that the most important attribute related to the decision-making skills that differentiate selected and deselected players is making faster decisions in both offensive and defensive situations. Therefore, developing this ability to make faster

decisions can help players keep their talent development pathway with continued access to high-level coaching and sport structures offered by elite youth academies. Furthermore, we found the most significant number of differences in the decision-making time for both the youngest (U-14) and oldest (U-17) players assessed in our study. It indicates that it is an important skill to be developed in different sport formation phases to keep soccer players selected in elite youth academies.

Considering the age groups assessed in our study and the Development Model of Sport Participation (DMSP) (Côté, 1999), players were part of either the specializing years (13-15 years old) or the investment years (16-18 years). This model of sport participation, jointly with previous studies about the talent development pathway of soccer players (Ford et al., 2012; Ford & Williams, 2012), shows that from 13 years onward, well-organized sport structure assume greater importance in the sport's formation, as those offered by elite youth academies. Due to that, the quality of the stimuli experienced in soccer practice from this age gains even more importance for talent development (Ford, Bordonau, et al., 2020). In addition, there is empirical evidence showing that the development of offensive and defensive decision-making skills is favoured by accumulating high-quality soccer practice coupled with high amounts of deliberate play activities (i.e. unstructured soccer activities, such as playing soccer with friends) (Machado et al., 2020; Roca et al., 2012).

These shortcomings of our study suggest the need to delve deeper into this issue in future studies. More research should investigate how the interaction among practice and play activities, considering the different sport development phases of DMSP, can contribute to the development of decision-making skills related to both decision time and quality and considering offensive and defensive skills. Such studies could focus on recording information about previous sport activities (e.g. practice and deliberate play). Moreover, it would be interesting to understand how training interventions in elite youth academies based on different methodologies, such as Teaching Games for Understanding (TGfU), Game Sense, Constraints-led Approach and others may be effective to develop decision-making skills. Furthermore, it could allow theoretical and methodological advances in the research area of talent development by providing empirical evidence of how to structure better soccer curriculums and how designing better training interventions contributes to the development of decision-making skills. Thus, it could contribute to developing important skills

in soccer players that enhance their chance to keep selected by youth elite soccer academies, as shown in our study.

When interpreting the findings from our study, some limitations must be considered. The present study considered only players that belonged to the top 0,5% for their age groups in Brazil. Consequently, it is only possible to infer these performance characteristics for such a competitive level. Future research should extend the assessment of decision-making skills jointly with multifactorial models assessing other domains in soccer (e.g. technical, physical, psychological, and sociological). Moreover, we suggest assessing different competitive levels and other countries in both South America and other continents, including Europe. Although most studies in this research area were carried out with European and Australian samples (Williams et al., 2020), they assessed decision-making skills considering mostly the offensive phase and the player in possession of the ball, and the quality of decision-making. Therefore, future studies in talent identification and development should include assessing decision-making skills related to decision time and quality in both defensive and offensive situations with and without the ball.

Conclusions

It is concluded that selected players by youth elite soccer academies in Brazil possess superior decision-making skills related to decision time and quality compared to those deselected. Selected players possessed advantages in every age group assessed on: 1) the decision-making time (U-16 and U-17 age groups); 2) the quality of decision-making (U-15 age group); or 3) in both decision-making time and quality (U-14 age group). Moreover, those advantages were related to offensive skills for the U-16 group, defensive skills for the U-15 group, and offensive and defensive skills for the U-14 and U-17 groups. The greatest number of differences found in our study was for the decision-making time for both the youngest (U-14) and oldest (U-17) players assessed in our study.

We highlight that among all variables assessed in our study ($n = 72$), considering both decision-making time and quality for every age group, the deselected players did not show any advantage compared to the selected ones. It shows how important decision-making skills are to the permanence of soccer players on elite youth academies in Brazil during their sport formation. We also acknowledge that to the best of our knowledge, it was the first study: 1) to assess both decision-

making time and quality based on offensive and defensive skills among selected and deselected youth soccer players; and 2) to assess differences on decision-making skills among selected and deselected youth elite soccer players with a South American sample.

Practical Applications

- Elite youth academies may benefit by incorporating on their talent identification and selection processes the use of objective assessment of players' offensive and defensive decision-making skills related to decision time and quality. This type of assessment could be incorporated into already existing protocols within those elite academies.
- More integration between science and the practical field: Professionals (managers, coaches, sport analysts and sport psychologists) and researchers involved in talent identification and development processes should use protocols that assess both offensive and defensive decision-making skills, not only the player's actions in possession of the ball. Players spend around 97% and 99% of the time performing movements without the ball in attack or defense during the actual game.
- Coaches could use representative training designs of the game that integrate perceptual-cognitive and perceptual-motor-skills, such as small-sided games, mainly focused on group tactics (2x2 up to 4x4) and collective tactics (5x5 or higher). These activities in practice are positively associated with the development of the *quality* of offensive and defensive decision-making skills (Machado et al., 2020) and may be important to be developed, especially for U-14 and U-15 players to keep selected.
- Coaches may use spatial-temporal constraints on training tasks to create more or less time pressure to develop players' decision-making time. For example, time pressure can be increased by: 1) decreasing the space of training tasks; 2) increasing the number of players (considering the same area); or 3) increasing the level of the opponent (Gonçalves et al., 2019; Menuchi, Moro, Ambrósio, Pariente, & Araújo, 2018). It may contribute to players making *quicker decisions* and may help especially U-14, U-16, and U-17 players to keep selected.

Acknowledgments

This study was supported by the Sports incentive law of the Government of Minas Gerais,

by the Academy & Soccer Program of the Ministry of Citizenship, through the National Secretariat of Football and Defense of Fans' Rights; the SEESP-MG, FAPEMIG, CNPq, Funarbe, the Dean's Office for Graduate and Research Studies and the Centre of Life and Health Sciences from Universidade Federal de Viçosa, Brazil. This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Finance Code 001.

References

- Altmann, S., Neumann, R., Härtel, S., Kurz, G., Stein, T., & Woll, A. (2021). Agility testing in amateur soccer: A pilot study of selected physical and perceptual-cognitive contributions. *PLoS One*, 16(6), 1–9. <https://doi.org/10.1371/journal.pone.0253819>
- Andrade, M. O. C. De, González-Víllora, S., Casanova, F., & Teoldo, I. (2020). The attention as a key element to improve tactical behavior efficiency of young soccer players. *Journal of Sport Psychology*, 29(2), 47–55.
- Andrade, L., Machado, G., Gonçalves, E., & Teoldo, I. (2021). Decision making in soccer: effect of positional role of U-13 soccer players. *Journal of Physical Education and Sport*, 21(3), 1413–1420. <https://doi.org/10.7752/jpes.2021.03180>
- Ashford, M., Abraham, A., & Poolton, J. (2021). A Communal Language for Decision Making in Team Invasion Sports. *International Sport Coaching Journal*, 8(1), 122–129. <https://doi.org/10.1123/iscj.2019-0062>
- Assis, J., Costa, V., Casanova, F., Cardoso, F., & Teoldo, I. (2021). Visual search strategy and anticipation in tactical behavior of young soccer players. *Science and Medicine in Football*, 5(2), 158–164. <https://doi.org/10.1080/24733938.2020.1823462>
- Assis, J., González-Víllora, S., Clemente, F., Cardoso, F., & Teoldo, I. (2020). Do youth soccer players with different tactical behaviour also perform differently in decision-making and visual search strategies? *International Journal of Performance Analysis in Sport*, 20(6), 1143–1156. <https://doi.org/10.1080/24748668.2020.1838784>
- Bennet, K., Vaeyens, R., & Fransen, J. (2019). Creating a framework for talent identification and development in emerging football nations. *Science and Medicine in Football*, 3(1), 36–42.

<https://doi.org/https://doi.org/10.1080/24733938.2018.1489141>

- Bennett, K. J. M., Novak, A. R., Pluss, M. A., Coutts, A. J., & Fransen, J. (2020). A multifactorial comparison of Australian youth soccer players' performance characteristics. *International Journal of Sports Science and Coaching*, 15(1), 17–25. <https://doi.org/10.1177/1747954119893174>
- Bergkamp, T. L. G., Frencken, W. G. P., Niessen, A. S. M., Meijer, R. R., & den Hartigh, R. J. R. (2021). How soccer scouts identify talented players. *European Journal of Sport Science*. <https://doi.org/10.1080/17461391.2021.1916081>
- Bruce, L., Farrow, D., Raynor, A., & Mann, D. (2012). But I can't pass that far! The influence of motor skill on decision making. *Psychology of Sport and Exercise*, 13(2), 152–161. <https://doi.org/10.1016/j.psychsport.2011.10.005>
- Cardoso, F., González-Víllora, S., Guilherme, J., & Teoldo, I. (2019). Young soccer players with higher tactical knowledge display lower cognitive effort. *Perceptual & Motor Skills*, 126(3), 499–514. <https://doi.org/https://doi.org/10.1177/0031512519826437>
- Cardoso, F., Neves, J., Roca, A., & Teoldo, I. (2020). The association between perceptual-cognitive processes and response time in decision making in young soccer players. *Journal of Sports Sciences*, 39(8), 926–935. <https://doi.org/10.1080/02640414.2020.1851901>
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Lawrence Erlbaum Associates. <https://doi.org/10.4324/9780203771587>
- Côté, J. (1999). The Influence of the family in the development of talent in sport. *The Sport Psychologist*, 13(4), 395–417. <https://doi.org/10.1123/tsp.13.4.395>
- Di Salvo, V., Baron, R., Tschan, H., Calderon-Montero, F. J., Bachl, N., & Pigozzi, F. (2007). Performance characteristics according to playing position in elite soccer. *International Journal of Sports Medicine*, 28, 222–227. <https://doi.org/10.1055/s-2006-924294>
- Dugdale, J. H., McRobert, A. P., & Unnithan, V. B. (2021). Selected, deselected, and reselected: A case study analysis of attributes associated with player reselection following closure of a youth soccer academy. *Frontiers in Sports and Active Living*, 3(March), 1–12.

<https://doi.org/10.3389/fspor.2021.633124>

- Ehmann, P., Beavan, A., Spielmann, J., Mayer, J., Altmann, S., Ruf, L., Rohrmann, S., Irmer, J. P., & Englert, C. (2022). Perceptual-cognitive performance of youth soccer players in a 360°-environment – Differences between age groups and performance levels. *Psychology of Sport and Exercise*, 59(April), 102120. <https://doi.org/10.1016/j.psychsport.2021.102120>
- FIFA. (2021). *Ten years of international transfers: A report on international football transfers worldwide 2011-2020*. <https://doi.org/10.1080/13533310308559344>
- Ford, P. R., Bordonau, J. L. D., Bonanno, D., Tavares, J., Groenendijk, C., Fink, C., Gualtieri, D., Gregson, W., Varley, M. C., Weston, M., Lolli, L., Platt, D., & Di Salvo, V. (2020). A survey of talent identification and development processes in the youth academies of professional soccer clubs from around the world. *Journal of Sports Sciences*, 38(11–12), 1269–1278. <https://doi.org/10.1080/02640414.2020.1752440>
- Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., Stenling, A., Moreno, J., Gall, F. Le, Holmström, S., Salmela, J., & Williams, A. M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, 30(15), 1653–1663. <https://doi.org/10.1080/02640414.2012.701762>
- Ford, P. R., Hodges, N. J., Broadbent, D., O'Connor, D., Scott, D., Datson, N., Andersson, H. A., & Williams, A. M. (2020). The developmental and professional activities of female international soccer players from five high-performing nations. *Journal of Sports Sciences*, 38(11–12), 1432–1440. <https://doi.org/10.1080/02640414.2020.1789384>
- Ford, & Williams, A. (2012). The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. *Psychology of Sport and Exercise*, 13(May), 349–352. <https://doi.org/10.1016/j.psychsport.2011.09.004>
- Gledhill, A., Harwood, C., & Forsdyke, D. (2017). Psychosocial factors associated with talent development in football: A systematic review. *Psychology of Sport and Exercise*, 31(July), 93–112. <https://doi.org/10.1016/j.psychsport.2017.04.002>

- Gonçalves, E., Noce, F., Barbosa, M. A. M., Figueiredo, A. J., Hackfort, D., & Teoldo, I. (2020). Correlation of the peripheral perception with the maturation and the effect of the peripheral perception on the tactical behaviour of soccer players. *International Journal of Sport and Exercise Psychology*, 18(5), 687–699. <https://doi.org/10.1080/1612197X.2017.1329222>
- Gonçalves, E., Noce, F., Barbosa, M. A. M., Figueiredo, A. J., & Teoldo, I. (2021). Maturation, signal detection, and tactical behavior of young soccer players in the game context. *Science and Medicine in Football*, 5(2), 158–164. <https://doi.org/10.1080/24733938.2020.1851043>
- Hartigh, R., Steen, S., Hakvoort, B., Frencken, W., & Lemmink, K. (2018). Differences in game reading between selected and non-selected youth soccer players. *Journal of Sports Sciences*, 36(4), 422–428. <https://doi.org/10.1080/02640414.2017.1313442>
- Hendry, D. T., & Hodges, N. J. (2019). Pathways to expert performance in soccer. *Journal of Expertise*, 2(1), 1–13.
- Höner, O., Murr, D., Larkin, P., Schreiner, R., & Leyhr, D. (2021). Nationwide Subjective and Objective Assessments of Potential Talent Predictors in Elite Youth Soccer: An Investigation of Prognostic Validity in a Prospective Study. *Frontiers in Sports and Active Living*, 3(May), 1–16. <https://doi.org/10.3389/fspor.2021.638227>
- Ivarsson, A., Kilhage-Persson, A., Martindale, R., Priestley, D., Huijgen, B., Ardern, C., & McCall, A. (2020). Psychological factors and future performance of football players: A systematic review with meta-analysis. *Journal of Science and Medicine in Sport*, 23(4), 415–420. <https://doi.org/10.1016/j.jsams.2019.10.021>
- Johnston, K., Wattie, N., Schorer, J., & Baker, J. (2018). Talent identification in sport: A systematic review. *Sports Medicine*, 48(1), 97–109. <https://doi.org/10.1007/s40279-017-0803-2>
- Joode, T., Tebbes, D. J. J., & Savelsbergh, G. J. P. (2021). Game insight skills as a predictor of talent for youth soccer players. *Frontiers in Sports and Active Living*, 2(January), 1–11. <https://doi.org/10.3389/fspor.2020.609112>
- Kelly, A., & Williams, C. (2020). Physical characteristics and the talent identification and development processes in male youth soccer: A narrative review. *Strength and Conditioning*

Journal, 42(6), 15–34. <https://doi.org/10.1519/SSC.0000000000000576>

- Konarski, J. M., Krzykała, M., Skrzypczak, M., Nowakowska, M., Coelho-E-Silva, M. J., Cumming, S. P., & Malina, R. M. (2021). Characteristics of select and non-select U15 male soccer players. *Biology of Sport*, 38(4), 535–544. <https://doi.org/10.5114/biolSport.2021.101126>
- Kunrath, C. A., Cardoso, F., Nakamura, F., & Teoldo, I. (2018). Mental fatigue as a conditioner of the tactical and physical response in soccer players: a pilot study. *Human Movement*, 19(3), 16–22. <https://doi.org/10.5114/hm.2018.76075>
- Larkin, P., & O'Connor, D. (2017). Talent identification and recruitment in youth soccer: Recruiter's perceptions of the key attributes for player recruitment. *PLoS ONE*, 12(4), 1–15. <https://doi.org/10.1371/journal.pone.0175716>
- Lath, F., Koopmann, T., Faber, I., Baker, J., & Schorer, J. (2021). Focusing on the coach's eye; towards a working model of coach decision-making in talent selection. *Psychology of Sport and Exercise*, 56(July), 102011. <https://doi.org/10.1016/j.psychsport.2021.102011>
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Machado, G., & Teoldo, I. (2020). TacticUP Video Test for soccer: Development and validation. *Frontiers in Psychology*, 11(1690), 1–12. <https://doi.org/10.3389/fpsyg.2020.01690>
- Macmahon, C., & Mcpherson, S. U. E. L. (2009). Knowledge base as a mechanism for perceptual-cognitive tasks: Skill is in the details! *International Journal of Sport Psychology*, 40(4), 565–579.
- Mann, D. Y., Williams, A. M., Ward, P., & Janelle, C. M. (2007). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology*, 29(4), 457–478. <https://doi.org/10.1123/jsep.29.4.457>

- Materniuk, R. (1976). *Information Processing in Motor Skills*. Holt, Rinehart, and Winston.
- McPherson, S. L., & Kernodle, M. (2003). Tactics, the neglected attribute to expertise: problem representations and performance skills in tennis. In J. L. Starkes & K. A. Ericsson (Eds.), *Expert performance in sports: advances in research on sport expertise* (pp. 137–167). Human Kinetics.
- Murr, D., Feichtinger, P., Larkin, P., O'Connor, D., & Höner, O. (2018). Psychological talent predictors in youth soccer: A systematic review of the prognostic relevance of psychomotor, perceptual-cognitive and personality-related factors. *PLoS ONE*, *13*(10), 1–24. <https://doi.org/10.1371/journal.pone.0205337>
- Murr, D., Larkin, P., & Höner, O. (2021). Decision-making skills of high-performance youth soccer players: Validating a video-based diagnostic instrument with a soccer-specific motor response. *German Journal of Exercise and Sport Research*, *51*(1), 102–111. <https://doi.org/10.1007/s12662-020-00687-2>
- O'Connor, D., Larkin, P., & Mark Williams, A. (2016). Talent identification and selection in elite youth football: An Australian context. *European Journal of Sport Science*, *16*(7), 837–844. <https://doi.org/10.1080/17461391.2016.1151945>
- Pastor-Vicedo, J. C., Prieto-Ayuso, A., Contreras-Jordán, O. R., Clemente, F. M., Nikolaidis, P. T., Rosemann, T. J., & Knechtle, B. (2020). Teaching and learning process of decision-making units in talented young players from U-10 to U-14. *Frontiers in Psychology*, *11*(April). <https://doi.org/10.3389/fpsyg.2020.00600>
- Reeves, M. J., & Roberts, S. J. (2020). A bioecological perspective on talent identification in junior-elite soccer: A Pan-European perspective. *Journal of Sports Sciences*, *38*(11–12), 1259–1268. <https://doi.org/10.1080/02640414.2019.1702282>
- Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, *30*(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>
- Sarmiento, H., Anguera, M., Pereira, A., & Araújo, D. (2018). Talent identification and

- development in male football: A systematic review. *Sports Medicine*, 48(4), 907–931. <https://doi.org/10.1007/s40279-017-0851-7>
- Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2019). Science or coaches' eye? – both! beneficial collaboration of multidimensional measurements and coach assessments for efficient talent selection in elite youth football. *Journal of Sports Science and Medicine*, 18(1), 32–43.
- Starkes, J., Cullen, J., & MacMahon, C. (2004). A life-span model of the acquisition and retention of expert perceptual-motor performance. In N. Hodges & M. Williams (Eds.), *Skill acquisition in sport: Research, theory and practice*. Routledge.
- Teoldo, I., & Cardoso, F. (2021). Talent map: how demographic rate, human development index and birthdate can be decisive for the identification and development of soccer players in Brazil. *Science and Medicine in Football*, 5(4), 293–300. <https://doi.org/10.1080/24733938.2020.1868559>
- Teoldo, I., Guilherme, J., & Garganta, J. (2022). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Vaeyens, R., Lenoir, M., Williams, A. M., & Philippaerts, R. M. (2008). Talent identification and development programmes in sport current models and future directions. *Sports Medicine*, 38(9), 703–714. <https://doi.org/10.2165/00007256-200838090-00001>
- Vänttinen, T., Blomqvist, M., & Häkkinen, K. (2010). Development of body composition, hormone profile, physical fitness, general perceptual motor skills, soccer skills and on-the-ball performance in soccerspecific laboratory test among adolescent soccer players. *Journal of Sports Science and Medicine*, 9(4), 547–556.
- Williams, A. M., Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.176664>

Capítulo VI

Estudo 6: Artigo original cinco

Este capítulo foi submetido como artigo original para a revista:

Research Quarterly for Exercise and Sport

Estudo 6: Two pathways in elite youth soccer: comparison of developmental activities in soccer, futsal, and practice structure between Brazil and Spain

Guilherme Machado; Sixto González-Víllora; Juan Carlos Pastor-Vicedo; Israel Teoldo

Abstract: The purpose of this study was threefold: 1) to compare the engagement in various types and amounts of soccer activities during childhood and adolescence between Brazilian and Spanish elite youth soccer players; 2) to discuss what sport's education pathway characterizes youth development in elite soccer in Brazil and Spain, and 3) to compare the practice structure between elite youth soccer in Brazil and Spain. Participants were 131 U-18 elite male soccer players from Brazil (n=68) and Spain (n=63) competing in the national league. The Participation History Questionnaire was used to measure the soccer activities undertaken by players. Developmental activities were analyzed for two age periods: childhood (6–12 y/o) and early adolescence (13–15 y/o). Spanish players started younger playing soccer, and participation in practice and competition compared to Brazilian players ($p < .05$). Brazilian players were more involved in structured activities, such as practice in soccer and futsal, and participated in a greater number of sports in childhood and early adolescence ($p < .05$). We found a very similar percentual practice structure (individual, pair, drills, group tactics, and collective tactics activities) between Spain and Brazil, although Brazilian players accumulated a greater practice volume. It is concluded that Spanish and Brazilian U-18 elite youth male soccer players were differentiated by their milestones in soccer and their engagement in practice activities during childhood and early adolescence. Sports education of male soccer players in Spain was characterized by the early engagement pathway, while the Brazilian system was characterized by the specialized sampling model.

Keywords: deliberate practice, deliberate play, expertise, football training, talent development, history profile.

Resumo: Este estudo teve três objetivos: 1) comparar a vivência prévia em atividades relacionadas ao futebol durante a infância e adolescência entre jogadores de futebol de base de elite do Brasil e Espanha; 2) discutir a trajetória esportiva que caracterizou o desenvolvimento no futebol de elite do Brasil e Espanha, e 3) comparar a estrutura do treinamento entre o futebol de base de elite do Brasil e na Espanha. Participaram 131 jogadores de futebol masculino de elite sub-18 do Brasil (n=68) e Espanha (n=63) que competiam à nível nacional. O questionário de histórico esportivo foi utilizado para avaliar as atividades de futebol vivenciadas pelos jogadores. Essas atividades foram analisadas por dois períodos de idade: infância (6-12 anos) e início da adolescência (13-15 anos). Os jogadores espanhóis começaram mais jovens a jogar futebol, e a participar de treinamentos e competições comparados aos jogadores brasileiros ($p < .05$). Os jogadores brasileiros se envolveram mais em atividades estruturadas, como a prática deliberada no futebol e futsal, e participaram de um maior número de esportes na infância e no início da adolescência ($p < .05$). Verificamos uma estruturação do treinamento (percentualmente) muito semelhante (atividades individuais, duplas, analíticas, táticas de grupo e tática coletiva) entre a Espanha e o Brasil, embora os jogadores brasileiros tenham acumulado um maior volume de treinamento. Conclui-se que os jogadores de futebol masculino de elite sub-18 espanhóis e brasileiros foram diferenciados pela idade de início no envolvimento de diferentes atividades no futebol pela participação em atividades de treinamento durante a infância e início da adolescência. A trajetória esportiva dos jogadores de futebol masculino na Espanha foi caracterizada pela trajetória de engajamento precoce, enquanto no Brasil foi caracterizada pela diversificação especializada.

Palavras-chave: prática deliberada, jogo deliberado, perícia, histórico esportivo.

Introduction

Talent development and the attainment of superior performance in soccer is a multidimensional process in which players' experience and participation in different developmental sports activities play an important role (Williams et al., 2020). The type, quantity, and quality of sports activities that players engage in usually will vary depending on the different phases of sports development (Sweeney et al., 2021). Regarding the stages of sports development, the theoretical model proposed by Côté and collaborators (1999; 2007; 2014), known as the Development Model of Sport Participation (DMSP), has been widely used in the world to understand and promote the process of sports education, including several studies in soccer (Ford, Hodges, et al., 2020; Roca et al., 2012).

The DMSP divides sports education into three different main stages, which are classified as 1) sampling years (6-12 years old); 2) specialization years (13-15 years old), and 3) investment years (from 16 years old to adulthood). These different stages are characterized by the age of the individuals, the number of sports practiced, and the type of activities involved in the practice of sport(s) (i.e. deliberate play and deliberate practice). On the one hand, deliberate play is a form of intrinsically motivating sports activity that provides immediate gratification and is specifically designed to maximize satisfaction (Côté, 1999). On the other hand, deliberate practice is characterized by activities performed to improve performance, and not necessarily to generate satisfaction, being positively associated with developing specific abilities (e.g. team practice led by the coach) (Ericsson et al., 1993).

Research using this model on talent development and identification usually seeks to identify what sport pathway and developmental activities contribute most to participation in elite performance (Bergkamp et al., 2021; Williams et al., 2020). It usually shows that sports participation in soccer has a major influence of cultural aspects, such as players born in different countries and continents. Studies carried out in England, Norway, and German (Erikstad et al., 2018; Hendry & Hodges, 2018; Horning et al., 2016) showed that hours accumulated in soccer-specific team practice and play in childhood is associated with expert levels of achievement. This pattern of sports participation in childhood characterized by high amounts of involvement in deliberate play and practice in the primary sport (soccer) and low sampling (participation) in other sports is known as the early engagement pathway (Ford et al., 2009).

More recently, a new pathway in soccer development, known as the specialized sampling model, was identified in Swiss soccer players by Sieghartsleitner et al. (2018). This pathway is characterized by engaging in high amounts of both deliberate play and deliberate practice activities in childhood - as in the early engagement pathway (Ford et al., 2009). However, it also includes diversification of soccer activities in different contexts (e.g. street soccer, beach soccer, structured team practice, and futsal). The foundation of this new pathway came with an update on the concept of sports diversification during childhood proposed by Côté and Erickson (2015). As a result, the understanding of this term came to be related to the diversification of the types of activities in different sporting contexts and not just between different sports, as first proposed within the DMSP.

In this line, recent research advocates the potential of engagement in futsal practice to contribute to talent development in soccer (Oppici et al., 2018; Travassos et al., 2018; Yiannaki et al., 2018). Futsal can be described as an indoor version of soccer, composed by teams of four outfield players and a goalkeeper that plays in a court of 20x40m. In this regard, Yiannaki et al. (2018) found that a large majority (~90%) of soccer coaches interviewed in their study considered futsal useful in soccer talent development and would consider using it in their coaching provision. Moreover, there is empirical evidence that futsal practice promotes the transfer of tactical-technical skills (e.g. passing skills) to soccer (Oppici et al., 2018). This potential for positive transfer between futsal skills to soccer skills has been attributed to similarities between perceptual-cognitive and perceptual-motor skills of both sports. Additionally, the characteristics of futsal, such as fewer players and dimensions compared to soccer, may contribute to a wide range of technical and tactical abilities development and decrease the game's complexity (Travassos et al., 2018). Therefore, research about talent development could assess players' previous futsal participation to further understand its role in soccer players' sports formation pathway (Sweeney et al., 2021).

Another important aspect considered within talent development and sport pedagogy research is the quality of practice (Roca & Ford, 2020). Some research has tried to identify the microstructure of training settings used in different contexts in soccer formation, such as various performance levels and countries (Ford, Yates, et al., 2010; Roca & Ford, 2020). This type of information has been used to identify whether practice has been designed according to the extensive scientific literature on sports pedagogy and coaching. In this regard, it was identified that practice structure in soccer clubs had changed a lot over the last ten years for a more evidence-based design,

although empirical evidence in this theme is still limited to a few European countries (Ford, Yates, et al., 2010; Roca & Ford, 2020).

It indicates a need to expand the body of knowledge in this area to more European countries and different continents, especially those with high-performance traditions in soccer. Various soccer stakeholders, such as coaches, clubs, and federations, could benefit from such information. It could help understand how practice has been organized within their sport formation context and provide insights into where it could be improved with more evidence-based approaches or even serve as a benchmark for developing soccer nations. In this regard, and to the best of our knowledge, we have not found any study that analyzed the developmental activities of elite soccer players in Spain nor a study that analyzed the practice structure of Brazilian elite soccer players. Thus, the purpose of this study was threefold: 1) to compare the engagement in various types and amounts of soccer activities during childhood and adolescence between Brazilian and Spanish elite youth soccer players; 2) to discuss what sport's education pathway characterizes youth development in elite soccer in Brazil and Spain, and 3) to compare the practice structure between elite youth soccer in Brazil and Spain.

Materials and Methods

Participants

The sample comprised a total of 131 U-18 elite male soccer players from Brazil ($n = 68$; $M = 16.2 \pm 2.1$ years of age) and Spain ($n = 63$; $M = 17.7 \pm 0.9$ years of age). Participants should be training regularly in the club and competing in the national league for their age group for inclusion criteria. They participated in four to six training sessions per week with duration between 80 to 100 minutes and participated in competition matches of 90 minutes. Players born in different countries than the club they were playing were excluded from the sample ($n = 4$ in Spain). Data collection was carried out with previous approval from club officials and athletes' legal guardians. The present study was approved by the Ethics Committee for Research with Human Beings from the leading institution (Approval number: 4.924.597) and is in accordance with the norms established by the Declaration of Helsinki (2013) for research with human beings. Participants and their legal guardians provided signed and informed consent.

Measures and Procedures for Data Collection

Developmental Activities: Participation History Questionnaire (PHQ)

The Participation History Questionnaire (PHQ), used in several studies (Ford, Low, et al., 2010; Ford & Williams, 2012; Machado et al., 2020; Roca et al., 2012), was used to measure the soccer activities undertaken by players. The test-retest reliability and the concurrent validity of the PHQ were shown in Ford et al. (2010). This questionnaire provided information about milestones in soccer (e.g. start age of playing soccer) and engagement in different soccer developmental activities (e.g. participation in soccer practice or competition). The milestones were about the age participants started to engage in different activities in soccer (see chart 1). Furthermore, seven variables related to developmental sports activities were assessed (see chart 1). All those variables have been included in previous studies (Ford et al., 2012; Hendry & Hodges, 2018), with exception of “total practice”. This variable is a composite metric calculated based on variables collected through the questionnaire, which comprises the time spent in soccer practice plus futsal practice. We proposed the inclusion of such variable, considering two main points: 1) the new interpretation of sports diversification through the opportunity to play activities related to the primary sport in different settings and contexts (Côté & Erickson, 2015; Sieghartsleitner et al., 2018); and 2) the cultural aspects in Brazil and Spain, where futsal is a popular sport, and both countries are the two most successful nations in the sport (Richard Moore et al., 2018). We also calculated the number of hours per week spent playing and practicing soccer, considering a 40-week sports season. Moreover, the final questionnaire section also elicited information about the practice structure in soccer for the present and past seasons (two years). The activities are described in chart 1. The subdivision of activities in low- and high- decision-making opportunities was performed considering the degree of complexity of each one of those activities and its similarity with the demands and components of the actual game (Ford, Yates, et al., 2010; Roca & Ford, 2020).

Chart 1. Variables assessed with the Participation History Questionnaire.

Variables	Explanation
<i>Milestones (starting age)</i>	
Participation in soccer	Kicking a ball around.
Supervised training with an adult	Participation in structured training with an adult.
Competition in soccer tournaments	Participation in soccer tournaments.
Play 11x11 format	Participation in matches with 11x11 format.
<i>Developmental Activities</i>	
Play in soccer	Play activities (i.e., deliberate play) in soccer are related to play-type games with specific rules created and supervised by participants, in which the primary goal is enjoyment (e.g., playing a soccer game with friends in the park).
Practice in soccer	Practice in soccer was related to soccer activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team).
The percentage of time in play	The “percentage time in play” was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer.
Competition in soccer	Amount of participation in soccer tournaments.
Practice in futsal	Practice in futsal was related to futsal activities under the supervision of coaches or adults in which the goal is to enhance performance (e.g., training with the team).
Total practice (soccer + futsal)	Composite metric suming up the hours accumulated on practice in soccer and practice in futsal.
The number of other sports	The number of other sports considered the participation in other sports than soccer, where participants were involved for more than three months in contexts that were not physical education classes.
<i>Practice structure</i>	
Individual	E.g., dribbling the ball alone.
Pairs	E.g., passing or 1 x 1.
Drills	E.g., situations that were re-enacting isolated simulated game incidents, such as going to a designated area to another.
Group tactics	E.g., small-sided and conditioned games of 2 x 2 up to 4 x 4.
Colective tactics	E.g., small-sided and conditioned games of 5 x 5 or higher configurations.
Low decision-making opporrunities	Composed by individual, pairs, and drills activities.
High decision-making opporrunities	Composed by group and colective tactics activities.

In order to complete the questionnaire, participants should provide the number of hours per week and the number of months per year they spent in those soccer activities since they started participating in soccer. They also provided information about the number of weeks from each year they were injured and unable to participate in soccer activities. This information was given

retrospectively, from the present season, going backward in a one-year interval up to 5 years of age, or the age they started participation in soccer activities. The calculation of the accumulated hours in soccer activities was performed by multiplying hours reported per week by weeks per year, minus weeks per year that players reported injuries that prevented them from participating in soccer activities.

This retrospective questionnaire was applied online, using a mobile phone, tablet, or computer with internet access, where the researcher in charge explained how to fill out the questionnaire. After the initial explanation, the participants answered the questionnaire, while the researcher was available to answer any questions that arose during the completion of the form. The application took approximately 60 minutes per player during a specific session in the day they were not training.

Statistical Analysis

Descriptive and inferential analysis was calculated for milestones, developmental activities, and practice structure. Developmental activities data were analyzed for two age periods: 1) 6–12 years of age (i.e. childhood); and 2) 13–15 years of age (i.e. early adolescence) to match the developmental stages outlined by Côté (1999). Afterward, we verified the between-group differences in all the variables measured by the PHQ using a Mann-Whitney U-test due to data distribution characteristics. Distributions were checked with a Kolmogorov-Smirnov test. (1999). The level of significance was set as $p < .05$. The effect size used for Mann-Whitney tests was calculated through the formula described by Fritz, Morris, and Richler (2012) as $(r = Z/\sqrt{n})$. The interpretation of the effect size value was made as small effect (.1 - .29); medium effect (.3 - .49); and large effect ($> .5$). For statistical procedures was utilized the software Statistical Package for Social Sciences 25.0.

Results

Milestones

The results showed main effects for the four milestones variables assessed (see Table 1). Spanish players started their participation in play, practice, and competition activities in soccer earlier than the Brazilian players. In turn, Brazilian players started earlier playing 11x11 format compared to Spanish players.

Table 1. Comparisons between Brazilian and Spanish players on their milestones and sports developmental activities in childhood and early adolescence.

	Brazil (M ± SD; n = 68)	Spain (M ± SD; n = 63)	p	Mann-Whitney U-test	Effect size
<u>Milestones</u>					
Start playing soccer (y/o)	6.2 ± 2.6	4.6 ± 1.4	< 0.001***	U = 1345.5, z = 3.75	0.328 (medium)
Start practice in soccer (y/o)	8.4 ± 2.6	5.8 ± 2.1	< 0.001***	U = 864.0, z = 5.86	0.512 (large)
Start competition in soccer (y/o)	8.8 ± 2.2	6.1 ± 1.8	< 0.001***	U = 734.0, z = 6.47	0.565 (large)
Start playing 11x11 (y/o)	10.5 ± 2.0	11.4 ± 1.3	< 0.001***	U = 1300.5, z = 3.86	0.337 (medium)
<u>Developmental Activities</u>					
Childhood (6-12 years)					
Play in soccer (h)	1810.7 ± 1787.3	1234.0 ± 1172.4	0.114	-	-
Play in soccer/week (h)	6.0 ± 5.9	4.1 ± 3.9	0.114	-	-
Practice in soccer (h)	1000.0 ± 971.6	919.4 ± 720.3	0.868	-	-
Practice in soccer/week (h)	3.3 ± 3.2	3.1 ± 2.4	0.868	-	-
% time in play ¹	57.9 ± 25.0	51.8 ± 21.1	0.097	-	-
Competition (h)	525.5 ± 868.7	474.8 ± 637.5	0.053	-	-
Practice in futsal (h)	486.5 ± 534.5	88.6 ± 237.6	< 0.001***	U = 978.0, z = 5.79	0.506 (large)
Total practice (soccer + futsal) (h)	1491.2 ± 1231.5	1008.0 ± 748.4	0.022*	U = 1620.0, z = 2.29	0.200 (small)
Number of other sports	1.3 ± 0.9	0.9 ± 1.0	0.007**	U = 1587.0, z = 2.71	0.237 (small)
Early adolescence (13-15 years)					
Play in soccer (h)	438.0 ± 539.1	364.8 ± 360.2	0.632	-	-
Play in soccer/week (h)	3.4 ± 4.2	2.8 ± 2.8	0.632	-	-
Practice in soccer (h)	928.3 ± 503.9	491.6 ± 258.5	< 0.001***	U = 1019.0, z = 5.17	0.452 (medium)
Practice in soccer/week (h)	7.2 ± 3.9	3.8 ± 2.0	< 0.001***	U = 1019.0, z = 5.17	0.452 (medium)
% time in play ¹	28.4 ± 23.5	36.4 ± 20.2	0.030*	U = 1670.0, z = 2.17	0.190 (small)
Competition (h)	359.7 ± 431.4	231.9 ± 173.9	0.250	-	-
Practice in futsal (h)	86.2 ± 151.0	28.1 ± 101.5	< 0.001***	U = 1463.5, z = 3.90	0.341 (medium)
Total practice (soccer + futsal) (h)	1005.4 ± 506.1	519.7 ± 277.6	< 0.001***	U = 910.5, z = 5.59	0.488 (medium)
Number of other sports	0.8 ± 0.7	0.4 ± 0.7	< 0.001***	U = 1448.5, z = 3.53	0.309 (medium)

¹ % time in play was calculated considering the percentual time spent in play activities in soccer, considering the total amount accumulated in practice and play in soccer.

*p < 0.05; **p < 0.01; ***p < 0.00

Childhood (6-12 years)

It was found main effects for three variables assessed in this developmental phase (see Table 1). Brazilian players accumulated more hours in futsal practice and total practice compared to Spanish players. Moreover, Brazilian players participated in a greater number of other sports compared to Spanish players. Considering participation in futsal, 67.6% (n = 46) of Brazilian players participated, while only 19.0% (n = 19) of Spanish players were involved.

Early adolescence (13-15 years)

It was the developmental phase where we found the greatest number of differences among Brazil and Spain (see Table 1). Brazilian players accumulated more hours in practice in soccer, practice in futsal and total practice, and participated in a greater number of other sports than Spanish players. Additionally, in Brazil the “percentual time in play” was lower compared to Spain. Considering the involvement in futsal, 41.2% (n = 28) of Brazilian players were involved, while only 9.5% (n = 6) of Spanish players took part.

We presented in Figure 1 the average hours per year between 6 to 15 years of age that Brazilian and Spanish players participated in three soccer activities (play, practice, and competition).

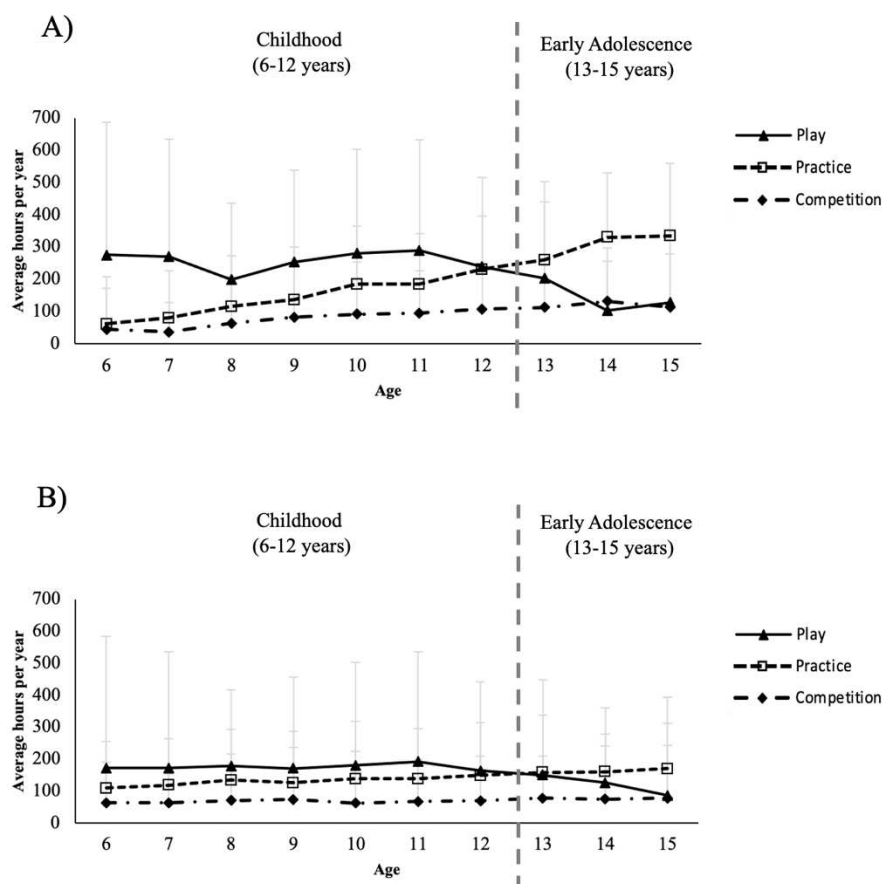


Figure 1. The average hours per year between 6 to 15 years of age in three soccer activities (play, practice, and competition) for a) Brazilian players; and b) Spanish players.

Practice structure

Considering the practice structure in soccer (see Table 2), we found that Brazilian players accumulated more hours than Spanish players in every activity assessed: individual, pair, drills, group tactics, collective tactics, low decision-making, and high decision-making activities. However, when we compared the percentual time spent in each activity, we found many similarities between Brazil and Spain. The only activity that showed difference was group tactics, where Brazilian players showed a greater percentual than Spanish players.

Table 2. The statistical and descriptive analyses for the practice structure between Brazilian and Spanish players.

	Brazil (M $\pm$ SD; n = 68)	Spain (M $\pm$ SD; n = 63)	p	Mann-Whitney U-test	Effect size
<u>Practice structure (hours)</u>					
Individual (h)	170.0 $\pm$ 268.7	74.0 $\pm$ 83.0	0.008**	U = 1562.5, z = 2.67	0.234 (small)
Pairs (h)	180.6 $\pm$ 276.7	82.5 $\pm$ 75.4	0.020*	U = 1636.5, z = 2.33	0.204 (small)
Drills (h)	202.1 $\pm$ 277.6	90.9 $\pm$ 64.1	0.006**	U = 1541.0, z = 2.77	0.242 (small)
Group tactics (h)	314.0 $\pm$ 319.6	120.6 $\pm$ 89.6	< 0.001***	U = 1114.5, z = 4.73	0.414 (medium)
Collective tactics (h)	317.9 $\pm$ 332.9	133.0 $\pm$ 91.0	< 0.001***	U = 1262.0, z = 4.05	0.354 (medium)
Low decision-making (h)	552.7 $\pm$ 777.5	247.4 $\pm$ 197.3	0.001**	U = 1394.5, z = 3.44	0.301 (medium)
High decision-making (h)	631.8 $\pm$ 643.7	253.6 $\pm$ 170.8	< 0.001***	U = 1119.5, z = 4.71	0.412 (medium)
<u>Practice structure (%)</u>					
Individual (%)	14.4 $\pm$ 13.9	14.7 $\pm$ 10.1	0.369	-	-
Pairs (%)	14.2 $\pm$ 8.7	15.9 $\pm$ 6.2	0.060	-	-
Drills (%)	17.9 $\pm$ 13.6	18.7 $\pm$ 7.0	0.099	-	-
Group tactics (%)	26.8 $\pm$ 9.8	23.8 $\pm$ 7.7	0.031*	U = 1713.5, z = 2.00	0.189 (small)
Collective tactics (%)	26.4 $\pm$ 9.3	26.8 $\pm$ 8.5	0.878	-	-
Low decision-making (%)	46.6 $\pm$ 15.9	49.3 $\pm$ 11.9	0.128	-	-
High decision-making (%)	53.3 $\pm$ 15.9	50.6 $\pm$ 11.9	0.128	-	-

*p < 0.05; **p < 0.01; ***p < 0.001

Discussion

The purpose of this study was threefold: 1) to compare the engagement in various types and amounts of soccer activities during childhood and adolescence between Brazilian and Spanish elite youth soccer players; 2) to discuss what sport's education pathway characterizes youth development in elite soccer in Brazil and Spain, and 3) to compare the practice structure between elite youth soccer in Brazil and Spain. Overall, we found many differences between Brazil and Spain for their milestones in soccer and their engagement in practice activities during childhood and early adolescence, especially related to futsal and the sum of practice in soccer and futsal, and the involvement in other sports. On the other hand, when analyzing the practice structure between

countries, we found a very similar percentual structure (individual, pair, drills, group tactics, and collective tactics activities), although Brazilian players accumulated a greater practice volume.

Considering the starting age of involvement in different soccer activities, we found that Spanish players started earlier playing soccer (~4 y/o), and their involvement in structured activities, such as practice (~5 y/o) and competition (~6 y/o), compared to Brazilian players. Our results confirm a previous study showing that Brazilian players usually start later their participation in structured activities, such as practice (~7-8 y/o) and competition (~8-9 y/o) (Ford et al., 2012), compared to other European countries (i.e. England, Finland, France, German, Portugal, Sweden, and Swiss) (Ford et al., 2009, 2012; Forsman et al., 2016; Güllich et al., 2016; Sieghartsleitner et al., 2018). Those European countries usually start practice (~4-6 y/o) and competition (~6-8 y/o) earlier in childhood.

Regarding the starting age of playing the official 11v11 format, Spanish players usually start later in childhood (~11-12 y/o) compared to Brazil (~10 y/o). This organization looks to be better structured in Spain once the 11v11 official format is considered too complex in terms of tactical, technical, and physical demands for children (Teoldo & Silvino, 2022). We suggest that such a format must be used later in sports formation, especially in the Brazilian context, while it can be first used with adaptations in the field size (e.g. playing 11v11 in a small field compared to the official dimensions). It can be done to progress first the adaptations in the complexity level, related to the official number of players, and later, adaptations in terms of spatial constraints (official field size) (O'Connor et al., 2018).

Considering the comparisons between developmental activities during childhood (6-12 y/o) and early adolescence (13-15 y/o), we found that Brazilian players were more involved in structured activities, such as practice, and participated in a greater number of sports in both stages analyzed. For example, most Brazilian players were involved with futsal (67.6%), while few Spanish players participated (19.0%). We also found that Brazilian players spent around five times more hours in futsal practice (~500h) during childhood compared to Spain (~90h). Additionally, in Brazil, they spent around 50% more hours on practice activities considering soccer and futsal (~1500h) compared to Spain (~1000h). During early adolescence, we found even more differences between countries, especially related to the volume of soccer practice. In this phase, Brazilian players spent around two times more hours in soccer practice (~930h) compared to Spain (~490h).

We also found that summing up the play and practice activities in soccer, Brazilian players showed a greater percentage of involvement in soccer practice (~72%) than Spanish players (~64%).

Overall, these results reinforce previous research showing that futsal practice is integrated within the sport formation structure of elite soccer players in Brazil, mainly in childhood (Ford et al., 2012). In turn, we found that in Spain, the involvement in futsal practice is apparently less integrated with the sport formation system in soccer, once only 19.0% participated in childhood and 9.5% in early adolescence. Moreover, the amount of futsal practice in Spain during childhood and early adolescence is much lower than in Brazil. To the best of our knowledge, it was the first study that assessed the involvement of elite soccer players in Spain with futsal during their sport formation.

The lower involvement of soccer players in Spain with futsal compared to Brazil was somehow surprising, once futsal is a popular sport in both countries and Spain is the second most successful nation in the sport (Moore et al., 2018). These results could be due to several socio-cultural factors. Among them, two aspects are highlighted. The first is related to the sports facilities of both countries, as it may directly impact the participation in futsal (Moore & Radford, 2014). On the one hand, Spain has many public soccer pitches (+7,000), that allow children and adolescents to practice soccer during their entire sport formation (MCDE, 2021). On the other hand, in Brazil is much more often to find futsal courts in primary and secondary public schools (~78%) compared to soccer pitches (~14%) (IBGE, 2010). Therefore, in Brazil, the lack of public soccer pitches also promotes greater participation in futsal practice during childhood due to the greater availability of futsal facilities and the large number of children that want to be involved in "football" sports. Secondly, a study carried out with 20,000 children and adolescents in Spain (CSDE, 2011) showed that around 66% of the population aged 6-11 practice only one sport. Moreover, children of this age practice soccer three times more often (around 33%) than futsal (around 11%). This sport participation profile in Spain suggests that children usually choose one sport between soccer and futsal to practice since childhood. However, more research is certainly needed to learn more about this issue.

The results of our study might provide insights to optimize the soccer developmental pathway considering the cultural differences of each country and not providing a rule for players' development. Considering the Spanish context, we found that the sport formation of U-18 elite soccer players was characterized by the early engagement pathway (Ford et al., 2009). During

childhood, players participated in high amounts of play and practice activities in soccer, with lower diversification in other sports or contexts in the primary sport. Moreover, Spanish players accumulated less than 10% of their structured practice during their childhood (6-12 years) in futsal. This result was somehow surprising considering that Spain is one of the best futsal nations in the world. For instance, in the last six FIFA Futsal World Cups (from 2000 to 2021), Spain got to the finals in four of them and won two.

Our data could indicate a potential for the Spanish soccer development system to explore more the use of futsal as part of their sport formation system to provide more diversification, especially in childhood (Castellanos-García et al., 2021; Côté & Erickson, 2015; Travassos et al., 2018). On the one hand, the use of futsal allows variability in the training context (i.e. different ball, court size, number of players, or speed of the game), which is positively associated with motor, cognitive and tactical skill acquisition on childhood (Teoldo et al., 2022). On the other hand, as futsal is usually played on indoor courts, it can be explored during specific seasons in the year as an alternative to keep players practicing in rough environmental conditions (i.e. heavy rains, negative temperatures, or snowfall). These suggestions could be translated not just for the Spanish sports development system but also for other European countries that suffer from significant environmental changes during wintertime.

Considering the Brazilian developmental pathway in soccer, we found that U-18 elite players usually accumulated around one-third of their structured practice during childhood (6-12 years) in futsal. This variability of participation in different contexts of the “main sport” (i.e. play in soccer and practice in soccer and futsal) characterizes the developmental pathway in Brazil as the specialized sampling model (Sieghartsleitner et al., 2018). These findings provide important empirical data showing that futsal is part of the sports education system in Brazil for the development of soccer players. Stakeholders involved in long-term athlete development in the Brazilian system, such as soccer clubs’ staff and regional and national soccer federations, might benefit from this information. Furthermore, recent research showed that futsal is a “donor sport” for soccer development, especially in childhood (Oppici et al., 2018; Travassos et al., 2018). Therefore, those involved in soccer could systematically provide better coach education to improve the quality of practice in futsal (Stonebridge & Cushion, 2018). Moreover, it could be integrated into soccer curriculums, which need a systematic organization of how its practice could optimize the teaching process of elements related to soccer skills and the transition between the futsal court

to the soccer pitch (Marques et al., 2021; Yiannaki et al., 2018). We highlight that such a strategy would need an integrative approach between both modalities (soccer and futsal) to plan an effective strategy to progress and adapt the structure of futsal (i.e. 4v4 + GKs) from a smaller court (40 x 20m) to larger structures (e.g. 7v7 + GKs) and bigger pitches (Teoldo et al., 2022; Yiannaki et al., 2020).

In terms of the practice structure of both countries, we found a very similar structure (percentual) between Spain and Brazil, although Brazilian players accumulated a greater practice volume. This result indicates similarities in how elite youth soccer coaches structure their practice in both countries, focusing mainly on tactical and decision-making aspects, as shown by previous research (Machado et al., 2020; Roca & Ford, 2020). In this line, Roca and Ford (2020) found that southern European countries like Spain and Portugal spend a greater amount of their practice in activities that contain active decision-making for the players (e.g. small-sided games) than other European countries, like Germany and England. This greater similarity in the practice structure between the Brazilian context and southern countries, such as Spain and Portugal, might be related to closer cultural similarities (e.g. style of play and language). Such results might be helpful for different stakeholders, such as coaches and club staff, to understand similarities/dissimilarities in the soccer system among countries (Ford, Bordonau, et al., 2020). For example, the data from our study and previous research might indicate that the cultural adaptation of international transferences of Brazilian soccer players to Europe might be easier to adapt in southern European countries than in central or northern European countries due to the organization of the soccer system. On the other hand, soccer players also may be prepared to face challenges and speed up their adaptation to soccer systems with greater differences than those they are used to training.

To the best of our knowledge, our study was the first to compare the practice structure in soccer between the European and South American contexts and analyze the developmental activities of elite youth soccer players in Spain. However, a limitation in our study was the assessment of the structure of practice activities, conducted only within the previous two years. For future research, we suggest including the analysis of the training structure with actual training recording, in addition to the use of retrospective questionnaires. Moreover, the practice structure of different age groups, competitive levels, and competitive periods could be assessed. In terms of the analysis of developmental pathways in soccer, in the future, similar studies could be done with

female players, and other nations in Europe and South America could be assessed additionally to other continents, as we found differences between and within continents (Ford et al., 2012).

Conclusions

It is concluded that Spanish and Brazilian U-18 elite youth male soccer players were differentiated by their milestones in soccer and their engagement in practice activities during childhood and early adolescence. In general, in Spain, players started their involvement in soccer earlier, but Brazilian players spent more time practicing soccer and futsal and were involved more in other sports. Moreover, during childhood, the sports education of male soccer players in Spain was characterized by the early engagement pathway (Ford et al., 2009) . On the other hand, the Brazilian system was characterized by the specialized sampling model (Sieghartsleitner et al., 2018) due to most players' participation in futsal. Finally, in terms of the practice structure of both countries, we found a very similar structure (percentual) between Spain and Brazil, although Brazilian players accumulated a greater practice volume.

Declaration of competing interest

The authors have no conflicts of interests to declare.

Funding

This study was supported by the Sports incentive law of the Government of Minas Gerais, by the Academy & Soccer Program of the Ministry of Citizenship, through the National Secretariat of Football and Defense of Fans' Rights; the SEESP-MG, FAPEMIG, CNPq, Funarbe, the Dean's Office for Graduate and Research Studies and the Centre of Life and Health Sciences from the leading institution. This study was also financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance Code 001.

References

- Bergkamp, T. L. G., Frencken, W. G. P., Niessen, A. S. M., Meijer, R. R., & den Hartigh, R. J. R. (2021). How soccer scouts identify talented players. *European Journal of Sport Science*. <https://doi.org/10.1080/17461391.2021.1916081>

- Castellanos-García, P., Lera-López, F., & Sánchez-Santos, J. M. (2021). Patterns of sports involvement in Spain. *European Journal of Sport Science*, 21(6), 895–906. <https://doi.org/10.1080/17461391.2020.1805025>
- Côté, J. (1999). The Influence of the family in the development of talent in sport. *The Sport Psychologist*, 13(4), 395–417. <https://doi.org/10.1123/tsp.13.4.395>
- Côté, J., Baker, J., & Abernethy, B. (2007). Practice and play in the development of sport expertise. In R. Eklund & G. Tenenbaum (Eds.), *Handbook of Sport Psychology* (3rd ed., pp. 184–202). John Wiley & Sons.
- Côté, J., & Erickson, K. (2015). Diversification and deliberate play during the sampling years. In J. Baker & D. Farrow (Eds.), *Routledge Handbook of Sport Expertise* (pp. 305–316). Routledge.
- CSDE (Superior Sports Council of Spain), (2011). *Los hábitos deportivos de la población escolar en España*.
- Ericsson, A. K., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100(3), 363–406. <https://doi.org/10.1037/0033-295X.100.3.363>
- Erikstad, M. K., Høigaard, R., Johansen, B. T., Kandala, N. B., & Haugen, T. (2018). Childhood football play and practice in relation to self-regulation and national team selection; a study of Norwegian elite youth players. *Journal of Sports Sciences*, 36(20), 2304–2310. <https://doi.org/10.1080/02640414.2018.1449563>
- Ford, Low, J., McRobert, A., & Williams, A. (2010). Developmental activities that contribute to high or low performance by elite cricket batters when recognizing type of delivery from bowlers' advanced postural cues. *Journal of Sport & Exercise Psychology*, 32(5), 638–654. <https://doi.org/10.1123/jsep.32.5.638>
- Ford, P. R., Bordonau, J. L. D., Bonanno, D., Tavares, J., Groenendijk, C., Fink, C., Gualtieri, D., Gregson, W., Varley, M. C., Weston, M., Lolli, L., Platt, D., & Di Salvo, V. (2020). A survey of talent identification and development processes in the youth academies of professional

- soccer clubs from around the world. *Journal of Sports Sciences*, 38(11–12), 1269–1278. <https://doi.org/10.1080/02640414.2020.1752440>
- Ford, P. R., Carling, C., Garces, M., Marques, M., Miguel, C., Farrant, A., Stenling, A., Moreno, J., Gall, F. Le, Holmström, S., Salmela, J., & Williams, A. M. (2012). The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. *Journal of Sports Sciences*, 30(15), 1653–1663. <https://doi.org/10.1080/02640414.2012.701762>
- Ford, P. R., Hodges, N. J., Broadbent, D., O'Connor, D., Scott, D., Datson, N., Andersson, H. A., & Williams, A. M. (2020). The developmental and professional activities of female international soccer players from five high-performing nations. *Journal of Sports Sciences*, 38(11–12), 1432–1440. <https://doi.org/10.1080/02640414.2020.1789384>
- Ford, P. R., Ward, P., Hodges, N. J., & Williams, A. M. (2009). The role of deliberate practice and play in career progression in sport: the early engagement hypothesis. *High Ability Studies*, 20(1), 65–75. <https://doi.org/10.1080/13598130902860721>
- Ford, P. R., Yates, I., & Williams, A. M. (2010). An analysis of practice activities and instructional behaviours used by youth soccer coaches during practice: Exploring the link between science and application. *Journal of Sports Sciences*, 28(5), 483–495. <https://doi.org/10.1080/02640410903582750>
- Ford, & Williams, A. (2012). The developmental activities engaged in by elite youth soccer players who progressed to professional status compared to those who did not. *Psychology of Sport and Exercise*, 13(May), 349–352. <https://doi.org/10.1016/j.psychsport.2011.09.004>
- Forsman, H., Blomqvist, M., Davids, K., Konttinen, N., & Liukkonen, J. (2016). The role of sport-specific play and practice during childhood in the development of adolescent Finnish team sport athletes. *International Journal of Sports Science and Coaching*, 11(1), 69–77. <https://doi.org/10.1177/1747954115624816>
- Fritz, C., Morris, P., & Richler, J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology: General*, 141(1), 2–18. <https://doi.org/10.1037/a0024338>

- Güllich, A., Kovar, P., Zart, S., & Reimann, A. (2016). Sport activities differentiating match-play improvement in elite youth footballers – a 2-year longitudinal study. *Journal of Sports Sciences*, 35(3), 207–215. <https://doi.org/10.1080/02640414.2016.1161206>
- Hendry, D. T., & Hodges, N. J. (2018). Early majority engagement pathway best defines transitions from youth to adult elite men's soccer in the UK: A three time-point retrospective and prospective study. *Psychology of Sport and Exercise*, 36(May), 81–89. <https://doi.org/10.1016/j.psychsport.2018.01.009>
- Horning, M., Aust, F., & Güllich, A. (2016). Practice and play in the development of German top-level professional football players. *European Journal of Sport Science*, 16(1), 16–105. <https://doi.org/10.1080/17461391.2014.982204>
- IBGE (Brazilian Institute of Geography and Statistics), (2010). *Censo Demográfico*.
- Machado, G., González-Víllora, S., Sarmiento, H., & Teoldo, I. (2020). Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. *International Journal of Performance Analysis in Sport*, 20(6), 1072–1091. <https://doi.org/10.1080/24748668.2020.1829368>
- Marques, R. F. R., Schubring, A., Barker-Ruchti, N., Nunomura, M., & Menezes, R. P. (2021). From soccer to futsal: Brazilian elite level men players' career pathways. *Soccer and Society*, 22(5), 486–501. <https://doi.org/10.1080/14660970.2020.1826936>
- MCDE (Spanish Ministry of Culture and Sports), (2021). *Anuário de Estadísticas Deportivas 2021*.
- Moore, R., & Radford, J. (2014). Is Futsal kicking off in England? A baseline participation study of futsal. *American Journal of Sports Science and Medicine*, 2(3), 117–122. <https://doi.org/10.12691/ajssm-2-3-9>
- Moore, Richard, Ramchandani, D. G., Bullough, S., Goldsmith, S., Edmondson, L., & Berdejo-del-Fresno, D. D. (2018). The world at their feet: A combined historical ranking of nations competing in football and futsal. *American Journal of Sports Science and Medicine*, 6(2), 49–59. <https://doi.org/10.12691/ajssm-6-2-3>

- O'Connor, D., Wardak, D., Goodyear, P., Larkin, P., & Williams, M. (2018). Conceptualising decision-making and its development: a phenomenographic analysis. *Science and Medicine in Football*, 2(4), 261–271. <https://doi.org/10.1080/24733938.2018.1472388>
- Oppici, L., Panchuk, D., Serpiello, F. R., & Farrow, D. (2018). Futsal task constraints promote transfer of passing skill to soccer task constraints. *European Journal of Sport Science*, 18(7), 947–954. <https://doi.org/10.1080/17461391.2018.1467490>
- Roca, A., & Ford, P. R. (2020). Decision-making practice during coaching sessions in elite youth football across European countries. *Science and Medicine in Football*, 4(4), 263–268. <https://doi.org/10.1080/24733938.2020.1755051>
- Roca, A., Williams, A. M., & Ford, P. R. (2012). Developmental activities and the acquisition of superior anticipation and decision making in soccer players. *Journal of Sports Sciences*, 30(15), 1643–1652. <https://doi.org/10.1080/02640414.2012.701761>
- Sieghartsleitner, R., Zuber, C., Zibung, M., & Conzelmann, A. (2018). “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. *Frontiers in Psychology*, 9(FEB), 1–12. <https://doi.org/10.3389/fpsyg.2018.00188>
- Stonebridge, I., & Cushion, C. (2018). An exploration of the relationship between educational background and the coaching behaviours and practice activities of professional youth soccer coaches. *Physical Education and Sport Pedagogy*, 23(6), 636–656. <https://doi.org/10.1080/17408989.2018.1485143>
- Sweeney, L., Horan, D., & MacNamara, Á. (2021). Premature professionalisation or early engagement? examining practise in football player pathways. *Frontiers in Sports and Active Living*, 3(June), 1–9. <https://doi.org/10.3389/fspor.2021.660167>
- Teoldo, I, Guilherme, J., & Garganta, J. (2022). *Football Intelligence: Training and Tactics for Soccer Success*. Routledge.
- Teoldo, Israel, & Silvino, M. P. (2022). Analysis of tactical behavior in full- and small-sided games : Comparing professional and youth academy athletes to enhance player development in soccer. *International Journal of Sports Science & Coaching*.

<https://doi.org/10.1177/17479541221074992>

- Travassos, B., Araújo, D., & Davids, K. (2018). Is futsal a donor sport for football?: exploiting complementarity for early diversification in talent development. *Science and Medicine in Football*, 2(1), 66–70. <https://doi.org/10.1080/24733938.2017.1390322>
- Turnnidge, J., Côté, J., & Hancock, D. (2014). Positive youth development from sport to life: Explicit or implicit transfer? *Quest*, 66(2), 203–217. <https://doi.org/10.1080/00336297.2013.867275>
- Williams, A. M., Ford, P. R., & Drust, B. (2020). Talent identification and development in soccer since the millennium. *Journal of Sports Sciences*, 38(11–12), 1199–1210. <https://doi.org/10.1080/02640414.2020.1766647>
- Yiannaki, C., Barron, D. J., Collins, D., & Carling, C. (2020). Match performance in a reference futsal team during an international tournament - implications for talent development in soccer. *Biology of Sport*, 37(2), 147–156. <https://doi.org/10.5114/BIOLSPORT.2020.93040>
- Yiannaki, C., Carling, C., & Collins, D. (2018). Futsal as a potential talent development modality for soccer—a quantitative assessment of high-level soccer coach and player perceptions. *Science and Medicine in Football*, 2(4), 299–308. <https://doi.org/10.1080/24733938.2018.1483079>

Considerações Finais

Esta tese teve como foco principal avançar o conhecimento científico acerca dos processos de desenvolvimento e avaliação da tomada de decisão no futebol. Para isso, o trabalho foi composto por seis estudos, que permitiram i) organizar a literatura científica disponível sobre esse tema e identificar lacunas a serem respondidas; ii) verificar em atletas profissionais de futebol feminino como a vivência durante a infância e adolescência em atividades de prática deliberada, jogo deliberado e futsal contribuem para o desenvolvimento da tomada de decisão e identificar a trajetória esportiva que propicia o melhor desenvolvimento dessa capacidade; iii) verificar que a qualidade e a velocidade da tomada de decisão se desenvolvem através da participação em diferentes tipos de atividades ao longo da formação esportiva durante a infância e adolescência em atletas profissionais de futebol feminino; iv) verificar que 25 sessões de treinamentos baseados nos conteúdos dos princípios táticos fundamentais e realizados a partir de jogos reduzidos e condicionados, permitem desenvolver habilidades perceptivo-cognitivas e perceptivo-motoras de jogadores de futebol sub-12 masculinos; v) verificar que a capacidade de tomada de decisão é um fator importante para que os jogadores de futebol de base masculino se mantenham selecionados no processo de formação em clubes de elite do Brasil; e vi) verificar as semelhanças e diferenças entre o contexto de formação de jogadores de elite masculino da América do Sul (Brasil) e Europa (Espanha) no que se refere a participação em diferentes atividades de formação no futebol e futsal, além da estruturação dos treinamentos de ambos os contextos relacionado ao treinamento da tomada de decisão.

O primeiro estudo desta tese verificou, a partir de uma revisão sistemática da literatura, a existência de várias lacunas nos estudos sobre o desenvolvimento da tomada de decisão no futebol. Dentre as lacunas encontradas, relacionadas à vivência prévia em atividades de futebol durante a formação, não foi identificado nenhum estudo no futebol feminino, nem estudos que verificassem atividades associadas ao desenvolvimento da velocidade da tomada de decisão no futebol. Considerando o futebol feminino, ele tem ganhado cada vez mais importância e popularização no cenário internacional, e se faz necessário criar um corpo de conhecimento específico à modalidade feminina, uma vez que a maior parte da literatura especializada foi desenvolvida no contexto masculino (WILLIAMS; FORD; DRUST, 2020). Entretanto, os resultados advindos do futebol masculino não podem ser transferidos diretamente para a modalidade feminina, uma vez que

existem inúmeras diferenças individuais e de organização do esporte entre os sexos (KRYGER *et al.*, 2021). Isso implica na necessidade de ampliar pesquisas focadas no futebol feminino (WILLIAMS; FORD; DRUST, 2020), pois é nossa responsabilidade como investigadores pesquisar a participação esportiva para promover a igualdade de oportunidades no esporte. Além disso, o estudo também identificou que nenhum estudo havia sido realizado sobre o desenvolvimento da *velocidade da tomada de decisão* associado à vivência prévia em atividades de futebol durante a formação. Essa é uma lacuna importante a ser investigada, considerando a mudança da dinâmica do jogo nos últimos anos, requerendo dos atletas uma tomada de decisão mais rápidas em função do aumento da velocidade do jogo em partidas oficiais (WALLACE; NORTON, 2014).

A identificação dessas duas lacunas importantes relacionadas ao desenvolvimento da tomada de decisão e à vivência prévia em atividades de futebol durante a formação, motivaram a realização dos estudos dois e três desta tese. A partir do estudo dois, verificamos que a variável mais importante para distinguir jogadoras brasileiras profissionais de futebol com níveis altos e baixos na capacidade de tomada de decisão, não era apenas o acúmulo de horas em atividades de prática ou jogo deliberado, mas sim a proporção entre elas. Ou seja, o principal fator associado ao desenvolvimento da qualidade da tomada de decisão perceptivo-cognitiva das atletas ao longo da sua formação era a interrelação e o acúmulo de ambas as atividades desde a infância (6-12 anos), passando pelo início da adolescência (13-15 anos), até o final da adolescência (16-18 anos). Atletas profissionais que possuíam uma melhor tomada de decisão apresentaram uma proporção mais equilibrada na participação em atividades de prática e jogo deliberado durante a infância (~50% de cada uma) e apresentaram um aumento gradativo no percentual de participação em atividades de prática deliberada no início da adolescência (~60%) e final da adolescência (~80%). Outro aspecto inovador deste estudo, foi analisar o impacto do tempo de prática deliberada em atividades de futsal ao longo da formação para desenvolver a tomada de decisão, uma vez que é um esporte muito presente na cultura brasileira (MOORE *et al.*, 2018) e estudos recentes tem mostrado o potencial de transferência de habilidades desenvolvidas no futsal para o futebol (OPPICI *et al.*, 2018; TEOLDO; GUILHERME; GARGANTA, 2021). Verificou-se uma relação positiva entre a prática deliberada de futsal no início da adolescência (13-15 anos) com o desenvolvimento da tomada de decisão, uma vez que as atletas com melhor qualidade da tomada de decisão acumularam mais horas de prática deliberada em futsal quando comparadas às atletas com pior tomada de decisão.

De maneira a complementar os achados do estudo dois, o terceiro estudo dessa tese buscou verificar quais atividades durante as diferentes fases da formação esportiva estavam associadas ao desenvolvimento da *qualidade e da velocidade da tomada de decisão* em jogadoras de futebol profissional de elite. Esse é o primeiro estudo na literatura, seja no futebol feminino ou masculino, a avaliar a associação de atividades de formação com o desenvolvimento da velocidade da tomada de decisão. Os achados desse estudo corroboraram os achados do estudo dois, mostrando a importância do envolvimento em atividades tanto de prática deliberada, quanto de jogo deliberado desde a infância para promover o desenvolvimento de aspectos complementares da tomada de decisão: *a qualidade e velocidade*. Os resultados desse estudo mostraram que o desenvolvimento da *qualidade da tomada de decisão* está associado à participação em atividades de prática deliberada, enquanto o desenvolvimento da *velocidade da tomada de decisão* está associado principalmente à participação em atividades de jogo deliberado desde a infância. Ou seja, ressaltamos que o desenvolvimento da tomada de decisão de jogadores de futebol é favorecido a partir do envolvimento durante a infância (6-12 anos) e início da adolescência (13-15 anos) em contextos de formação com um ambiente mais estruturado, através de treinamentos sistematizados e também de contextos menos estruturados, através de jogos onde os participantes têm mais liberdade para se organizarem e criarem sem a supervisão de um adulto.

Outro achado importante, está relacionado à contribuição do futsal para o desenvolvimento de alguns aspectos da tomada de decisão durante a infância e início da adolescência. Os resultados desta tese mostraram que há uma relação positiva entre a quantidade de horas acumuladas no treinamento do futsal com o desenvolvimento de comportamentos ofensivos da tomada de decisão (estudo três). Entretanto, essa associação estava limitada a situações ofensivas com bola, e situações ofensivas dentro do centro de jogo, que são ações realizadas mais próximas da bola. São resultados coerentes com a estrutura reduzida do futsal, que favorece a realização de mais ações com bola e próximas dela, por ser jogado em um espaço reduzido e com menos jogadores em relação às dimensões oficiais do futebol (YIANNAKI; CARLING; COLLINS, 2018).

Dessa forma, considerando o contexto de *formação de talentos no futebol*, essas informações podem dar subsídio baseado em evidências científicas à clubes que tem adotado o ensino concomitante do futsal e futebol a entender quais fases de formação pode ser melhor adotar essa estratégia e qual a sua potencialidade e limitação no desenvolvimento da tomada de decisão de futebolistas. A partir dos nossos resultados, verificamos que durante a infância e início da

adolescência (6-15 anos) a participação em treinamentos de futsal pode favorecer a qualidade da tomada de decisão em situações ofensivas com bola e próximas dela, mas não de comportamentos defensivos. Além disso, a prática do futsal no final da adolescência (16-18 anos) não esteve associada a nenhuma dimensão da tomada de decisão, indicando que a sua participação neste período não favorece o desenvolvimento da tomada de decisão em jogadores de futebol. Vale ressaltar que os achados relacionados ao futsal, foram encontrados nos dois estudos desta tese realizada no contexto do futebol feminino. Portanto, sugerimos certa cautela na transferência direta destes resultados para o futebol masculino, apesar de estudos anteriores (FORD *et al.*, 2012), juntamente com os resultados encontrados no estudo seis desta tese, sugerirem que o futsal exerce um papel importante na formação de jogadores brasileiros de futebol masculino de elite. Essa cautela na transferência dos resultados se deve à diferente organização entre ambos os esportes masculino e feminino, uma vez que os estudos têm apontado que jogadores de futebol masculino geralmente acumulam mais tempo de experiência de treinamento no futebol do que atletas de futebol feminino para chegar até a elite (FORD *et al.*, 2020, 2012). Portanto, isso pode implicar em uma contribuição diferente do futsal para o contexto feminino e masculino, e sugerimos que estudos futuros investiguem em amostras masculinas como a vivência no futsal está associada ao desenvolvimento da tomada de decisão no futebol.

Considerando os resultados em conjunto dos estudos dois e três, verificamos que para desenvolver jogadores no contexto brasileiro com uma melhor qualidade de tomar decisões assertivas e rápidas é importante vivenciar um contexto variado na infância e início da adolescência dentro do esporte que é foco principal do desenvolvimento, o futebol. Esse contexto variado é caracterizado pela participação em atividades de jogo deliberado no futebol, prática deliberada no futebol e de prática deliberada no futsal, que pode ser considerado uma “versão reduzida do futebol” devido às semelhanças entre ambos os esportes (TEOLDO; GUILHERME; GARGANTA, 2021). Dessa forma, podemos caracterizar essa trajetória de formação no esporte que favorece o desenvolvimento da tomada de decisão de jogadores de futebol no contexto brasileiro, como diversificação especializada (SIEGHARTSLEITNER *et al.*, 2018).

A partir dos nossos resultados (estudos um, dois e três), verificamos também o importante papel que o treinamento sistematizado exerce desde a infância até o final da adolescência, para favorecer o desenvolvimento da tomada de decisão. Além disso, foi identificado através da nossa revisão sistemática (estudo um) que até o momento nenhum estudo havia verificado a efetividade

de intervenções em desenvolver aspectos perceptivo-cognitivos e perceptivo-motores da tomada de decisão em jogadores no contexto de clubes de futebol. Em função disso, o estudo quatro desta tese buscou verificar a efetividade de 25 sessões de treinamentos baseados nos conteúdos dos princípios táticos fundamentais e realizados a partir de jogos reduzidos e condicionados para desenvolver as habilidades perceptivo-cognitiva e perceptivo-motora em jogadores de futebol sub-12. Essa foi uma abordagem mais *qualitativa* de entender como a *qualidade* do treinamento pode favorecer o desenvolvimento da tomada de decisão, para complementar o entendimento dos achados nos estudos dois e três com uma abordagem mais *quantitativa* em relação à contribuição do acúmulo de horas de treinamento.

O estudo cinco da tese trouxe como aspecto inovador no seu desenho experimental a utilização de instrumentos complementares para avaliar tanto a tomada de decisão perceptivo-cognitiva (TacticUP), como a tomada de decisão perceptivo-motora (FUT-SAT) baseadas no mesmo pressuposto teórico (princípios táticos fundamentais do futebol). Outro aspecto inovador deste estudo, foi individualizar os estímulos fornecidos no treinamento a partir das necessidades individuais de melhora dos jogadores, considerando seus resultados na avaliação objetiva da tomada de decisão perceptivo-cognitiva (TacticUP). Essa individualização foi realizada a partir da adequação das interações no treinamento (oposição e cooperação entre os jogadores) considerando o nível de rendimento dos jogadores em cada um dos conteúdos trabalhados (princípios táticos fundamentais).

Os resultados deste estudo indicaram que os 25 treinamentos geraram melhorias nas habilidades perceptivo-cognitivas relacionadas ao tempo de tomada de decisão tanto para ações ofensivas quanto defensivas realizadas dentro do centro de jogo (ações com a bola e perto da bola) e ações defensivas realizadas fora do centro de jogo (ações longe da bola). Além disso, também encontramos melhorias nas habilidades perceptivo-motoras (eficiência tática) para ações defensivas realizadas dentro do centro de jogo (ações próximas da bola). Os resultados também indicaram que, em termos de habilidades perceptivo-cognitivas, aparentemente o tempo de tomada de decisão se desenvolve mais rapidamente do que a qualidade da tomada de decisão. Esses achados contribuem para a área de pedagogia do esporte, mostrando a efetividade de uma intervenção baseada nos conteúdos dos princípios táticos fundamentais e realizada a partir de jogos reduzidos e condicionados. Além disso, mostramos a importância de individualizar os estímulos fornecidos através do processo de treinamento para as necessidades individuais dos jogadores. Esta

estratégia pode melhorar a qualidade das intervenções baseadas em jogos reduzidos e condicionados e abordagens baseadas em jogos (por exemplo, *TGfU*, Escola de Bola, Iniciação Esportiva Universal e etc.) para o treinamento que consideram o papel do professor e do treinador como um facilitador do processo de aprendizagem (KINNERK *et al.*, 2018; PILL *et al.*, 2021).

Os quatro primeiros estudos desta tese buscaram aprofundar o entendimento de como o desenvolvimento da tomada de decisão ocorria a partir da vivência prévia em diferentes atividades de formação no futebol e da aplicação de intervenções no treinamento. Na sequência, o quinto estudo desta tese buscou verificar como a inclusão de avaliações objetivas da capacidade de tomada de decisão perceptivo-cognitiva no processo de seleção de atletas de base, seria capaz de diferenciar atletas que já faziam parte das categorias de clubes de elite em serem selecionados ou não selecionados para continuar no processo de desenvolvimento de talentos no clube. Destacamos que este quinto estudo foi o primeiro na literatura a: i) avaliar tanto a velocidade quanto a qualidade da tomada de decisão com base nas habilidades ofensivas e defensivas entre jogadores de futebol de base selecionados e não selecionados; e ii) avaliar as diferenças na tomada de decisão entre jogadores de futebol de base selecionados e não selecionados com uma amostra sul-americana. Os resultados deste quinto estudo indicaram que jogadores selecionados por clubes de base da elite no Brasil possuem uma tomada de decisão superior relacionadas à velocidade e à qualidade em comparação com aqueles não selecionados.

Verificamos que os jogadores selecionados possuíam vantagens em todas as faixas etárias avaliadas (sub-14, -15, -16 e -17), sendo elas: i) melhor velocidade de tomada de decisão (sub-16 e sub-17); ii) melhor qualidade de tomada de decisão (sub-15); ou iii) melhor velocidade e qualidade de tomada de decisão (sub-14). Além disso, essas vantagens estavam relacionadas às habilidades ofensivas para a categoria sub-16, habilidades defensivas para a categoria sub-15, e habilidades ofensivas e defensivas para as categorias sub-14 e sub-17. O maior número de diferenças encontradas foi para a velocidade de tomada de decisão tanto para os jogadores mais jovens (sub-14) quanto para os mais velhos (sub-17) avaliados em nosso estudo. Além disso, destacamos que entre todas as variáveis avaliadas em nosso estudo ($n = 72$), considerando tanto a velocidade quanto a qualidade da tomada de decisão para cada faixa etária, os jogadores não selecionados não apresentaram nenhuma vantagem em comparação com os selecionados. Isto mostra como desenvolver a tomada de decisão é importante para a permanência dos jogadores de futebol nas categorias de base de elite no Brasil. Também reforça a necessidade de avaliar de

maneira objetiva a capacidade de tomada de decisão dos jogadores para qualificar tanto o processo de seleção, quanto de desenvolvimento de talentos ao longo da formação esportiva (MACHADO; TEOLDO, 2020).

A partir dos resultados deste quinto estudo, verificamos a importância de desenvolver nos jogadores de base a capacidade de tomada de decisão para se manterem selecionados em clubes de elite do futebol. A continuação em clubes de elite, implica para os atletas o acesso contínuo à infraestrutura e recursos humanos de alta qualidade para continuarem o seu processo de desenvolvimento no futebol (ROCA; FORD, 2020). De posse dessa informação, ressaltamos a necessidade de treinadores e profissionais envolvidos com a formação de atletas dessas faixas etárias, buscarem desenvolver treinamentos que favoreçam o desenvolvimento da tomada de decisão (como apresentado no estudo quatro desta tese) para que os jogadores continuem selecionados e com acesso a recursos favoráveis para o seu desenvolvimento. Isso também implica para os clubes a otimização dos recursos financeiros investidos na formação dos atletas de base, uma vez que se espera a continuidade de um percentual maior de atletas provenientes da sua própria categoria de base. Ou seja, um menor percentual de atletas dispensados (não selecionados) reflete um melhor aproveitamento e maior retorno aos investimentos realizados na formação dentro do clube.

Como os cinco primeiros estudos desta tese focaram em jogadores de elite do Brasil, para que pudéssemos entender até que ponto os resultados desta tese poderiam ser transferidos para outros contextos de formação internacional, o sexto estudo buscou comparar o contexto da formação esportiva de jogadores de futebol de elite do contexto Sul-Americano (Brasil) com o Europeu (Espanha). Para isso, esse estudo realizado com jogadores de futebol masculino de elite na fase final de formação (sub-18) do Brasil e Espanha buscou: i) comparar a vivência prévia em atividades relacionadas ao futebol durante a infância e adolescência entre jogadores de futebol de base de elite do Brasil e Espanha; ii) discutir a trajetória esportiva que caracterizou o desenvolvimento no futebol de elite do Brasil e Espanha, e iii) comparar a estrutura do treinamento entre o futebol de base de elite do Brasil e na Espanha.

Os resultados mostraram que os jogadores espanhóis começaram mais jovens a jogar futebol, e a participar de atividades estruturadas (prática deliberada e competições) comparados aos jogadores brasileiros. Apesar dos jogadores espanhóis terem iniciado o envolvimento com o esporte mais cedo, os jogadores brasileiros se envolveram em um número maior de horas em

atividades estruturadas, como a prática deliberada no futebol e futsal, e participaram de um maior número de esportes na infância e no início da adolescência. A partir desses dados, verificamos que a trajetória esportiva dos jogadores de futebol masculino na Espanha durante a infância foi caracterizada pela trajetória de engajamento precoce, enquanto no Brasil foi caracterizada pela diversificação especializada, semelhante aos resultados dos estudos dois e três desta tese com jogadoras de futebol feminino. De forma geral, esses resultados sugerem uma semelhança na trajetória esportiva entre jogadores de futebol masculino e feminino de elite do Brasil, sendo caracterizado pela diversificação especializada. Apesar disso, os resultados indicam que no esporte masculino os jogadores acumulam em média durante a infância praticamente o dobro de horas em atividades de prática deliberada no futebol (homens: ~1.000h; mulheres: ~550h) e de jogo deliberado no futebol (homens: ~1.800h; mulheres: ~990h) e uma quantidade semelhante de prática deliberada no futsal (homens: ~500h; mulheres: ~550h).

Em relação à Espanha, percebemos que a presença da prática deliberada no futsal na formação de jogadores de futebol masculino é muito menor, uma vez que durante a infância os jogadores acumularam em média ~90h comparado à ~500h dos jogadores brasileiros. Isso sugere que os achados desta tese, relacionados à contribuição do futsal para o desenvolvimento da tomada de decisão de jogadores de futebol durante a infância e início da adolescência na América do Sul, parece não transferir para a realidade esportiva europeia, através dos resultados encontrados na Espanha. Em função desses resultados, é possível que a interrelação entre a prática deliberada e o jogo deliberado no futebol no contexto de formação espanhol tenha uma importância ainda maior no desenvolvimento da tomada de decisão para os jogadores, uma vez que não é comum a prática do futsal.

Esses resultados também sugerem um potencial para que o contexto de formação esportiva no futebol espanhol explore mais o uso do futsal para proporcionar maior diversificação, especialmente na infância (CASTELLANOS-GARCÍA; LERA-LÓPEZ; SÁNCHEZ-SANTOS, 2021; TRAVASSOS; ARAÚJO; DAVIDS, 2018). Por um lado, o uso do futsal permite a variabilidade no contexto de treinamento (ou seja, diferença na bola, tamanho da quadra, número de jogadores e velocidade do jogo), o que está positivamente associado à aquisição de habilidades motoras, cognitivas e táticas na infância (TEOLDO; GUILHERME; GARGANTA, 2021). Por outro lado, como o futsal é normalmente jogado em quadras cobertas, ele pode ser explorado durante estações específicas do ano como uma alternativa para manter os jogadores praticando em

condições ambientais adversas (ex.: chuvas fortes, temperaturas negativas ou queda de neve). Estas sugestões poderiam ser traduzidas não apenas para o sistema de desenvolvimento esportivo espanhol, mas também para outros países europeus que sofrem com mudanças ambientais significativas durante o inverno.

Apesar dessas diferenças na trajetória esportiva entre Brasil e Espanha, o estudo seis identificou uma estruturação do treinamento (percentualmente) muito semelhante entre a Espanha e o Brasil, considerando atividades: i) individuais; ii) duplas; iii) analíticas; iv) tática de grupo (2x2 até 4x4); e v) tática coletiva (5x5 até estruturas maiores). Embora houve uma semelhança de estruturação à nível percentual, os jogadores brasileiros acumularam um maior volume de treinamento em comparação aos Espanhóis. Este resultado indica semelhanças em como os treinadores de futebol de base de elite estruturam seu treinamento em ambos os países, focando principalmente em aspectos táticos e de tomada de decisão, como demonstrado por pesquisas anteriores (MACHADO *et al.*, 2020; ROCA; FORD, 2020).

Esses resultados sugerem que estudos de intervenção realizados na realidade brasileira, como o estudo quatro desta tese, podem ter uma alta transferência para o contexto de formação espanhol, considerando essas semelhanças culturais de treinamento entre os países. O sistema de formação brasileiro também tem muito a se beneficiar destes achados, uma vez que a revisão sistemática desta tese identificou que seis intervenções realizadas em clubes de futebol foram realizadas no contexto de formação espanhol. Portanto, esse estudo demonstra a importância de entendermos pontos de convergência e divergência de diferentes contextos de formação no futebol, considerando diferenças culturais à níveis de continentes, países e até mesmo regiões em países com dimensões continentais, como é o caso Brasil, ou com culturas regionais bastante diferentes, como é o caso da Espanha. Estudos futuros nessa linha de pesquisa podem favorecer a transferência do conhecimento desenvolvido em diferentes contextos de formação. Isso aprofundará o nosso entendimento sobre os diferentes sistemas de formação no futebol a nível global, permitindo assim qualificar a formação de jogadores de futebol masculino e feminino de diferentes regiões do mundo.

Resumidamente, esta tese permitiu avanços na compreensão e proposição de melhorias nos processos de desenvolvimento da capacidade de tomada de decisão no futebol relacionados à avaliação e ao treinamento. Inicialmente foi possível organizar o conhecimento acerca do desenvolvimento da tomada de decisão do futebol e compreender as lacunas nesta linha de pesquisa

através do estudo de revisão sistemática (estudo um). A partir disso, lacunas da literatura neste tema foram preenchidas a partir dos estudos dois, três e quatro. Estes estudos focaram na integração do processo de avaliação objetiva da tomada de decisão para compreender e propor melhorias no processo de formação e treinamento da tomada de decisão de jogadores de futebol nos contextos feminino e masculino. Além disso, o estudo cinco mostrou que a integração de avaliações sistematizadas no processo de seleção de atletas em clubes de elite pode otimizar o processo de seleção dos jogadores e contribuir para a retenção de atletas com maior potencial de se manterem selecionados para continuar seu desenvolvimento no clube. Por fim, o estudo seis identificou as possibilidades de transferência dos resultados advindos desta tese para o contexto europeu ao comparar o sistema de formação no futebol entre Brasil e Espanha.

A relevância dos resultados advindos desta tese pode impactar em termos sociais no desenvolvimento de políticas públicas para ações que promovam o ensino do futebol de maneira mais coerente e baseado em dados empíricos, ao propor a inserção de avaliações e organização do treinamento comprovadas cientificamente, de forma sistematizada e compatíveis com as fases de ensino do futebol. Isso permitirá ajustar os estímulos do treinamento de acordo com as necessidades de melhora individuais dos jogadores ao longo da sua formação esportiva. Juntamente à isso, ao entendermos quais tipos de atividades ao longo da formação contribuem de maneira mais significativa para o desenvolvimento dos jogadores nesta modalidade, é possível otimizar a utilização de recursos financeiros, de infraestrutura e humanos utilizados ao longo da formação esportiva de crianças e adolescentes, ao direcionar tais recursos para ações que sejam mais eficazes no ensino da modalidade.

Considerando a relevância social e científica do projeto, a proposta de avanços metodológicos, através da utilização de instrumentos de avaliação mais coerentes com as diferentes fases de ensino do futebol, viabiliza a utilização de métricas mais relevantes para a escolha de estratégias de ensino que sejam mais eficazes. Desta forma, isso beneficia diretamente os profissionais que atuam com o ensino do futebol, ao permitirem qualificar sua intervenção, e impactar diretamente as crianças e adolescentes, que poderão ter acesso a uma formação esportiva mais qualificada.

Referências

- CASTELLANOS-GARCÍA, P; LERA-LÓPEZ, F; SÁNCHEZ-SANTOS, J. Patterns of sports involvement in Spain. **European Journal of Sport Science**, vol. 21, no. 6, p. 895–906, 2021. DOI 10.1080/17461391.2020.1805025.
- FORD, P; HODGES, N; BROADBENT, D; O’CONNOR, D; SCOTT, D; DATSON, N; ANDERSSON, H; WILLIAMS, M. The developmental and professional activities of female international soccer players from five high-performing nations. **Journal of Sports Sciences**, vol. 38, no. 11–12, p. 1432–1440, 2020. DOI 10.1080/02640414.2020.1789384.
- FORD, P; CARLING, C; GARCES, M; MARQUES, M; MIGUEL, C; FARRANT, A; STENLING, A; MORENO, J; GALL, F; HOLMSTRÖM, S; SALMELA, J; WILLIAMS, M. The developmental activities of elite soccer players aged under-16 years from Brazil, England, France, Ghana, Mexico, Portugal and Sweden. **Journal of Sports Sciences**, vol. 30, no. 15, p. 1653–1663, 2012. DOI 10.1080/02640414.2012.701762.
- KINNERK, P; HARVEY, S; MACDONNCHA, C; LYONS, M. A review of the game-based approaches to coaching literature in competitive team sport settings. **Quest**, vol. 70, no. 4, p. 401–418, 2018. DOI 10.1080/00336297.2018.1439390.
- KRYGER, K; WANG, A; MEHTA, R; IMPELLIZZERI, F; MASSEY, A; MCCALL, A. Research on women’s football: a scoping review. **Science and Medicine in Football**, 2021. DOI 10.1080/24733938.2020.1868560.
- MACHADO, G.; GONZÁLEZ-VÍLLORA, S.; SARMENTO, H.; TEOLDO, I. Development of tactical decision-making skills in youth soccer players: Macro- and microstructure of soccer developmental activities as a discriminant of different skill levels. **International Journal of Performance Analysis in Sport**, vol. 20, no. 6, p. 1072–1091, 2020. DOI 10.1080/24748668.2020.1829368.
- MACHADO, G.; TEOLDO, I. TacticUP Video Test for soccer: Development and validation. **Frontiers in Psychology**, vol. 11, no. 1690, p. 1–12, 2020. <https://doi.org/10.3389/fpsyg.2020.01690>.
- MOORE, R; RAMCHANDANI, G; BULLOUGH, S; GOLDSMITH, S; EDMONDSON, L; BERDEJO-DEL-FRESNO, D. The world at their feet: A combined historical ranking of nations competing in football and futsal. **American Journal of Sports Science and Medicine**, vol. 6, no. 2, p. 49–59, 2018. DOI 10.12691/ajssm-6-2-3.
- OPPICI, L; PANCHUK, D; SERPIELLO, F; FARROW, D. Futsal task constraints promote transfer of passing skill to soccer task constraints. **European Journal of Sport Science**, vol. 18, no. 7, p. 947–954, 2018. DOI 10.1080/17461391.2018.1467490.
- PILL, S; EVANS, J; WILLIAMS, J; DAVIES, M; KIRK, M. Conceptualising games and sport teaching in physical education as a culturally responsive curriculum and pedagogy. **Sport**,

Education and Society, 2021. DOI 10.1080/13573322.2021.1964461.

ROCA, A; FORD, P. Decision-making practice during coaching sessions in elite youth football across European countries. **Science and Medicine in Football**, vol. 4, no. 4, p. 263–268, 2020. DOI 10.1080/24733938.2020.1755051.

SIEGHARTSLEITNER, R; ZUBER, C; ZIBUNG, M; CONZELMANN, A. “The early specialised bird catches the worm!” - A specialised sampling model in the development of football talents. **Frontiers in Psychology**, vol. 9, no. FEB, p. 1–12, 2018.

TEOLDO, I; GUILHERME, J; GARGANTA, J. **Para um futebol jogado com ideias: Concepção, treinamento e avaliação do desempenho tático de jogadores e equipes**. 2nd ed. Curitiba: Appris, 2021.

TRAVASSOS, B; ARAÚJO, D; DAVIDS, K. Is futsal a donor sport for football?: exploiting complementarity for early diversification in talent development. **Science and Medicine in Football**, vol. 2, no. 1, p. 66–70, 2018. DOI 10.1080/24733938.2017.1390322.

WALLACE, J; NORTON, K. Evolution of World Cup soccer final games 1966-2010: Game structure, speed and play patterns. **Journal of Science and Medicine in Sport**, vol. 17, no. 2, p. 223–228, 2014. DOI 10.1016/j.jsams.2013.03.016.

WILLIAMS, M; FORD, P; DRUST, B. Talent identification and development in soccer since the millennium. **Journal of Sports Sciences**, vol. 38, no. 11–12, p. 1199–1210, 17 Jun. 2020.

YIANNAKI, C; CARLING, C; COLLINS, D. Could futsal hold the key to developing the next generation of youth soccer players? **Science and Medicine in Football**, vol. 2, no. 1, p. 71–74, 2018. DOI 10.1080/24733938.2017.1332422.