

**Developing creativity in football:
The role of motor skills and idea generation in top-level players**

UEFA Research Grant Programme

Final report

Stephan Zahno

University of Bern in collaboration with the Swiss Football Association

Table of Contents

<i>Executive Summary</i>	4
1. Introduction: Context of research and relevance	6
2. Research questions	8
3. Literature review: Current state of knowledge	9
4. Research design and strategy	10
4.1 Study design	10
4.2 Sample frame and size	11
4.3 Key variables for quantitative work	11
4.4 Hypothesis and analysis strategy	14
4.5 Validity and reliability	15
4.6 Ethical issues	15
5 Overview of milestones	16
5.1 Milestone Phase 1 – Preparation	16
5.2 Milestones Phase 2 – Execution	17
5.3 Milestones Phase 3 – Finalisation	17
6. Overview of the main research findings	18
6.1 Systematic evaluation of current creativity test	18
6.1.1 Main analysis	18
6.1.2 Further analysis	21
6.1.3 Discussion and practical implications	26
6.2 Development of practical guidelines	27
6.2.1 Testing.....	28
6.2.2 Training	28
7. Limitations	30
8. Impact of the research	30
9. References	32
10. Appendix	35
Appendix 1 – Instructions in German	35
Appendix 2 – Instructions in French	37
Appendix 3 – Data collection arrangement	38

Table of Figures

Figure 1- Study design.	11
Figure 2 - Rating process in LimeSurvey.	13
Figure 3 - Output ranking in LimeSurvey.....	13
Figure 4 - Project Plan Phase 1.	16
Figure 5 - Project Plan Phase 2.	17
Figure 6 - Project Plan Phase 3.	17
Figure 7- Relationship between on-field creativity and players divergent thinking scores for the Footuro- (left) and BSC Young Boys-players (right).	19
Figure 8 - Relationship between on-field creativity and players' motor-skill level for Footuro- (left) and BSC Young Boys-players (right).	20
Figure 9 - Combined plot of Figure 7 and 8 for Footuro- (left) and BSC Young Boys-players (right).	20
Figure 10 - Relationship between players' motor-skill level and divergent thinking scores for the Footuro (left) and BSC Young Boys players (right).	21
Figure 11 - T-test of mean rank between Footuro- and BSC Young Boys-players.....	22
Figure 12 – Relationship between DT score and Originality of decision for Footuro- (top left) and BSC Young Boys-players (top right). And the relationship between DT score and Decision-making quality for Footuro- (bottom left) and BSC Young Boys-players (bottom right).....	23
Figure 13 - Plots of relationship between DT score and the three single components of the DT score and single components within each other (Fluency, Originality and Flexibility) in Footuro-players.	24
Figure 14 - Plots of relationship between DT score and the three single components of the DT score and single components within each other (Fluency, Originality and Flexibility) in BSC Young Boys-players.....	25

Executive Summary

Performing creative actions is a decisive factor in football, especially at the top-level. Thus, developing creative players is a key objective in talent promotion. Football coaches, clubs and associations are increasingly challenged to implement effective programmes for testing and training creativity.

Specifically, football associations, such as the Swiss Football Association, are facing two challenges:

(1) In recent years, football-specific creativity tests have been developed. These tests are increasingly proposed (a) as a talent assessment tool and (b) to evaluate the effectiveness of designated creativity trainings. However, the validity of these tests remains unclear and systematic evaluations are missing so far. Leading to the question: Should these tests be implemented for performance and talent assessment? (2) A transfer of the latest scientific knowledge into practical guidelines has yet to be provided. Leading to the question: What inputs can be gained from current scientific findings to create effective programmes for testing and training creativity?

In this project, these two demands were directly addressed in two working packages:

Package 1 - “systematic evaluation”: Currently available creativity tests are *off-field* tests measuring players’ cognitive capacity to *generate ideas* in game situations (independently of their motor skills to put these ideas to action). So far, there are no studies showing that performances in these tests correlate with creative actions *on-field*. In contrast, recent studies in youth football indicate that on-field creativity is foremost enabled (or limited) by players’ *motor skills* rather than their idea generation capacity. Thus far, however, there were no studies in top-level players. In our study, we directly addressed this question: Does *top-level* players’ on-field creativity correlate with (I) their idea generation capacity, as assessed in current creativity tests, and (II) their motor-skill level? 15 top Swiss youth national players (Footuro

programme) and 20 under-21 players from the BSC Young Boys participated. No positive correlation between players' DT test scores and on-field creativity could be observed. In contrast, a large correlation was found between players' motor-skill level and on-field creativity. Taken together, the results challenge the validity of currently proposed creativity tests uniquely focusing on idea generation. Instead, the results suggest that creative actions are based on players' own options in action, which crucially depend on motor skills.

Package 2 - "practice-transfer": To directly translate the scientific findings to explicit practical guidelines, we organised an expert-workshop with highly experienced coaches of the Swiss Football Association. At the workshop, we (a) communicated our results, (b) conducted focus group discussions on their opinions and inputs regarding the findings and (c) elaborated guidelines based on an integration of the present scientific results and their longstanding practical experience in a collaborative process. For testing, the workshop provided consensus that, from both practical and scientific perspectives, the validity of currently available football-specific creativity tests should be critically considered. Furthermore, four key points for future test developments were elaborated. For training, the workshop provided consensus that aiming to enhance players' motor skills rather than idea generation capacities is a more promising strategy to promote on-field creativity. In collaboration with the coaches, five key points were elaborated for designing trainings to extend players' motor-skill repertoire and – consequently – their creativity on the field.

1. Introduction: Context of research and relevance

Performing creative actions is considered a key factor in football, especially at the highest performance level (e.g., Cross, 2013; for a scientific analysis: Kempe & Memmert, 2018). According to the standard definition of creativity (cf. Runco & Jaeger, 2012), actions are described as “creative” when they are both functional (i.e., support task success) and unconventional (i.e., beyond typical standards) in a particular context. In football, being able to deviate from standard solutions – at the right moment – to take the opponent by surprise is deemed a hallmark of expertise (Roca et al., 2018). Therefore, developing more creative players, capable of “making the difference”, is widely discussed as a crucial – as well as challenging – objective of football coaches, clubs and associations. This has been emphasised in many training manuals, such as the FIFA guidelines that state: “creativity must remain at the nucleus of youth development” (Bénézet & Hasler, 2018, p. 10) as well as by expert coaches, such as Joachim Löw, Arsène Wenger and many more.

In recent years, a range of recommendations for football-specific creativity testing and training have been proposed (e.g., Memmert, 2015a, 2021), that are based on scientific studies (e.g., Memmert, 2011). In these studies, players’ creativity is assessed with standardised, off-field tests. Specifically, these cognitive tests measure players’ capacity to generate many different *ideas* to solve game situations (independently of their motor skills to actually put these ideas to action). Enhancing this cognitive idea generation capacity through dedicated interventions is, in turn, expected to enable players to perform creative actions. In the scientific literature, this capacity to generate ideas is known as divergent thinking (DT; Guilford, 1967). Accordingly, we use the term “DT test” in the report to refer to tests that measure players’ idea generation capacity. For practice, DT tests have been (1) proposed as talent assessment tool and (2) used in sports science studies to investigate the effectiveness of creativity training principles. Empirically, numerous studies have shown that DT can be improved with training

(for an overview, see Memmert 2015a). However – and despite the gaining popularity of these creativity tests and trainings – the crucial questions for practice remain open: Are the players who score high on those football-specific DT tests the players who perform creative actions on-field? Do improvements in DT transfer to more creative actions on the field?

In my PhD-studies, we have (1) argued that it is crucial to systematically evaluate whether high scores in DT tests actually manifest in more creative actions and (2) have proposed an alternative theoretical approach to creativity in team sports (Zahno & Hossner, 2020; Zahno & Hossner, 2022). In essence, instead of attributing creative actions, a purely cognitive idea generation capacity, as assessed in DT tests, we proposed that creative actions are enabled (or limited) by players' *own* options in action, which crucially depend on their motor skills. Specifically, we hypothesised that the on-field creativity can better be explained by players' motor-skill level than by their DT test scores. Empirically, our hypothesis was confirmed in three studies in youth football. In an intervention study with under-13 players (Zahno & Hossner, 2022), we showed that DT, as such, can indeed be improved by implementing designated creativity training principles found in the current literature. However, these improvements in DT did *not* transfer to more creative actions on-field. Rather, players who received motor skill training showed greater improvements not only in the functionality but also in the creativity of their on-field actions. This finding is further supported by two correlational studies examining male under-12 and female under-19 elite youth players (Zahno, 2022). Both studies indicated the same pattern: No correlations between players' DT test scores and on-field creativity in contrast to moderate to large correlations between players' motor-skill level and on-field creativity. Based on these results, first conclusions can be drawn for testing and training in youth football: (1) For testing, performances in DT tests of youth players did *not* capture their potential to perform creative actions on-field. As current football-specific creativity tests essentially measure DT, their validity needs to be questioned and further

evaluated. (2) For training: Improvements in DT did *not* transfer to more creative actions. As current creativity trainings are essentially based on improvements in DT, their practical impact needs to be questioned. In contrast, the results suggest that programmes aiming to develop on-field creativity should focus on enhancing players' motor skills to extend their actions repertoire and thus their potential to perform creative solutions in action.

So far, however, these results are limited to *youth* football. Could it be that for top-level players who are all extremely skilled, their capacity to generate ideas still plays an important role alongside motor skills? Or could it even “make the difference”?

In the present UEFA research project, we directly addressed this research gap and investigated the role of motor skills and idea generation for creative performance in top-level players. The aim is to provide a scientific evaluation of the validity of currently available football-specific creativity tests (measuring idea generation) and on the role of motor skills for the development of creative players. The project contained two working packages. In package 1, “systematic evaluation”, the focus lies on the analysis. In package 2, “practice-transfer”, we build on the results of package 1 to create practical guidelines for developing creativity in close collaboration with expert coaches of the Swiss Football Association. These guidelines will support associations, clubs and coaches of all levels to develop creative players.

2. Research questions

Question I: Do top-level players' performances in DT tests (measuring *idea generation* capacity) correlate with their potential to perform creative actions?

Question II: Does top-level players' motor-skill level correlate with their potential to perform creative actions?

3. Literature review: Current state of knowledge

Driven by the high levels of interest in creativity in sports, the topic has drawn increasing attention from the sport science field (De Sa Fardilha & Allen, 2020). However, while it has become a popular topic of discussion, the rather elusive construct of “creativity” poses challenges to both researchers and practitioners. Thus, we conducted a systematic literature review (Zahno & Hossner, 2020) to provide a comprehensive overview of research on creativity in team sports (with a focus on football), which is available here: <https://www.frontiersin.org/articles/10.3389/fpsyg.2020.575475/full>. Systematic scientific research on creativity in team sports began in the early 2000s (e.g., Memmert, 2006). In the following years, many considerably differing definitions and measures of “creativity” have been used to study the topic; including important contributions from dynamical systems theory (Hristovski et al. 2011) and ecological psychology (Orth et al., 2017). In most studies, however, creativity has been understood and assessed as players’ DT; that is, their cognitive competence to generate many different and original ideas in response to a given problem or stimulus (for an overview, Memmert, 2015a). To provide context, DT is a traditional concept in psychometric creativity research (Guilford, 1967) and is still extensively used as a measure in general standardised creativity tests (for an overview, Kaufman et al., 2008; Reiter-Palmon et al., 2019), although not without criticism (e.g., Baer, 2011). In such tests, participants are asked to generate ideas in response to open-ended problems. As an indicator of a person’s creativity, three DT components are assessed: fluency (the number of generated ideas), flexibility (the variety of generated ideas) and originality (the unusualness of generated ideas). In sport-specific studies (e.g., Memmert et al., 2013), those general creativity tests have been adapted to sports situations to quantify players’ creativity. The core assumption of the DT approach is that more creative players differ from less creative players in terms of a distinct idea generation capacity (i.e., DT), which can be revealed through sport-specific DT tests. Generally, according

to the DT approach, the concepts of creativity and DT are frequently equated and used as synonyms (cf. Memmert, 2015b).

Numerous studies have shown that DT can be improved with training and that DT test scores are correlated with many different aspects, such as attentional capabilities (Hüttermann et al., 2019), motivational states (Memmert et al., 2013) and even neural activities (Fink et al., 2018). Based on these studies, practical recommendations for creativity training and testing have extensively been proposed in recent years (e.g., Memmert, 2015a, 2021).

However, none of these studies has investigated if enhanced DT transfers to more creative actions on-field. We have addressed this research gap (Zahno & Hossner, 2020; Zahno, 2022) and investigated the relationship between players' DT scores and on-field performance in *youth* football (under-12, under-13, under-19). Our results suggest that creative on-field actions are much more enabled by players' motor-skill repertoire than their capacity to generate ideas (as assessed in DT tests). To date, however, there are no data on the role of idea generation (DT) and motor skills for creative actions of adult, top-level players.

4. Research design and strategy

4.1 Study design

In the current project, the outlined research questions are answered in a correlational study design. Specifically, players' (1) potential for on-field creativity, (2) their motor-skill level and (3) their DT ability, assessed with a standardised, football-specific DT test were measured at a single measurement point. As illustrated in Figure 1, we analysed the correlations between players' on-field creativity and their DT scores (Research Question I) as well their motor-skill level (Research Question II). This design appears to be adequate both conceptually (cf. Zahno, 2022) as well as in terms of feasibility with elite players.

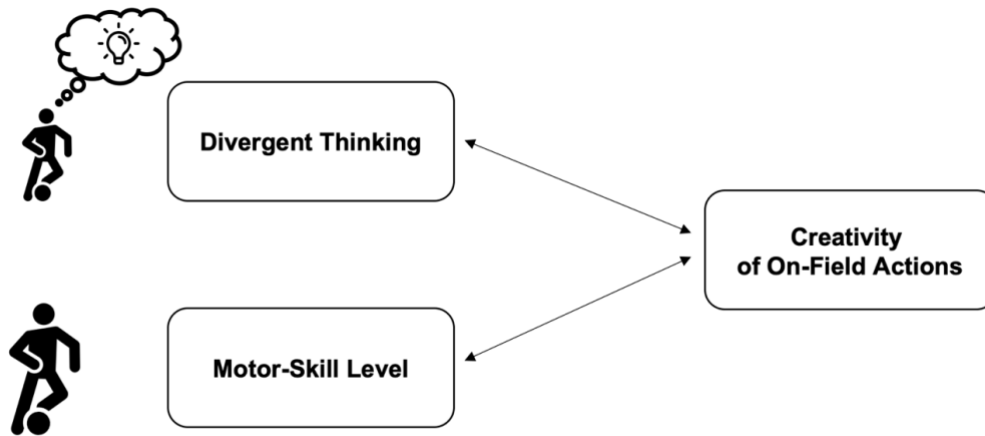


Figure 1- Study design.

4.2 Sample frame and size

In total, 35 top-level football players participated in this study. Two groups of players were assessed: (1) Footuro-players ($N = 15$). Footuro is a program for the most talented players in Switzerland aged between 16-21. Footuro-players are either at their last step before the professional level or already playing at professional level. They are members of youth national teams and train in different professional clubs across Switzerland. (2) U21 players of the BSC Young Boys ($N = 20$). The BSC Young Boys is a professional football club based in Bern, Switzerland. Players of the U21 are elite players at a very high level and train on daily basis (for an overview of the discussed data collection arrangement, see Appendix 3 on p. 38). Players of all positions except goalkeepers and injured players participated in the study.

4.3 Key variables for quantitative work

To answer the research questions, three measures were required: players' (1) potential for on-field creativity, (2) motor-skill level, and (3) DT ability. Data to calculate the three measures were collected in individual sessions (one player, one researcher) of 45 minutes.

Measure 1: On-field creativity

To assess players' potential for on-field creativity, a standardised rating procedure was developed. Players were shown a list of names of their teammates with the following question:

Please rank all players of your team according to their creative potential on the field.

The players' task was to rank all players of their team (including themselves) on a tablet per "drag and drop". We used LimeSurvey (see Figure 2) as a software to implement the rating procedure. Importantly, we ensured the players and guaranteed (in a written consent) that their answers remain anonymous and are exclusively used by the researchers for data analysis. Thus, each player was ranked 20 times in total. To examine the reliability of the obtained measure, the agreement between the rankings were quantitatively checked using Intra-Class Correlations (ICC). After the check, a score for each players' on-field creativity was calculated based on average rankings.

This complete procedure applies to all U21-players of the BSC Young Boys. To assess the Footuro-players the exact same rating procedure was used; however, with the difference, that the players did not rate each other. As the Footuro-players all play in different teams and age groups, they do not know each other's current level well enough to conduct the ranking procedure. Thus, the Footuro-players were only rated by their talent managers and coaches ($N = 2$) who have the experience and knowledge to provide a valid rating of the players' current capacities. Again, the ICC was calculated to check the agreement.

Measure 2: Motor-skill level

To assess players' motor-skill level, a similar ranking procedure (Figure 2) was used as for measure 1. Here, players were asked to rank all their teammates according to their motor skills.

Again, players were shown a list of names of their teammates with the following question:

Please rank all players of your team according to their technical potential on the field.

As for measure 1, an ICC-check was conducted before aggregating motor-skill score for each player based on average rankings.

Question in German and French

List of Players

Conduct raking by drag and drop to this space

Figure 2 - Rating process in LimeSurvey.

As illustrated in Figure 3, the output of both rating procedures consists of date, the raters' name, and the names of each player with his assigned rank. The output was subsequently exported to excel.

Zeige Antwort ID 1	
[submitdate] Absendedatum	25.11.2022 10:25:51
Abgeschlossen	Y
[id] Antwort ID	1
[startlanguage] Start-Sprache	de
[startdate] Datum gestartet	25.11.2022 10:24:56
[datestamp] Datum letzte Aktivität	25.11.2022 10:25:51
[Frage01] Schreibe bitte deinen Vor- und Nachnamen ins Feld.	test
[Frage02_1] Rangiere deine Mitspieler nach ihrer technischen Fähigkeit auf dem Spielfeld. (Von oben = höchste technische Fähigkeit, nach unten = niedrigste technische Fähigkeit) Classez vos coéquipiers en fonction de leurs compétences techniques sur le terrain. (Du haut = capacité technique la plus élevée, au bas = capacité technique la plus faible) (Rank 1)	Ben Schläppi [A21]
[Frage02_2] Rangiere deine Mitspieler nach ihrer technischen Fähigkeit auf dem Spielfeld. (Von oben = höchste technische Fähigkeit, nach unten = niedrigste technische Fähigkeit) Classez vos coéquipiers en fonction de leurs compétences techniques sur le terrain. (Du haut = capacité technique la plus élevée, au bas = capacité technique la plus faible) (Rank 2)	Aaron Appiah [A1]
[Frage02_3] Rangiere deine Mitspieler nach ihrer technischen Fähigkeit auf dem Spielfeld. (Von oben = höchste technische Fähigkeit, nach unten = niedrigste technische Fähigkeit) Classez vos coéquipiers en fonction de leurs compétences techniques sur le terrain. (Du haut = capacité technique la plus élevée, au bas = capacité technique la plus faible) (Rank 3)	Jacel Rhodes [A19]
[Frage02_4] Rangiere deine Mitspieler nach ihrer technischen Fähigkeit auf dem Spielfeld. (Von oben = höchste technische Fähigkeit, nach unten = niedrigste technische Fähigkeit) Classez vos coéquipiers en fonction de leurs compétences techniques sur le terrain. (Du haut = capacité technique la plus élevée, au bas = capacité technique la plus faible) (Rank 4)	David Piffero [A18]
[Frage02_5] Rangiere deine Mitspieler nach ihrer technischen Fähigkeit auf dem Spielfeld. (Von oben = höchste technische Fähigkeit, nach unten = niedrigste technische Fähigkeit) Classez vos coéquipiers en fonction de leurs compétences techniques sur le terrain. (Du haut = capacité technique la plus élevée, au bas = capacité technique la plus faible) (Rank 5)	Junior Eyamba [A7]

Figure 3 - Output ranking in LimeSurvey.

Measure 3: Divergent thinking

To assess players' DT, we employed a standardised DT test as used in numerous published studies (e.g., Memmert et al. 2013). The DT test was video based. In the test, players were shown 20 videos of attacking game situations on a tablet. Each situation lasted about 10 seconds before stopping at a critical decision moment. The player's task was to imagine himself as the player in ball possession and, first, to name all solution ideas that he could think of within 45 seconds, and finally, to name the option he would choose in the situation (for task instructions, see Appendix 1 on p. 35). From the players' responses, three DT score components were assessed: fluency (the number of ideas generated for each situation), flexibility (the number of different categories of ideas generated for each situation; namely, shot on a goal, dribbling, short pass, feint followed by a pass, lob, cross) and the originality of ideas (the unusualness of ideas generated for each situation, cf. Memmert et al., 2013). The ideas' originality and decision-making values are based on a rating of three independent experts (coaching experience: $M = 12.6 \pm 5.5$ years, UEFA-A licenced coaches) on a scale from 1 – 5 (1 = not original, 5 = very original). The three ratings were averaged to obtain an originality value for every solution (ICC = .78). Following the standard procedure in the field, the three components were z-standardised and averaged to obtain a DT score for every player, representing their idea generation capacity.

4.4 Hypothesis and analysis strategy

Hypothesis: Top-level players' potential to perform creative actions is better explained by their *motor-skill* level than their capacity to *generate ideas* (i.e., their DT score).

Due to the applied ranking procedure for the motor-skill and on-field creativity level, Spearman correlations (r_s , one-tailed) were calculated to quantify (1) the relationship between players'

on-field creativity and their DT score and (2) the correlation between players' on-field creativity and their motor-skill level. To facilitate the interpretation, players' performances in DT are also presented as ranks. The significance level was a priori fixed at $\alpha = .05$. As a direct answer to the research questions, we report Spearman correlation coefficients (r_s), p -values and illustrate the relationships graphically with scatterplots.

4.5 Validity and reliability

Reliability checks were performed after completion of the data collection. For the DT test, 20 % of the data collected were independently classified by two researchers. A very high agreement (ICC = .99) indicated that the DT test scoring procedure was reliable and objective. For the rating procedures, the agreement between raters (players, coaches and talent managers) were sufficient for both the motor-skill level rating (Footuro; ICC = .73, BSC Young Boys; ICC = .66) and the on-field creativity rating (Footuro; ICC = .74, BSC Young Boys; ICC = .60).

4.6 Ethical issues

There are no ethical issues to be reported. The study was conducted in accordance with the Declaration of Helsinki and approved by the Faculty Ethics Committee. Furthermore, we ensured the players in the written consent that their test performances remain anonymous and will not be used in any selection procedures.

5 Overview of milestones

5.1 Milestone Phase 1 – Preparation

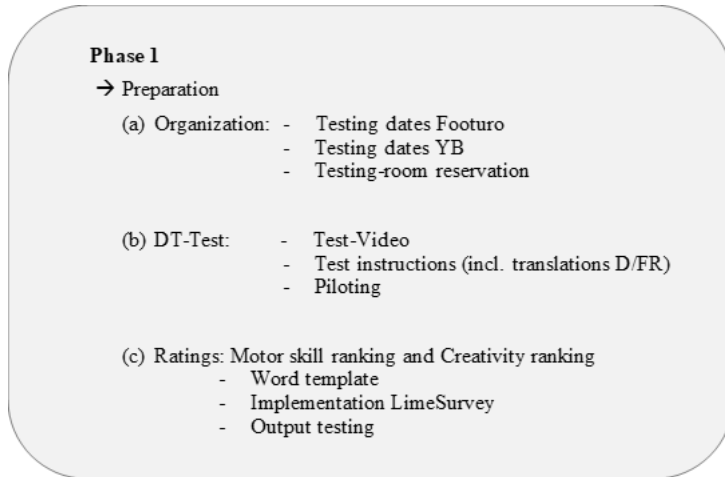


Figure 4 - Project Plan Phase 1.

In Phase 1, the process preparation was started by (a) organising the testing dates for the Footuro- and BSC Young Boys-players and (b) developing the test and rating procedures. A major part was the preparation of the test-videos and instructions for the DT test. Here, we were able to build upon test material from our previous studies (Zahno & Hossner, 2022). Minor changes to the instructions had to be implemented, piloted and validated due to (1) different population and (2) slightly different explanation concerning the task. Furthermore, many players participating in the study were French speaking. Therefore, the instructions were translated from German to French by professionals (see Appendix 1 and 2 on p. 35-37). After preparing the test, videos and instructions were piloted with a small sample of sport students from the University of Bern.

Furthermore, the motor-skill level and on-field creativity rankings were developed, designed, and piloted in LimeSurvey. To avoid tendencies of rating due to the initial position of the names, we made sure that for every player the names are arranged randomly.

5.2 Milestones Phase 2 – Execution

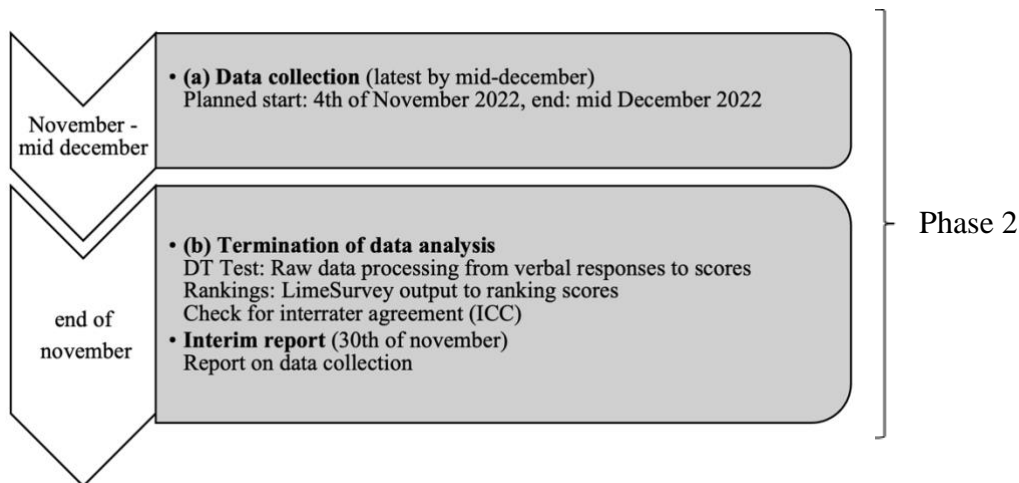


Figure 5 - Project Plan Phase 2.

After a successful preparation, the data collection started on the 4th of November 2022 and was ongoing to the 14th of January 2023. After the data collection, the next step was the raw data processing (a) from verbal responses to aggregated DT scores for all players as well as (b) from LimeSurvey output data to on-field creativity and motor-skill scores, followed by checking the interrater agreement (ICC).

5.3 Milestones Phase 3 – Finalisation

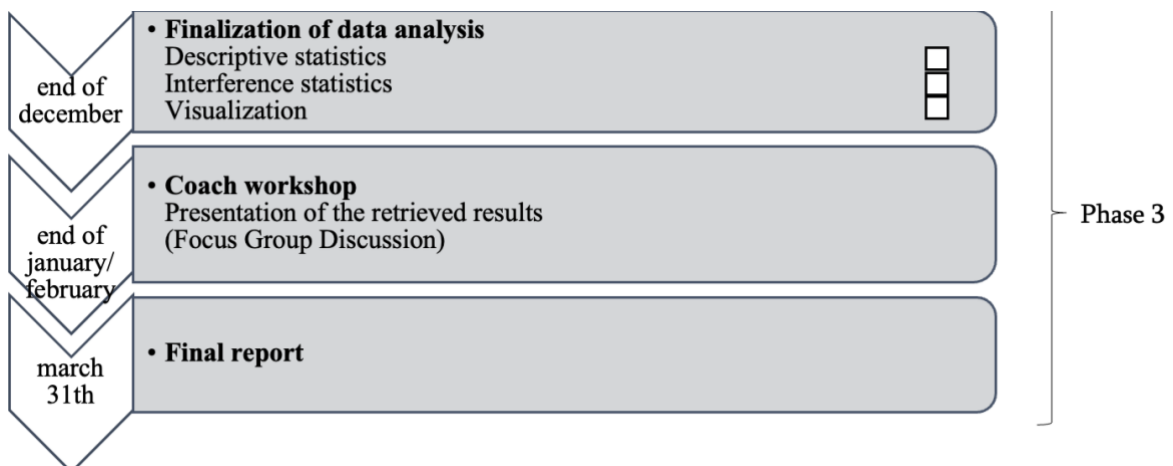


Figure 6 - Project Plan Phase 3.

After raw data processing, descriptive and interference statistics were calculated to test the hypotheses and conduct further explorative analysis. Moreover, the results were visualised to prepare for the coach's workshop. The aim of the workshop was to communicate the study results, to discuss practical implications and elaborate guidelines with expert coaches in a collaborative process. The exchange of information was held in form of a focus group discussion.

6. Overview of the main research findings

This chapter will provide the results of the research questions formulated in chapter 2 and further analysis that gives a deeper understanding of the collected data.

6.1 Systematic evaluation of current creativity test

6.1.1 Main analysis

- (1) Do top-level players' performances in DT tests (measuring *idea generation* capacity) correlate with their potential for on-field creativity?

As shown in Figure 7, no positive correlation between DT scores and on-field creativity was found; neither for the Footuro- ($r_s = -.12, p = .67$; left) nor for the BSC Young Boys-players ($r_s = -.16, p = .51$; right).

These results, indicating no correlation between DT test scores and on-field creativity, challenge the validity of the DT tests as a measure of players' football-specific creativity, as it has been used in previous studies (e.g., Memmert, 2011) and has been proposed for talent assessment (Memmert, 2015b).

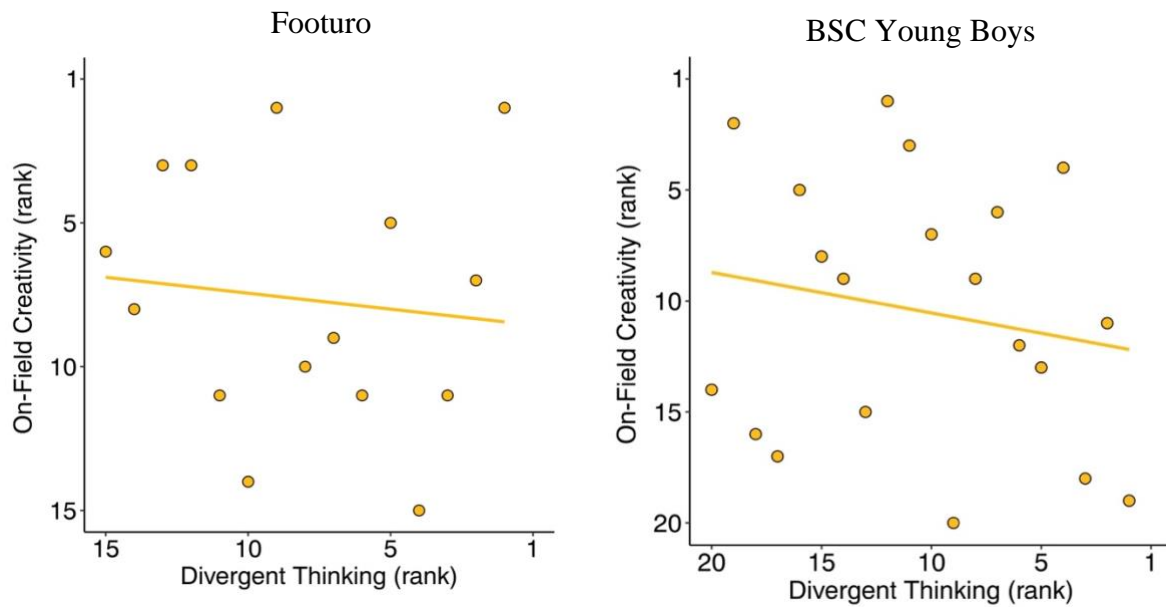


Figure 7- Relationship between on-field creativity and players divergent thinking scores for the Footuro- (left) and BSC Young Boys-players (right).

(2) Does top-level players' *motor-skill* level correlate with their potential to perform creative actions?

As illustrated in Figure 8, a large correlation between players' motor-skill level and on-field creativity was observed for both Footuro- ($r_s = .97, p < .01$; left) and BSC Young Boys-players ($r_s = .90, p < .01$, right).

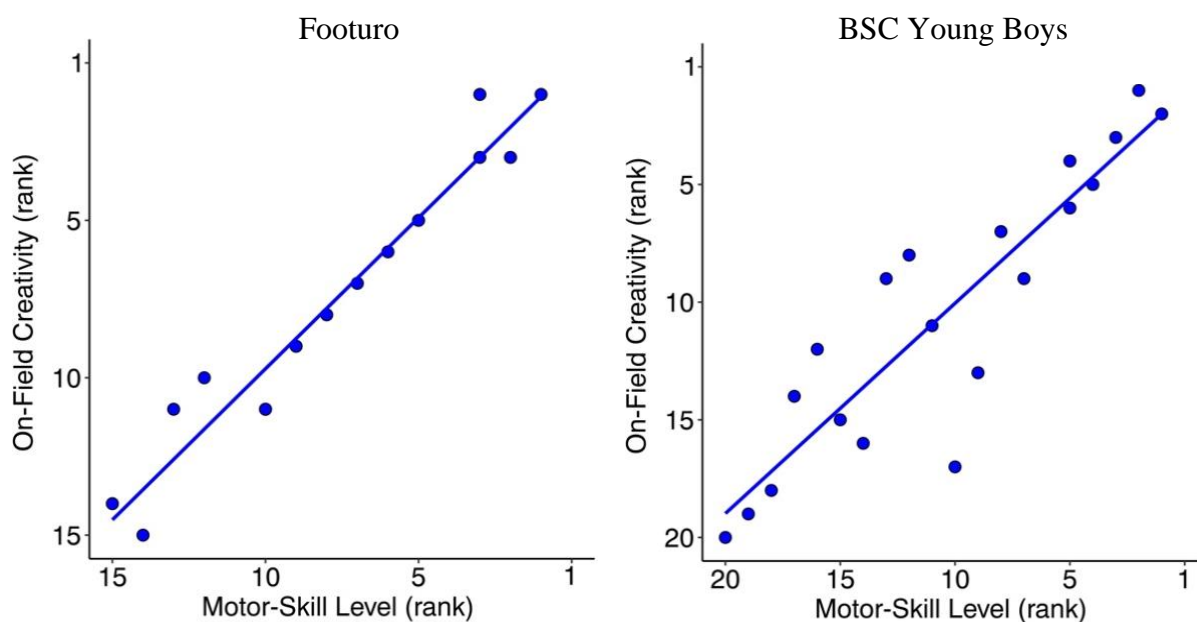


Figure 8 - Relationship between on-field creativity and players' motor-skill level for Footuro- (left) and BSC Young Boys-players (right).

Overall, in both Footuro and BSC Young Boys the results show, that the on-field creativity is better explained by the player's motor-skill level than by the DT score (see Figure 9). In Figure 9, the combined plots of results of Research Question I and II are combined for a better overview.

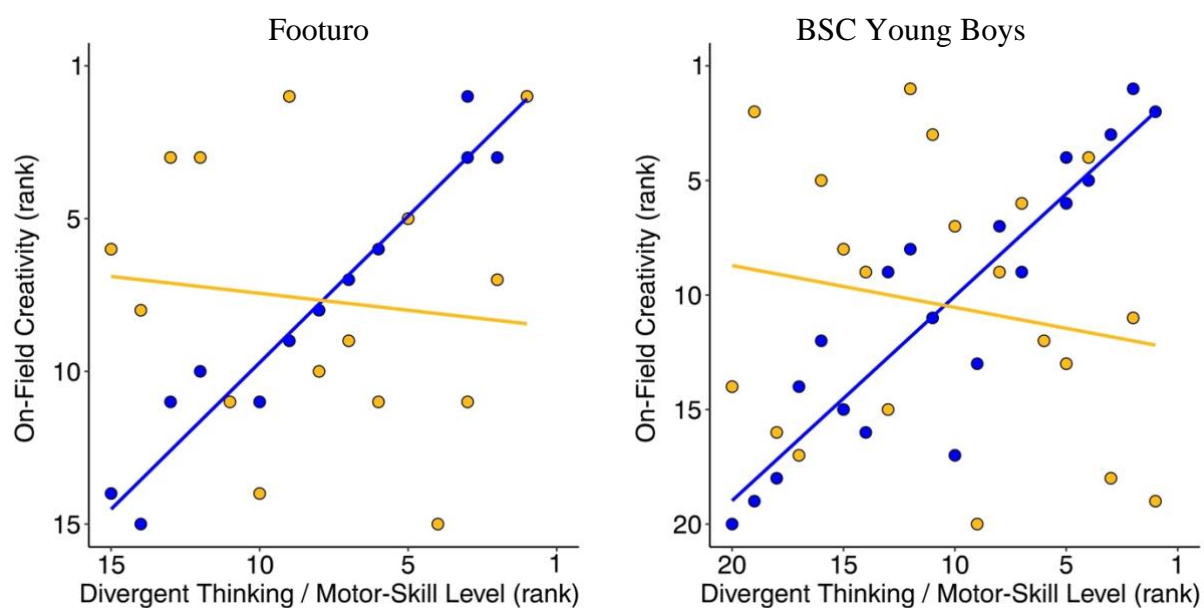


Figure 9 - Combined plot of Figure 7 and 8 for Footuro- (left) and BSC Young Boys-players (right).

6.1.2 Further analysis

In addition to testing the specific hypotheses outlined in the project, we conducted a range of further explorative analyses on the data. These are presented in the following paragraphs.

6.1.2.1 Correlation DT score and motor-skill level

Shown in Figure 10, no positive correlation between the DT score and players' motor-skill level were found for Footuro- ($r_s = -.12$, $p = .66$) and BSC Young Boys-players ($r_s = -.16$, $p = .50$).

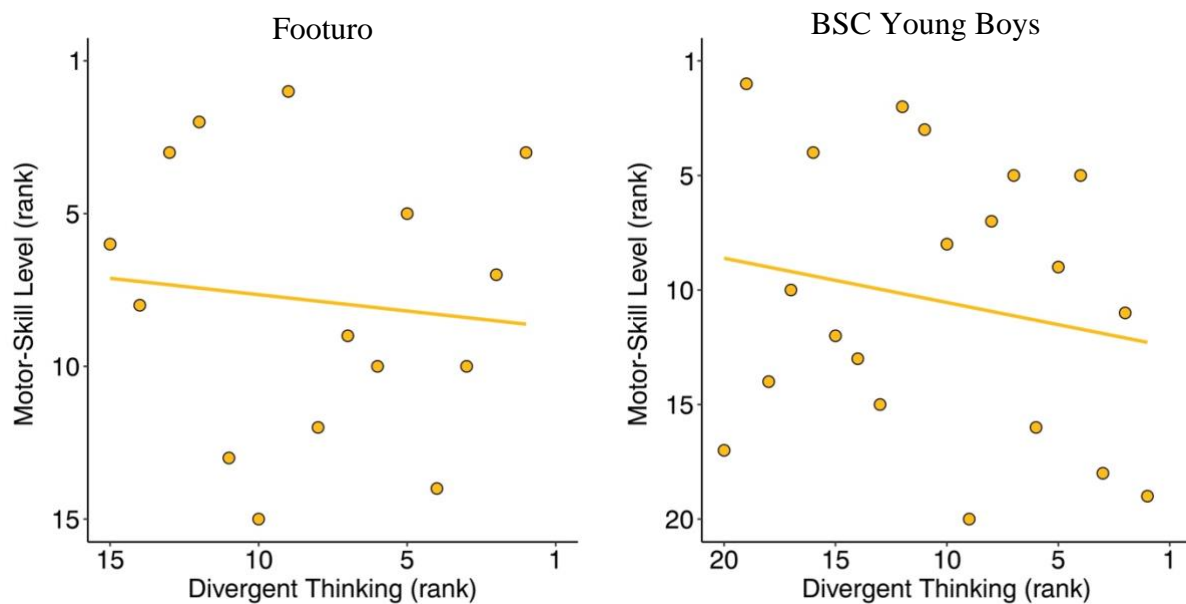


Figure 10 - Relationship between players' motor-skill level and divergent thinking scores for the Footuro (left) and BSC Young Boys players (right).

6.1.2.2 Comparing DT scores between Footuro- versus BSC Young Boys-players

To compare DT test scores between the two measured teams (Footuro vs. BSC Young Boys), we recalculated the DT scores and ranked them as one whole group. A two-tailed t-test was conducted to check if there is a significant difference in mean rank between the two groups. The t-test shows no significant difference between the two groups mean rank ($p = .28$). By trend, Footuro-players were slightly ranked higher in the DT test in comparison to the BSC Young Boys-players (see Figure 11).

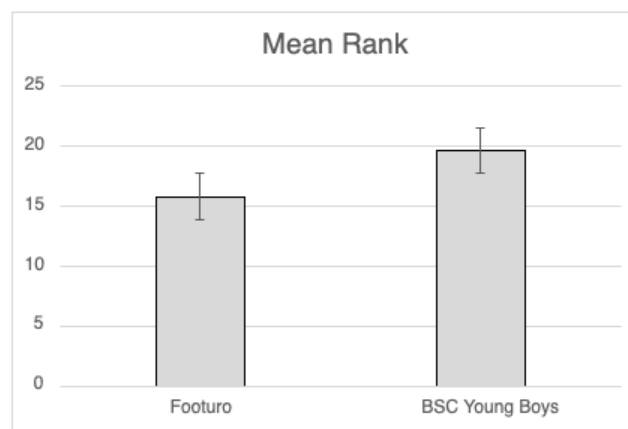


Figure 11 - T-test of mean rank between Footuro- and BSC Young Boys-players.

6.1.2.3 Correlation DT score and decision-making quality

As mentioned in chapter 4.2, we not only asked the players to generate as many ideas as possible (DT), but also to name the option they would finally choose. The player's answer was rated in terms of originality and decision-making quality. Given the results from the main findings, where no positive correlation between the DT score and creativity could be found, it now seems interesting to see if there is any correlation between the DT score and the originality and quality of options the players selected. In this context, we must keep in mind that a creative action does not necessarily represent the best solution in given situation. The results are shown in Figure 12. In regard to the originality of the decision, no correlation to the DT score was

found in the Footuro group ($r_s = .04, p = .89$) while a moderate and significant correlation ($r_s = .50, p = .02$) could be observed in the BSC Young Boys group. Regarding decision-making quality, no correlation with the DT score was found for the BSC Young Boys group ($r_s = .02, p = .95$) while even a negative correlation could be observed in the Footuro group ($r_s = -.24, p = .39$).

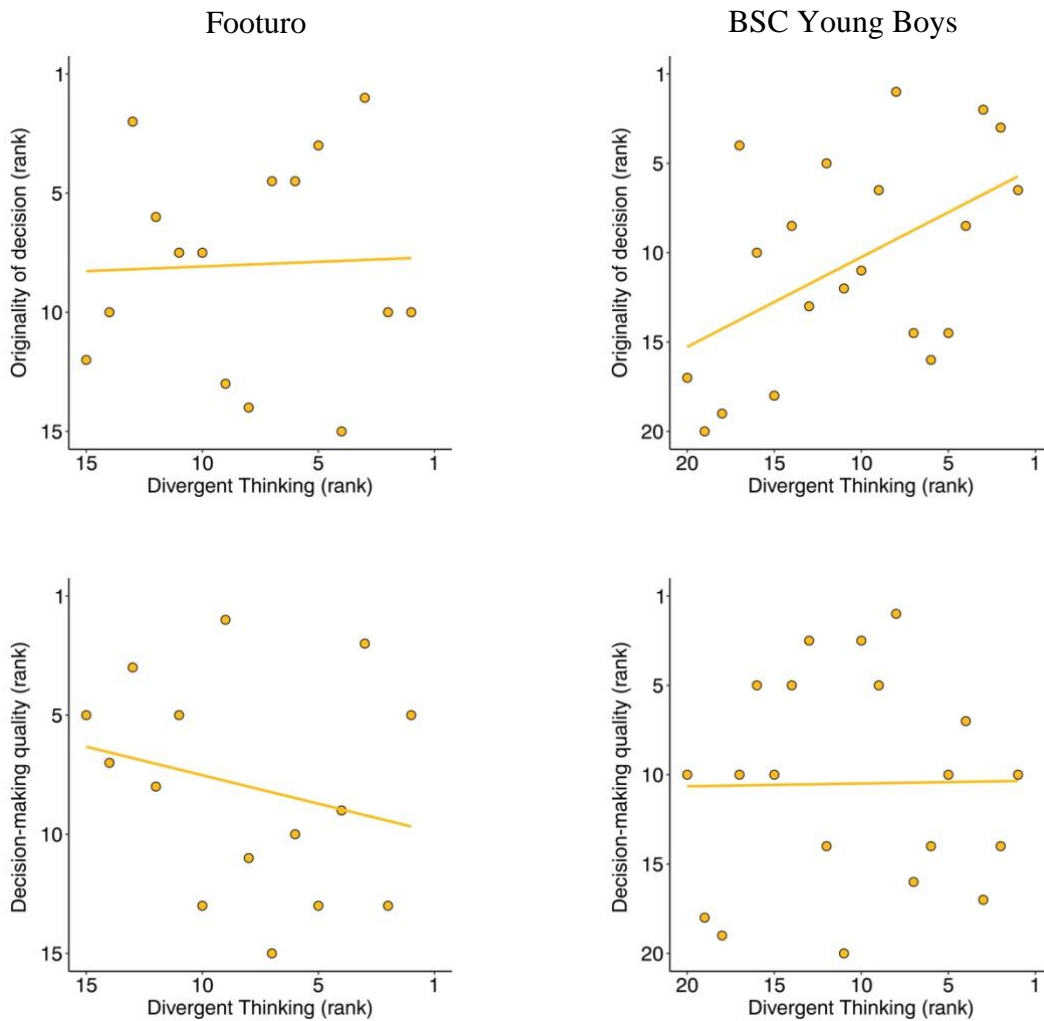


Figure 12 – Relationship between DT score and Originality of decision for Footuro- (top left) and BSC Young Boys-players (top right). And the relationship between DT score and Decision-making quality for Footuro- (bottom left) and BSC Young Boys-players (bottom right).

6.1.2.4 Correlation of the three DT score components

From a methodological and test development perspective, it is also interesting to see how the three DT-components (Fluency, Originality and Flexibility) that define the DT score correlate with the overall DT score and within each other. Therefore, the correlations for each condition were calculated and are shown in Figure 13 and 14.

Footuro:

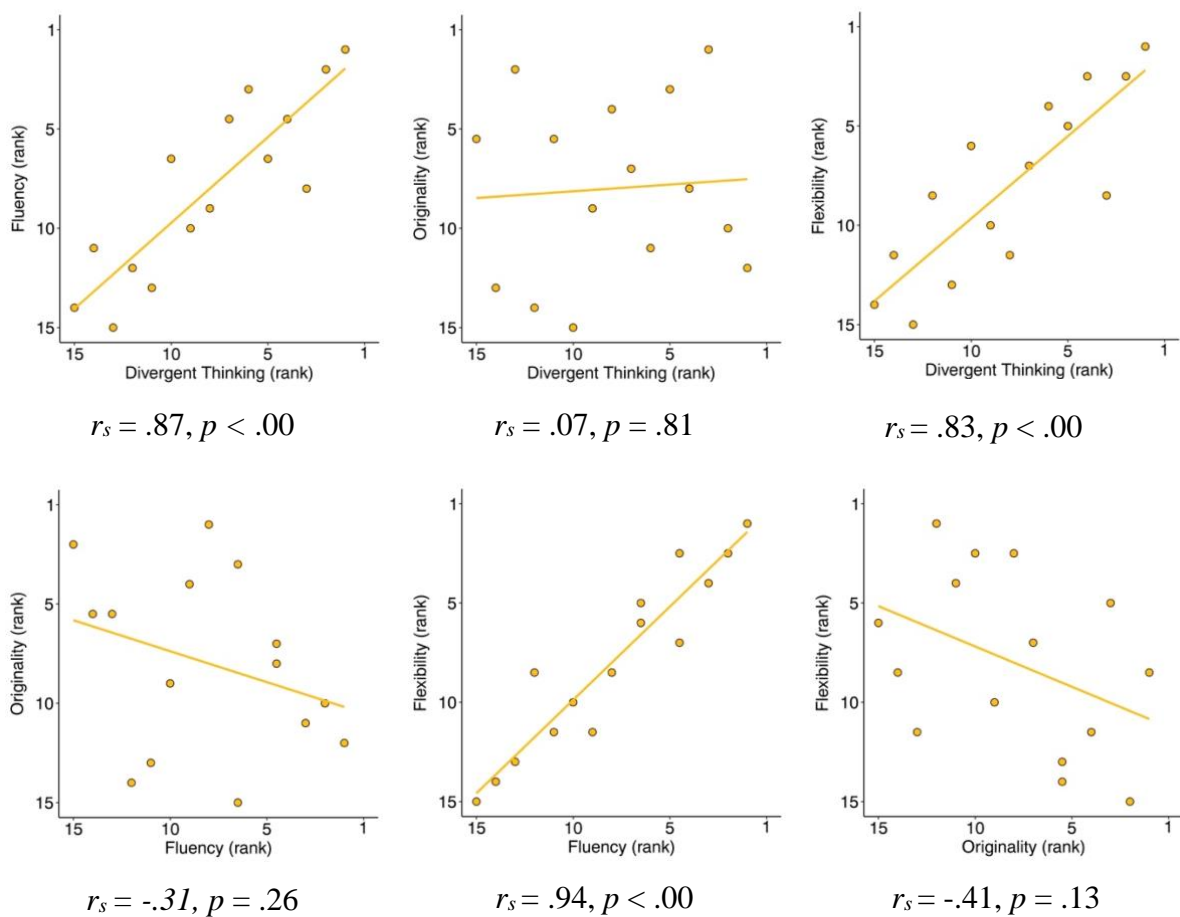


Figure 13 - Plots of relationship between DT score and the three single components of the DT score and single components within each other (Fluency, Originality and Flexibility) in Footuro-players.

Overall, there are three relationships with significant and large correlations (DT and Fluency, DT and Flexibility, Fluency and Flexibility). The relationship between the DT score and

Originality (top row, centre plot), however, is small and not significant. The results from the DT scores of the BSC Young Boys show a similar pattern (see Figure 14), except from the relationship between the DT score and Originality (top row, centre plot), Originality and Fluency (bottom row, left) and Flexibility and Originality (bottom row, right).

BSC Young Boys:

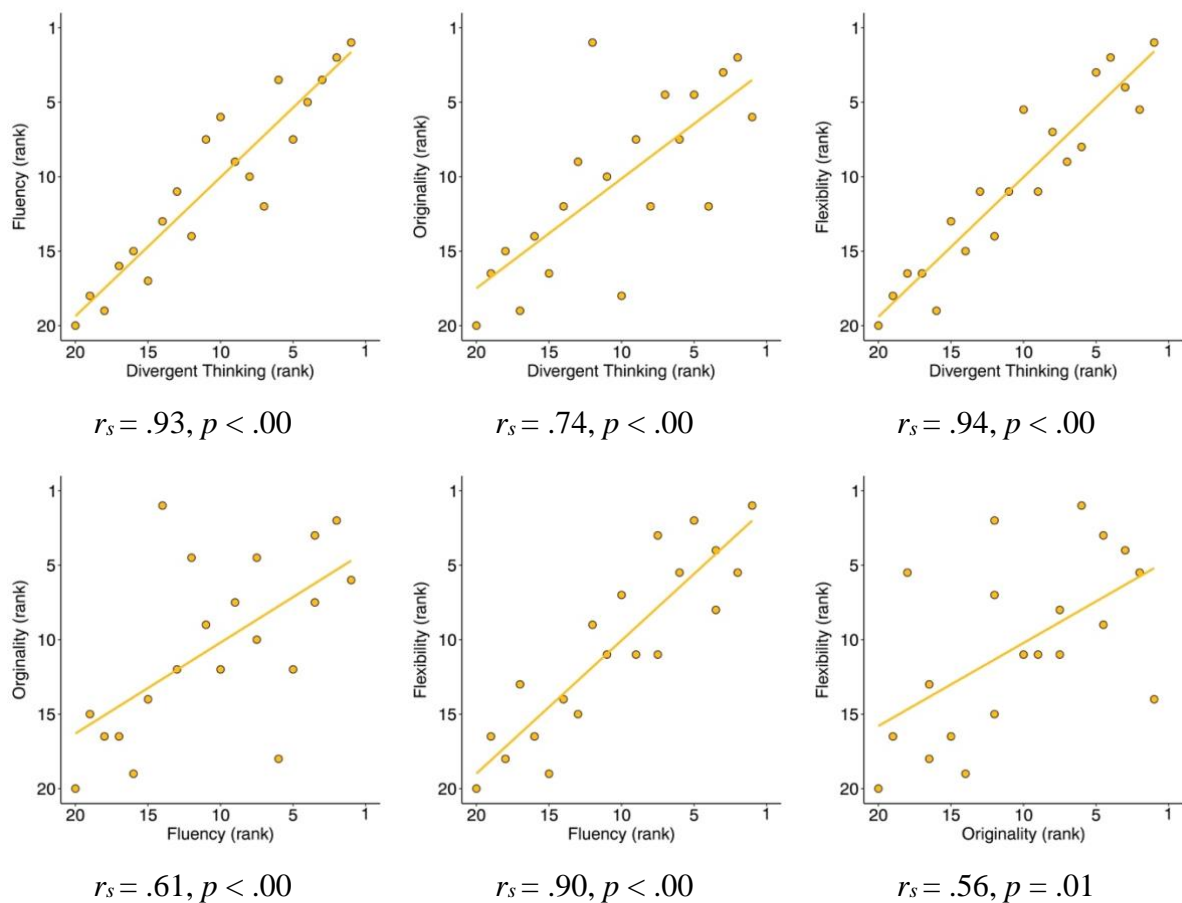


Figure 14 - Plots of relationship between DT score and the three single components of the DT score and single components within each other (Fluency, Originality and Flexibility) in BSC Young Boys-players.

6.1.2.5 Is the relationship between DT and on-field creativity dependent on motor skills?

Overall, no positive correlations were found between players' DT scores and on-field creativity. However, is it possible that the relationship between DT and on-field creativity is

more pronounced for the players at the highest levels of motor-skill? To test this idea, we analysed the correlations when only considering the top 10 players in terms of motor-skill level. This selection of top-players did not change the pattern of results (Footuro, $r_s = -.10$; BSC Young Boys, $r_s = -.06$).

6.1.3 Discussion and practical implications

In the present study, two approaches to explain creative actions in football were contrasted and put to empirical test with elite players. Firstly, the study indicates no relevant correlations between players' DT score and their on-field creativity. Secondly, a large correlation between players' motor-skill level and on-field creativity was observed. Taken together, the results challenge the DT approach to explain creative actions. Specifically, the lacking positive correlation between performances in the DT test and on-field creativity questions the validity of DT tests as a measure of players' football-specific creativity, as has been used in previous studies (e.g., Memmert, 2011) and has been proposed as a talent assessment tool (e.g., Memmert, 2015a). In contrast, the results support the alternative hypothesis that creative actions are grounded in players' own options in action, with heavily depend on their motor skill (Zahno & Hossner, 2022; Zahno & van der Kamp, 2022).

Importantly, this does not imply that the emergence of creative actions can be solely attributed to motor skill. Other factors, such as environmental opportunities (e.g., Caso & van der Kamp, 2020) and psychological factors like motivational states (e.g., Amabile, 1985) also impact a players' options in specific situations and thus the possibility for creative actions. Notably, our study does not rule out that DT may contribute to creative behaviour to some extent, albeit not as the primary factor. Our findings do, however, challenge the notion of equating DT with creativity on a conceptual level (cf. Memmert, 2015b) and the use of DT tests as the sole

predictor of creativity in empirical studies (cf. Memmert et al., 2013) and for performance and talent assessment in practice. For training, our findings suggests that motor skill trainings targeted at expanding players' action repertoire in specific situations are an effective approach to encourage creative actions in team sports. Conversely, training programs aiming at enhancing a players' DT are not likely to result in significant improvements in on-field creativity.

To conclude, our results suggest that football-specific DT tests – in the form they are currently used in sport science and popularly recommended to practice – are not valid as a measure of players' on-field creativity. Beyond this particular study, no other studies have so far indicated that a high score in the DT test is correlated with any measure of on-field creativity. More generally – and beyond creativity – the finding highlights the need to critically evaluate further off-field tests in football, which aim to capture players' capacities in cognitive components, in terms of their transfer to on-field performance.

For training, studies have shown that DT, as such, can be improved by implementing designated training principles. However, no indication of a positive transfer from improvements in DT to creative on-field actions could be observed. Instead of seeking ways to train DT, the present findings suggest that a more promising strategy is to aim to extend players' motor skills to solve specific situations in many ways. A larger action repertoire, in turn, allows highly skilled players to perform functional and creative solutions in action.

6.2 Development of practical guidelines

In a focus group discussion with three experts, the results of this study were presented and discussed in-depth. The main topic was to debate how the gained information of this study can be implemented into practice.

6.2.1 Testing

In the focus group discussion, there was a clear consensus among the experts that the validity of the proposed creativity tests – in its current form – should be critically considered. For the development of future performance tests, four inputs were elaborated. First, in most cases, *on*-field tests including representative game demands should be prioritized over *off*-field tests aiming to capture specific cognitive components in isolation. Second, novel opportunities for football-specific off-field tests using video-based or virtual reality technologies should be closely followed and evaluated. In doing so, two aspects seem important: (a) to systematically evaluate the tools with on-field-transfer tests and (b) to clearly define which functional aspect of performance is targeted in the test and how it is representative and/or transferable to behaviour on the field. Third, taking specific football situations is a more promising starting point for test developments than taking established psychometric tests and aiming to transfer them to the domain of football. Fourth, several key components were identified that appear key for future tests and were missing the examined creativity test: (1) the test should include motor responses (vs. naming solutions), (2) the players should view the situation from a natural first-person perspective (vs. third-person perspective), (3) the players should have the opportunity to actively create situations (vs. passively react to situations) and (4) the task should include time constraints that are similar to game demands (vs. having 45 s).

6.2.2 Training

Previous studies (e.g., Zahno & Hossner, 2022) indicated that DT, as such, can indeed be improved by implementing designated training principles found in the current literature (e.g., Memmert, 2015b). However, no indication of a positive transfer from enhanced DT to on-field creativity could be observed in empirical studies so far. Consequently, based on the present

data and discussions with experts, limited transfer to on-field creativity can be expected from creativity trainings dedicated to improving players' DT.

Instead of seeking ways to train DT, the present findings suggest that a more promising strategy is to aim to extend players' skill repertoire in order to solve specific situations in many ways. An enhanced action repertoire, in turn, allows players to act creatively on-field. In collaboration with the expert coaches, guidelines for the design of functional motor skill trainings were elaborated and summarised in five points: (1) Trainings should take specific situations and task demands as a starting point; (2) players should be encouraged to gather task-specific experiences and to explore different – functional – solutions to solve the situational task; (3) players should experience many repetitions of representative situations under variable conditions; to this end, the coach should systematically manipulate task-relevant constraints (e.g., distances and angles between players, numerical imbalances etc.). Varying task-constraints “forces” the players to continuously adapt, find functional – and potentially novel – solutions. (4) When players are confronted with representative tasks, coaches should focus their instructions on movement effects, i.e., outcomes (e.g., to bring the opponent off-balance) vs. on ideal techniques on how to do so. (5) The exercises should be implemented with a mix of drills and small-sided games. However, also in drill-based exercises the link to the game situation should always be apparent for the coaches and the players and the exercises should always contain a decision-making element. In sum: techniques should always be seen as tools to solve situations. Acquiring a large toolbox with a wide variety of tools is the basis for on-field creativity.

7. Limitations

For our study, the reliability of our measures are fundamental to provide valid answers to the research questions. Two of our main measures (on-field creativity and motor-skill level) are based on expert ratings. While these remain subjective, we are confident that they provide a valid and reliable indicator for our variables. For the BSC Young Boys-sample, we are confident to achieve high reliability due to the large number of ratings. Specifically, each players' rating-score is based on ratings of 20 raters, which provides a robust estimate. For the Footuro-sample, it was more difficult. Each players' rating-score is based on ratings of two experts only. However, the two experts know the players very well and the agreement between their individual rating were sufficient. Thus, we are confident that our procedure led to indicators for the players' on-field creativity and motor-skill level that are valid to answer our research questions. Overall, we are convinced that the obtained data of these top players yield valuable insights for football coaches, clubs and associations.

8. Impact of the research

Developing creative players is a key objective in talent promotion. The current UEFA research project offers: (1) A research-based evaluation of currently available football-specific creativity tests, which provides a basis for the decision: should we, as a coach, club or association implement this test? (2) Knowledge on the role of motor skills and idea generation in top-level players, which provides a theoretically and empirically sound foundation for the development of effective programmes. Furthermore, it extends the current state of research in sports science. (3) Practical inputs for the development of programmes for creativity testing and training, which were elaborated based on an integration of the current scientific literature,

the results of the present studies and valuable practical inputs from highly experienced football coaches.

All steps of the projects were conducted in close collaboration with the Swiss FA. Thus, there was a continuous knowledge exchange: from the scientific project to practice and from practice to the scientific project. Additionally, the project was presented and discussed at various meetings of the Swiss FA with coaches of different regions, levels and age groups.

Our aim is that the current research helps coaches, clubs and associations in Switzerland as well as internationally to develop, implement and evaluate effective testing and training programmes and, ultimately, to promote more creative football players.

9. References

- Amabile, T. M. (1985). Motivation and creativity: Effects of motivational orientation on creative writers. *Journal of Personality and Social Psychology*, 48(2), 393–399. <https://doi.org/10.1037/0022-3514.48.2.393>
- Baer, J. (2011). How divergent thinking tests mislead us: Are the Torrance Tests still relevant in the 21st century? The Division 10 debate. *Psychology of Aesthetics, Creativity, and the Arts*, 5(4), 309–313. <https://doi.org/10.1037/a0025210>
- Bénézet, J.-M., & Hasler, H. (2018). Youth football training manual. Retrieved from FIFA Education and Technical Development Department website: https://resources.fifa.com/mm/document/footballdevelopment/generic/02/86/63/17/fifa_youthfootball_e_neutral.pdf
- Caso, S., & van der Kamp, J. (2020). Variability and creativity in small-sided conditioned games among elite soccer players. *Psychology of Sport and Exercise*, 48, 101645. <https://doi.org/10.1016/j.psychsport.2019.101645>
- Cross, K. (2013). The football coaching process. An official FFA publication. Sydney, Australia: Football Federation Australia. https://websites.mygameday.app/get_file.cgi?id=35723649
- De Sa Fardilha, F., & Allen, J. B. (2020). Defining, assessing, and developing creativity in sport: A systematic narrative review. *International Review of Sport and Exercise Psychology*, 13(1), 104–127.
- Fink, A., Rominger, C., Benedek, M., Perchtold, C. M., Papousek, I., Weiss, E. M., Seidel, A., & Memmert, D. (2018). EEG alpha activity during imagining creative moves in soccer decision-making situations. *Neuropsychologia*, 114, 118–124
- Furley, P., & Memmert, D. (2015). Creativity and working memory capacity in sports: working memory capacity is not a limiting factor in creative decision making amongst skilled performers. *Frontiers in Psychology*, 6(115). <https://doi.org/10.3389/fpsyg.2015.00115>
- Guilford, J. P. (1967). The nature of human intelligence. McGraw-Hill.
- Hristovski, R., Davids, K., Araújo, D., & Passos, P. (2011). Constraints-induced emergence of functional novelty in complex neurobiological systems: a basis for creativity in sport. *Nonlinear Dyn. Psychol. Life Sci.* 15, 175–206.

- Hüttermann, S., Memmert, D., & Nerb, J. (2019). Individual differences in attentional capability are linked to creative decision making. *Journal of Applied Social Psychology*, 49, 159–167.
- Kaufman, J. C., Plucker, J. A., & Baer, J. (2008). *Essentials of creativity assessment*. John Wiley & Sons.
- Kempe, M., & Memmert, D. (2018). ‘Good, better, creative’: The influence of creativity on goal scoring in elite soccer. *Journal of Sports Sciences*, 36, 2419–2423.
- Memmert, D. (2006). Developing creative thinking in a gifted sport enrichment program and the crucial role of attention processes. *High Abil. Stud.* 17, 101–115. doi: 10.1080/13598130600947176
- Memmert, D. (2011). Creativity, expertise, and attention: Exploring their development and their relationships. *Journal of sports sciences*, 29(1), 93–102.
- Memmert, D. (2015a). Development of tactical creativity in sports. In J. Baker & D. Farrow (Eds.), *Routledge handbook of sport expertise* (pp. 363–372). Routledge.
- Memmert, D. (2015b). *Teaching tactical creativity in sport: Research and practice*. Routledge.
- Memmert, D. (2021). *The Mental Game: Cognitive Training, Creativity, and Game Intelligence in Soccer*. Meyer & Meyer.
- Memmert, D., Hüttermann, S., & Orliczek, J. (2013). Decide like Lionel Messi! The impact of regulatory focus on divergent thinking in sports. *Journal of Applied Social Psychology*, 43(10), 2163–2167. <https://doi.org/10.1111/jasp.12159>
- Orth, D., van der Kamp, J., Memmert, D., and Savelsbergh, G. J. P. (2017). Creative motor actions as emerging from movement variability. *Frontiers in Psychology*. 8:1903. doi: 10.3389/fpsyg.2017.01903
- Reiter-Palmon, R., Forthmann, B., & Barbot, B. (2019). Scoring divergent thinking tests: A review and systematic framework. *Psychology of Aesthetics, Creativity, and the Arts*, 13(2), 144–152. <https://doi.org/10.1037/aca0000227>
- Roca, A., Ford, P. R., & Memmert, D. (2018). Creative decision making and visual search behavior in skilled soccer players. *PLoS One*, 13(7), e0199381. <https://doi.org/10.1371/journal.pone.0199381>
- Runco, M. A., & Jaeger, G. J. (2012). The standard definition of creativity. *Creativity Research Journal*, 24(1), 92–96. <https://doi.org/10.1080/10400419.2012.650092>

- Zahno, S. (2022). Creativity in elite youth football: Enhancing players' motor skills rather than a divergent thinking ability fosters creative actions [Abstract]. In «Sport & Big Data» -Challenges and opportunities for sport science. 13th annual congress of the SGS/4S. February 9–10, 2022, Lausanne: University of Lausanne.
- Zahno, S. & Hossner, E.-J. (2020). On the issue of developing creative players in team sports: a systematic review and critique from a functional perspective. *Frontiers in Psychology*, 11:575475. doi:10.3389/fpsyg.2020.575475
- Zahno, S., & Hossner, E.-J. (2022). Creative actions in team sports are rooted in motor skills rather than in a divergent thinking ability. *German Journal of Exercise and Sport Research*, <https://doi.org/10.1007/s12662-022-00847-6>
- Zahno, S., & van der Kamp, J. (2022). When insights based on ecological and cognitive theories to movement science converge – The case of creativity in sports. *Frontiers in Psychology*, 13:959599. <https://doi.org/10.3389/fpsyg.2022.959599>

10. Appendix

Appendix 1 – Instructions in German

Kognitiver Test: “Optionen wahrnehmen – Lösungen erkennen”

Material

Wird zur Verfügung gestellt: - Tablet (mit Videodatei DT_Test.mp4/DT_Demovideo_1und2)
- Diktiergerät (Handy)
- Zusatzblatt für Notizen + Spielerliste

Ablauf

- Spieler vor dem Eingang abholen, mit Spieler in den Raum gehen
- Namen nachfragen, Nr (01) auf Zusatzblatt eintragen (NR_Namen_Footuro oder NR_Namen_YB)

Instruktion

«Auf dem Tablet zeige ich dir ein Video mit 20 Offensivsituationen.

In einem bestimmten Moment wird das Video gestoppt – das Standbild bleibt.

Deine Aufgabe ist es, dich in den Spieler in Ballbesitz hineinzusetzen und alle Optionen – also Lösungsmöglichkeiten – aufzuzählen, die dir für diese Situation einfallen. Deine Antworten beziehen sich nur auf die Optionen für den ballführenden Spieler – und nicht auf Folgeaktionen – und du musst deine Antworten auch nicht begründen, sondern nur nennen.

Nachdem du alle Möglichkeiten aufgezählt hast: Nenne mir die Option, die du ausführen würdest.

Dafür hast du immer 45 Sekunden Zeit – das siehst du am Countdown –, dann folgt automatisch die nächste Szene.

Den ganzen Ablauf zeige ich dir gerade an einem Beispiel...

- Demo-Szene (D) auf Tablet starten (DT_Demovideo1)

Hier könntest du z.B. sagen: Pass zurück zum Mitspieler an der Mittellinie; Hacken-Pass zum rechten Aussenverteidiger; Chip in freien Raum hinter die Abwehr usw., bis du keine weiteren Optionen mehr siehst. Am Schluss bevor der Countdown fertig ist, nenne die Option, die DU ausführen würdest (z.B Hackenpass zum rechten Aussenverteidiger).

Dribblings oder direkte Torschüsse sind auch möglich.

Wichtig: Beschreibe zu welchem Mitspieler oder in welchen Raum du spielst. Also nicht nur «zu dem», sondern z.B. «in die Tiefe zum linken Flügelspieler» – und ‘wie’ du denn Ball spielen würdest (z.B. direkt, nach Ballannahme, nach Finte, zuerst Spieler fixieren und binden usw.)

Bitte beschreibe die Optionen, welche dir einfallen kurz und klar.

Deine Antworten nehme ich auf Tonband auf – lass dich aber nicht davon stören, diese brauchen wir nur für die Auswertung und hört ausser uns niemand.

Hast du noch Fragen zum Ablauf?

Dann würden wir nun noch ein zweites Beispielvideo anschauen, welches du gleich durchspielen kannst. → DT_Demovideo_2

- Tonaufnahme starten + Probanden-Nr nennen**
- Test-Video laufen lassen
 - Bitte der/die Testleiter*in bei jeder Szene die Szenen-Nr ansagen
- Nach 40s neutral nachfragen: Und welche Option würdest du auswählen?
- Aktiv zuhören, aber Antworten nicht werten. Notizen machen, wenn Antworten nicht ganz klar sind.
- Nur wenn die Antwort sehr unklar ist nachfragen: «*Meinst du diesen Pass hier?*» Und zeichnest gerade auf das Blatt ein.

Appendix 2 – Instructions in French

Test cognitif : "Percevoir les options - reconnaître les solutions"

Instruction

"Sur la tablette, je te montre une vidéo avec 20 situations offensives.

A un moment donné, la vidéo s'arrête - l'image reste fixe.

Ta tâche consiste à te mettre à la place du joueur en possession du ballon et à énumérer toutes les options - c'est-à-dire les solutions possibles - qui te viennent à l'esprit pour cette situation. Tes réponses ne concernent que les options pour le joueur en possession du ballon - et non les actions consécutives - et tu ne dois pas non plus justifier tes réponses, mais seulement les citer.

Après avoir énuméré toutes les possibilités : Cite l'option que tu exécuterais.

Tu as toujours 45 secondes pour le faire - tu le vois sur le compte à rebours -, puis tu passes automatiquement à la scène suivante.

Je te montre tout le déroulement à l'aide d'un exemple".

➔ Démarrer la scène de démonstration 1 sur la tablette (DT_Demovideo1)

"Ici, tu pourrais par exemple dire : passe en arrière au coéquipier sur la ligne médiane ; passe sur le côté au latéral droit ; longue balle dans l'espace libre derrière la défense, etc. jusqu'à ce que tu ne voies plus d'autres options. A la fin, avant que le compte à rebours ne soit terminé, cite l'option que tu exécuterais (par exemple : passe sur le côté au latéral droit).

Les dribbles ou les tirs directs au but sont également possibles.

Important : décris à quel coéquipier ou dans quel espace tu joues. Donc pas seulement "vers", mais par exemple "en profondeur vers l'ailier gauche" - et 'comment' tu jouerais le ballon (par ex. directement, après contrôle ou amorti du ballon, après une feinte, en fixant d'abord le joueur, etc.)

Merci de décrire brièvement et clairement les options qui te viennent à l'esprit.

Je vais enregistrer tes réponses sur un magnétophone - mais ne t'inquiètes pas, nous n'en avons besoin que pour l'évaluation et personne d'autre ne les entendra à part nous.

As-tu encore des questions sur le déroulement ?

Dans ce cas, regardes maintenant un deuxième exemple de vidéo que tu pourrais jouer tout de suite".

➔ Démarrer la scène de démonstration 2 sur la tablette (DT_Demovideo 2)

Appendix 3 – Data collection arrangement

Table comparing data collection arrangements (1) in the original research proposal, (2) in the kickoff meeting, and (3) the new solution elaborated after in-depth planning with all involved partners

	Subjects	Sample Size	Timings	Measurements	Expected outcomes
(1) original research proposal	Planned with U21-Swiss National Players	26-28	Individual Sessions with players in October and November.	Proposal p. 5-6	Proposal p. 6-7
(2) kickoff meeting	U19-Swiss National Players	22-24	During a gathering on the 24 th -27 th October.	Proposal p. 5-6	Proposal p. 6-7
(3) new solution	(1) "Footuro"-Players; most talented National Players U19 to U21 players (N = 16) (2) U21 players of the BSC Young Boys (N = 20-22)	36-38	(1) During "Footuro" performance test meetings in Magglingen in October and November (exact dates to be confirmed) (2) Individual Sessions before regular trainings sessions (starting 10 th of October, finalized 7 th of November)	Proposal p. 5-6. The measurements are identical to the original research proposal. Additionally , regarding the analysis, having the two groups of investigation allows to compare results of the top-players that are part of the "Footuro"-program for very outstanding players vs. players who are not part of the program (but still at a very high level). Statistically, the between-group differences in players' idea generation capacity will be tested with an independent t-test.	The expected outcomes are identical to the original research proposal. Regarding the additional analysis, we expect no differences in the idea generation test between group (1) and (2). Furthermore, we expect the same pattern of results in both groups. We hypothesize that the potential to perform creative actions on-field is better predicted by players' motor-skill level than by their idea generation capacity!