Abstract

Purpose: The concepts of creativity and intuition have been well studied in isolation, but less is known about their distinctive contributions to option generation in decision making.

Method: We examined the relation between creative and intuitive decision making in two studies—one involving coaches and one involving soccer players—using video footage of real soccer matches. Additionally, we analyzed whether this relation is culture generic or culture specific by conducting matched cross-cultural studies in a European and a South American country.

Results: In Study 1, results indicate a conceptual overlap of creativity and intuition for Brazilian and German soccer coaches. Furthermore, coaches did not differ in their evaluation of creative and intuitive actions of players of both cultures. In Study 2, we found that for both subsamples the total number of generated options was positively correlated with the quality of the first and the final option and that the quality of players' first (intuitive) option was higher than that of options generated later. Moreover, results indicate a positive correlation between a player's creativity score and the quality of the first generated option for the whole sample.

Conclusion: Overall, our findings provide meaningful information regarding athletes' and coaches' option-generation processes in decision making in complex team sports.

Keywords: choice, cognitive process, evaluation, soccer

Creative and intuitive decision-making processes: A comparison of Brazilian and German soccer coaches and players

Top international stars in fast team sport games, such as soccer, are often applauded for their exceptional actions. Players such as Özil and Neymar often seem to make the right decision in almost any game situation. By spectators these decisions are then referred to as resulting from intuitive and creative thinking at the same time, as they are being conducted fast under the constraints of the game and are often surprising to the opponent teams. But can cognitive processes lead to a decision being intuitive and creative at the same time? In this project, we examine what German and Brazilian coaches consider to be intuitive and creative decision making in soccer (Study 1) and whether players' cognitive processes leading to a decision are intuitive and/or creative in terms of cognitive theories.

In cognitive psychology, intuition and creativity in decision making have been examined scientifically (for a review, see Hennessey & Amabile, 2010). Creativity has been defined as a process that creates novel and appropriate solutions (Hennessey & Amabile, 2010), and intuition as a process that produces rapid solutions based on experiences, without deliberately and consciously balancing alternatives (Harteis & Billett, 2013). Conceptually, both constructs of intuitive and creative decision making have in common that before a decision is made, option generation processes are involved, which bring about the options to choose among. These processes differ regarding certain criteria based on which a choice is made—namely in intuition one assumes the first generated option to be the best choice (Johnson & Raab, 2003), whereas in creativity the first generated option is not necessarily considered to be the best one (cf. Memmert, 2015). In this study, we focus on this option-generation process, because it can help shed light on the relation between intuitive and creative processes involved in making decisions. In sports, making a creative and an intuitive decision may result from the same generated option (e.g., when the first, intuitive option generated happens to be the one that is unexpected for the other team) or from different options (e.g., when the first, intuitive option generated is not unexpected or a later generated option is unexpected). In sports, neither an intuitive nor a creative option is good or bad per se as we can envision creative solutions that lead to a goal or not, as well as intuitive

decisions that will result in a goal or not. Thus, the success of creative and intuitive decision making depends on the task or the situation at hand (e.g., Todd et al., 2012).

Previous research in sports has either examined what conditions enable people to decide particularly creatively in various situations (e.g., Memmert, Hüttermann, & Orliczek, 2013) or focused on how people differ regarding their intuitive decision-making processes (e.g., Raab & Laborde, 2011). Yet it is still unclear how creative and intuitive decision-making processes are related, namely whether or how often creative decisions result from intuitive option generation, or vice versa, and how option generation processes interact with each other due to training (Johnson & Raab, 2003). For instance, the difference between Özil's and Neymar's playing style (decision making) might be partly explained by the kind of training they received or by their cultural experience. Previous research on dynamic decision making has found differences in decision making between Germans and Brazilians based on the conditions of the cultural context (Güss & Dörner, 2011). Such cultural differences could be the result of early commitment to a sports club or the "culture of playing in the streets" (cf. Memmert & Roth, 2007). We argue that how sports experts generate options might differ depending on their country of origin. Thus, we examined creative and intuitive option generation in a cross-cultural study design, focusing on the similarities/differences of both concepts.

Option Generation in Decision Making

Over the last decades, decision making has become a well-investigated research area in sport psychology (for a meta-analysis, see Travassos et al., 2013). It is one of the fundamental elements of any sport, especially in fast and dynamic team sport games (Kaya, 2014). Athletes have to continually make decisions in game situations that are highly temporally constrained.

Focusing on the option generation preceding the actual decision is relevant for several reasons: First, the generation of options is one of the key aspects of decision making, as option generation sets the constraints for the decision-making process (Del Missier, Visentini, & Mäntylä, 2015). Moreover, considering option generation allows specifying the relation between the generation and the resulting decisions (Musculus, 2018). In sport, option generation is usually measured by sport-specific option-generation tasks (e.g., Johnson & Raab, 2003; Memmert et al., 2013). In these tasks, participants are shown different offensive situations in

team sports (e.g., handball, soccer). Participants are told to put themselves in the position of the offensive player with the ball and to generate alternative options to continue the play. If a soccer player, for example, does not recognize a possible action as an option, it will not be considered. This indicates that the options generated by a person determine the quality of his/her decision (Sprenger & Dougherty, 2012). Consequently, focusing on the option-generation process can help to better understand the cognitive process leading to intuitive and/or creative decisions in sports.

Creative players, especially in team sports, have been found to be able to generate more original and rare solutions in a playing situation compared to less creative players (Furley & Memmert, 2015). Theoretically, three characteristics describe creativity in sports games, namely, *originality, flexibility*, and *fluency* (Memmert & Roth, 2007). Originality describes the number of *exceptional* (infrequent) solutions (identified by expert raters or statistical sparseness, among other methods) generated by a participant. Flexibility describes the variety of solutions, that is, the diversity of responses (e.g., in soccer: shot on goal, feint followed by a pass, dribble, short pass, lob, cross) given by a person (i.e., the higher the diversity of responses, the higher the flexibility). Fluency refers to the number of generated solutions. The higher the number of appropriate solutions generated by a participant concerning a situation, the higher the fluency of his/her option generation ("more-is-more"). All three factors are important in determining a person's overall creativity score, but the fluency factor is of particular interest for a possible comparison with the intuitive option-generation process.

Intuitive decision making is, by definition, carried out in a short amount of time with little effort (Hogarth, 2001). Intuitive decisions which are based on experiences are often considered effective in sports when the athlete is pressed for time, insecure, or lacking knowledge about the current situation (or a combination of these), and therefore, experiencing some kind of uncertainty (e.g., Musculus, 2018). One approach that has theoretically explained intuitive decision making, comprising the generation of options and the decisions of athletes under uncertainty, is the theory of simple heuristics (Gigerenzer & Goldstein, 1996). Simple heuristics can be defined as cognitive shortcuts or rules of thumb. Heuristics are based on the principle of bounded rationality, which assumes that people have limited processing capacities and therefore make choices that are "satisficing" rather than optimal (Gigerenzer & Goldstein, 1996). This is why simple

heuristics are characterized by the small amount of information used for decision making. In general, simple heuristics can be formally characterized by building blocks, i.e. rules for searching, for stopping the search, and for making a decision (Raab & Gigerenzer, 2015). The search rules specify the order in which information is searched for or generated, the stopping rules define when to stop searching for information, and the decision rules determine how the final decision is reached. For instance, a heuristic that has been applied to explain ball allocation decisions in sports, comprising how athletes come up with options and how they choose among these options, is the take-the-first (TTF) heuristic (Johnson & Raab, 2003). TTF predicts that "rather than exhaustively generating all possible options and subsequently processing them deliberately" (Johnson & Raab, 2003, p. 218), a person selects the initial option generated. Because options are generated in order of validity (search rule), the first option is likely to be successful (Johnson & Raab, 2003; the less-is-more approach). Several studies have come to the conclusion that options generated earlier are of higher quality than options generated later, which do not appear to be very successful (e.g., Johnson & Raab, 2003). The TTF heuristic can serve as a theoretical starting point of this project because it considers predecisional option generation and makes specific predictions about the relation of the option generation and the decision itself.

Empirically, the relation between intuitive and creative option generation and decision-making performance can be addressed and compared best by looking at the fluency factor, that is, the number of options generated. With respect to intuitive decisions, simple heuristics predict a negative relation between the number of options generated and the quality of the decision (Johnson & Raab, 2003). However, other scientists have postulated a positive correlation between the number of options generated and their quality, meaning that increasing quantity can result in an increase of quality as well ("quantity breeds quality"; for a review, see Rietzschel, Nijstad, & Stroebe, 2007). These competing hypotheses, resulting from the theoretical predictions of the simple heuristics approach on the one hand, and creative decision-making theories on the other hand, will be tested against each other in this project.

In addition to cognitive parameters affecting decision-making processes, creativity and intuition might also be driven by the same or different physiological processes, such as cardiac vagal activity, that is, the

activity of the vagus nerve which regulates cardiac functioning (Berntson et al., 1997; Laborde, Mosley, & Thayer, 2017; Laborde, Raab, & Kinrade, 2014). Cardiac vagal activity can be measured noninvasively via heart rate variability (HRV), which reflects changes in the time intervals between adjacent heartbeats. Theoretically, the neurovisceral integration model (Thayer, Hansen, Saus-Rose, & Johnsen, 2009) can serve as a starting point to predict the relation between cardiac vagal activity and decision-making processes. In particular, the neurovisceral integration model postulates that higher cardiac vagal activity is linked to better executive performance, given that it reflects the efficiency of neural mechanisms in the prefrontal cortex. In line with the neurovisceral integration model, previous research showed that cardiac vagal activity was linked to option generation performance (option quality) in team sports (Laborde & Raab, 2013; Laborde et al., 2014). However, the relationship between cardiac vagal activity, creativity and intuition is still unclear. To the best of our knowledge, creativity has not been investigated together with cardiac vagal activity in previous research. However, previous theoretical and empirical accounts would suggest that creativity is based on executive functioning (Benedek et al., 2014; Diamond, 2013), which may suggest a path to cardiac vagal activity. Regarding intuition, previous research found that it was positively related to cardiac vagal activity (Laborde & Raab, 2013; Laborde et al., 2014). However, from a conceptual perspective, Diamond (2013) assumes that when individuals rely on intuition, executive functions are not solicited. The current study is aimed at clarifying the links between cardiac vagal activity, creativity and intuition.

Culture-Specific Differences in Decision Making

So, how much do creative and/or intuitive option generation and resulting decisions depend on cultural differences? In general, culture can be defined as "the collective programming of the mind, which distinguishes the member of one human group from another" (Hofstede, 2007, p. 413). With the rise in globalization and growing economic independence between countries, comparative analyses of national cultures has become an important topic in scientific research in recent years (e.g., Podrug, Filipović, & Stančić, 2014). Especially over the last 20 years, researchers have started to investigate how culture influences decision making (e.g., Strohschneider & Güss, 1999). Various research studies have underlined differences between the cultures of Germany and Brazil and have indicated that decision making is adapted to

the conditions of the cultural context. For example, there is empirical evidence that Germans usually plan in more detail and are more long-term oriented than Brazilians (e.g., Güss & Dörner, 2011; Strohschneider & Güss, 1998). However, given the immediacy of required action, decisions cannot be scheduled a long time in advance in sports situations, in which case the Germans' behavior is not necessarily beneficial. Brazilians—as observations of daily life plausibly suggest—begin their involvement with sports primarily as more casual play (e.g., through beach games such as beach volleyball, beach handball, beach football, footvolley). In contrast, German athletes in childhood and adolescence are frequently trained before they can play; that is, they acquire intentional experience early (e.g., Raab, Hamsen, Roth, & Greco, 2001). German children (just as in most western European countries) are often trained in one specific game in an organized sports club independent of organized school sports. The majority of youth sports in German sports clubs involve competition (Güllich, Kovar, Zart, & Reimann, 2017). In contrast, in Brazil, children usually develop their sports skills by playing games in the streets (Memmert & Roth, 2007). While Brazilians do not necessarily receive organized coaching (e.g., instructions)—which would be advantageous in developing psychological skills such as goal setting, leadership, and visualization—street games give children the opportunity to play with more freedom (i.e., to explore/try different things), and therefore, to develop their creative skills more intensively, and to "go with the gut" (cf. Lyle & Cushion, 2010) or to make their decisions intuitively rather than through formal decision-making training. Possibly, the process of generating intuitive and creative decisions in sport-specific settings underlies the cultural differences related to training and playing experiences.

The Present Research

The relevance of creative and intuitive decisions in sports, as emphasized in previous research (e.g., Memmert et al., 2013; Raab & Laborde, 2011), and the high demands on decision making (e.g., Belling, Suss, & Ward, 2015) make team sports the ideal environment in which to explore our research questions. Players always have to make decisions in a variety of different situations, most often under high time pressure. Without doubt, making the right decision is a fundamental element in soccer, for example, that relates to

individual expertise development. For this reason, but also because soccer is popular across the world and is the favorite sport in Europe and South America, we conducted our cross-cultural research with soccer experts.

Our project involved Brazilian and German soccer coaches (Study 1) and players (Study 2). In Study 1, we used open questions that were analyzed qualitatively to shed light on the coaches' concepts of creativity and intuition. This qualitative approach was combined with a quantitative approach by using scale questions, allowing quantitative analyses in addition. Study 2 used a quantitative approach. While most previous studies have concentrated on players' option-generation process, the coaches' evaluation of creativity and intuition needs to be understood first. Understanding coaches' concepts of creativity and intuition allows to find common definitions of the concepts as well as differences mediated, for instance, by cultural stereotypes. For example, stereotypes of Brazilian and German soccer cultures would suggest that there are differences concerning creative and intuitive decision making between soccer players and coaches of the two countries (Güss & Dörner, 2011; Memmert & Roth, 2007; Raab et al., 2001). To understand the concepts of creativity and intuition still better, i.e. to examine possible similarities and differences, we conducted two studies—one involving soccer coaches and one involving soccer players. We first explored whether cultural differences between Brazilian and German soccer coaches exist with respect to the definitions and evaluations of creative and intuitive decisions, before moving on to scrutinize the relation between intuitive and creative option generation and decision-making performance in soccer players of both countries in a second study.

More precisely, using a combination of qualitative and quantitative data in Study 1, we asked Brazilian and German soccer coaches to describe what they considered to be creative and intuitive actions, after which they rated the actual decision making of professional soccer players during soccer competitions at the 2016 Summer Olympic Games. On the basis of stereotypes/anecdotal evidence (e.g., "Brazilian culture of playing in the streets"; Memmert & Roth, 2007), we assumed that the decisions of Brazilian players would be rated as more creative and more intuitive than the decisions of German players. Furthermore, we hypothesized that the creativity and intuition ratings would differ between German and Brazilian coaches and especially that Brazilian coaches, seeking for a higher level of creativity and intuition, would be more reluctant to give high ratings than German coaches.

In Study 2, we analyzed the relation of creative and intuitive option generation of soccer players by studying their potential cognitive and physiological underlying mechanisms. More precisely, our aim in Study 2 was to explore whether German and Brazilian soccer players differ in their option-generation process in our soccer-specific task. We primarily focused on the fluency factor, that is, the number of options generated, because it allowed us to capture both creative and intuitive option generation. We aimed to test whether the more-is-more or the less-is-more tenet can describe decision making of German and Brazilian soccer players. Additionally, we investigated if creative players (with fluency as one factor of their creativity score) are good intuitive decision makers as well. While there is evidence (e.g., Rietzschel et al., 2007) of a positive relation between option-generation fluency and the quality (but not necessarily the unexpectedness) of the final choice (more-is-more), the TTF heuristic (Johnson & Raab, 2003) predicts a negative relation (less-is-more) between them in a sense that the quality of options decreases from the option generated first to the option generated last). We analyzed the empirical differences between the two approaches in a sample of German and Brazilian soccer players. We assumed that the Brazilian players' first answer would be qualitatively better than the first answer of the German players and that the Brazilians would generate more options. Finally, we examined the influence of cardiac vagal activity on players' cognitive decision-making processes. Considering, on the one hand, that the neurovisceral integration model (Thayer et al., 2009) assumes a positive relationship between cardiac vagal activity and executive functioning, and on the other hand, that creativity relies to some extent on executive functioning (Benedek, Jauk, Sommer, Arendasy, & Neubauer, 2014), we expected a positive correlation between cardiac vagal activity and our creative option-generation measures. Regarding intuition, previous research (e.g., Laborde & Raab, 2013; Laborde et al., 2014) found a positive association with cardiac vagal activity, which would suggest that executive functions may be involved in intuition; however, this is conceptually contradicted by Diamond (2013), who assumes that individuals relying on intuition are on automatic pilot and that executive functions are not involved in such situations. Consequently, given the fact that both the presence and the absence of a relationship between intuition and cardiac vagal activity could be assumed based on previous research and conceptual considerations, we investigated the relationship between

intuition and cardiac vagal activity in an exploratory fashion. No differences were expected between the two cultures regarding the relationship between cardiac vagal activity, creativity, and intuition.

Study 1

Method

Participants. This study tested a total of 62 coaches (45 German and 17 Brazilian male soccer coaches). The German coaches' mean age was 34.67 years (*SD* = 11.69 years), and the Brazilian coaches' mean age was 31.18 years (*SD* = 7.73 years). The German coaches had 7.07 years (*SD* = 5.86 years) of coaching experience and the Brazilian coaches 5.29 years (*SD* = 4.31 years), and both groups coached at a comparable level (highest youth league).

Materials. Twenty video scenes (average length 10 s; the design was based on previous studies, see Memmert et al., 2013) of offensive actions performed by the male teams from Germany, Brazil, and Nigeria (functioning as control group) during the 2016 Summer Olympic Games were selected. Scenes of Nigerian soccer players were added to control for coaches' knowledge-based expectations regarding certain German or Brazilian players. We wanted to check if previous knowledge of German and Brazilian players could bias judgments of the expert raters. This was considered to be highly unlikely in the case of Nigerian players who were less famous than some of the other teams' players, such as Özil or Neymar.

Three experts, who were naïve regarding the purpose of the study, were asked to choose footage for the study that had to meet three conditions. Videos had to end shortly before an attempt to shoot on the goal; they had to be quite diverse (i.e., goal-scoring opportunities as a result of crosses, passes, dribbling, through balls, etc.); and footage from the national teams had to be as comparable as possible (i.e., same number of crosses, etc.).

Procedure. The study was implemented online via SoSci Survey, a software package for the generation and completion of online surveys (https://www.soscisurvey.de). The hyperlink to the study was distributed via a number of bulletin boards in soccer clubs. Moreover, coaches were invited to participate in the study via email. Their email addresses were obtained through websites of soccer clubs and the German and Brazilian soccer federations. Participants gave their consent online and could only then proceed with the questionnaires

and the test. They were debriefed afterward. Participants received no money for participating. The study received approval from the researchers' local ethics committees.

At the beginning, the coaches were asked to describe their understanding of soccer players' creativity and intuition in counterbalanced order. In detail, coaches reported their subjective definitions of creativity and intuition by spelling out their responses to the open questions. Afterwards, the coaches were shown the video scenes of soccer games (Brazilian, German, Nigerian) and were asked to indicate how creative and how intuitive (alternating order) they perceived the decision for the last action of each video (featuring German, Brazilian, and Nigerian players) to be. The players' decision making was evaluated quantitatively by coaches on a scale of 1 (*not at all*) to 7 (*completely*).

Qualitative and quantitative analyses. First, coaches' subjective definitions of creativity and intuition were analyzed. As a first step, the responses to the open questions of the Brazilian and German coaches were analyzed separately. In detail, the answers were analyzed with respect to the description the coaches gave while focusing on the adjectives they used (qualitative analysis). The characteristics obtained were all listed to provide a full picture of their concepts. In a second step, via a quantitative frequency analysis, we counted how often specific characteristics were named (quantitative analysis). Thereby, both qualitative and quantitative data was obtained and combined (see Figure 1 and 2).

Lastly, the coaches' evaluations regarding creativity and intuition of the players' decisions depicted in the video scenes , were analyzed using a 2 (Nationality of Coaches: German, Brazilian) × 3 (Nationality of Players: German, Brazilian, Nigerian) multivariate analysis of variance (MANOVA) with repeated measures on the second factor and creativity as well as intuition ratings of decisions as dependent variables. Thereby, we analyzed whether the German and Brazilian coaches differed in their ratings and whether their ratings also depended on the nationalities of players displayed in the video scenes of games of the Olympic tournament.

Results

We investigated whether Brazilian and German coaches have the same or different concepts of intuitive and creative choices in terms of decision-making processes in soccer. The qualitative data analyses revealed concept overlap as well as differences between coaches of both cultures for the concepts creativity and

intuition (all characteristics are summarized and listed in Figures 1 and 2). In the following, the three most frequently named characteristics for each concept are reported.

For creativity, "finding surprising, new solutions" was named most frequently by both Brazilian and German coaches and was, therefore, ranked the most important defining characteristic of creativity. While for Brazilian coaches "anticipation" was ranked second, "richness of ideas" was named second most frequently by German coaches. The characteristic "good technique (ball)" was ranked third for coaches of both nationalities. For intuition, "anticipation ability" was named most frequently by both Brazilian and German coaches and was, therefore, ranked most characteristic of intuition. The characteristics ranked second and third were the same for German and Brazilian coaches, just in reverse order. "Gut decision" was named second most frequently by Brazilian coaches and third most frequently by German coaches; "ability to act" was named second most frequently by German coaches and third most frequently by Brazilian coaches. To sum up, for the concepts of creativity and intuition, German and Brazilian coaches named very similar characteristics most often, meaning that there was a fair amount of conceptual overlap for the term creativity and a high overlap for intuition between coaches of the two countries.

For quantitative data of the coaches' evaluations, the 2 (Nationality of Coaches: German, Brazilian) × 3 (Nationality of Players: German, Brazilian, Nigerian) MANOVA was conducted. Table 1 shows the coaches' ratings of how creative and intuitive the players' decisions depicted in the video scenes were. The respective MANOVA showed no multivariate main effect of the nationality of coaches ($V = 0.066$), $F(2,37) = 1.31$; $p = .283$, and no interaction between the nationality of coaches and the nationality of players ($V = 0.112$), $F(4,35) = 1.1$; $p = .372$, but a multivariate main effect of the nationality of players ($V = 0.318$), $F(4,35) = 4.08$; $p = .008$, $\eta^2 = .318$.

Following up on the multivariate main effect of the nationality of players with univariate analyses revealed that the nationality of players affected only the coaches' creativity ratings, $F(2,76) = 10.21$; $p < .001$, $\eta^2 = 0.21$, and not their intuition ratings, $F(2,76) = 1.33$; $p = .272$. Post hoc pairwise comparisons indicated that coaches rated the decisions of the Nigerian players as less creative than the decisions of the German and

Brazilian players (both *p*s < .009). There was no difference in mean evaluations between the German and Brazilian national teams ($p > .9$).

Discussion

In Study 1, we explored whether concepts and evaluation of creativity and intuition differ between German and Brazilian coaches, i.e., we examined similarities/differences of both concepts for coaches of various cultures. To this end, Brazilian and German coaches provided their definitions of creativity and intuition before evaluating how creatively and how intuitively German, Brazilian, and Nigerian national team players acted during the soccer tournament at the 2016 Summer Olympic Games. Whereas the determination of players' option-generation fluency is usually based on athletes generating as many appropriate options as possible (fluency), which are then assigned to different categories and compared to solutions of experts in order to determine a creativity score (Furley & Memmert, 2015), the determination of intuition is concentrated on athletes generating a satisfying solution (Johnson & Raab, 2003). Regarding the qualitative data, we conclude that there was a fair amount of conceptual overlap for creativity and a high amount of overlap in the understanding of intuition between Brazilian and German coaches. Interestingly, Brazilian coaches considered "anticipation" highly relevant for both creativity and intuition, which was not true for German coaches, who considered it important only for intuition. This might indicate that for Brazilian coaches, the two concepts of creativity and intuition overlap to a larger extent than for German coaches.

Furthermore, German and Brazilian coaches did not differ in how they actually rated players' actions regarding their level of creativity and intuition. That is, though concepts seemed to differ to a certain extent, coaches still mostly agreed on whether a player's action was creative/intuitive or not. In contrast, the nationality of the players had an impact on creativity but not on intuition ratings, either because Nigerian players' actions were indeed less creative or because expectations regarding their style of play could have biased German and Brazilian coaches. That is, German and Brazilian players could have simply been judged as more creative and more intuitive because they were in general considered more skilled players than their Nigerian counterparts.

Study 2

Study 1 demonstrated conceptual overlap for the definitions of creativity and intuition between German and Brazilian soccer coaches, and it also showed that German and Brazilian coaches did not differ in what actions they considered creative or intuitive. Study 2 was designed to investigate the empirical differences between the more-is-more approach from creativity research (with option-generation fluency as one factor of creativity) and the less-is-more approach from intuition research, using cognitive decision-making processes as well as a physiological indicator (cardiac vagal activity). Additionally, we analyzed the relation of creative and intuitive option generation in soccer players. We hypothesized that Brazilian players might generate more options (higher fluency score) and might, therefore, be more creative; moreover, we assumed that Brazilian players might be better intuitive decision makers than German players (Memmert & Roth, 2007; Raab et al., 2011). Furthermore, based on the neurovisceral integration model and previous empirical research, we expected cardiac vagal activity to correlate positively in the combined sample of Brazilian and German players with the quality of options (Laborde & Raab, 2013; Laborde et al., 2014; Thayer et al., 2009). Finally, we expected cardiac vagal activity to correlate positively with creativity measures, given that creativity is conceived as relying on executive functions (Benedek et al., 2014, Diamond, 2013). Regarding intuition, on the one hand, previous research found that intuition was positively related to cardiac vagal activity (Laborde & Raab, 2013; Laborde et al., 2014). However, on the other hand, Diamond (2013) mentions that when individuals rely on intuition, executive functions are not solicited. Consequently, we do not have a directional hypothesis regarding the relationship between intuition and cardiac vagal activity.

Method

Participants. Fifty-six male midfield soccer players aged 15 to 19 years voluntarily participated in the study. Thirty-two of the participants were German (M_{age} = 16.38 years, *SD* = 1.24 years) and 24 were Brazilian (M_{age} = 16.57 years, *SD* = 0.76 years). At the time of the study, one of the German players played in the Under-19 German *Bundesliga* (the highest national league for players younger than 19 years), 18 in the fourth division, six in the sixth division, five in the seventh division, and two in the Senior fifth division. All Brazilian participants played in the A division of *Campeonato Brasileiro* (the highest national league for players younger than 19 years). The German players practiced 9.27 h per week on average (*SD* = 3.04 h) and

had an average of 9.92 years of experience (*SD* = 2.48 years) as a player in a club. The Brazilian players practiced 10.83 h per week on average (*SD* = 1.88 h) and had an average of 9.58 years of experience (*SD* = 2.67 years) as a player in a club. The study was approved by the researchers' local ethics boards. Written consent was obtained from each participant prior to testing according to the Declaration of Helsinki.

Materials and Procedure.

Soccer-specific option-generation task. A soccer-specific option-generation task was used to determine participants' creative and intuitive solutions related to their decision making in game situations. It was presented using E-Prime 2.0 (Psychology Software Tools, Pittsburgh, PA). Validated video clips (Furley & Memmert, 2015; Memmert et al., 2013) of 25 offensive soccer scenes from a bird's eye perspective, including two test scenes, were shown to each participant on a laptop (screen size: 15 in., diagonal; distance = 45 cm, visual angle of the display: 27° vertical × 34° horizontal). Scenes from the Australian A-League were shown to reduce the probability that participants had seen the material before. The videos were presented in randomized order after the two test scenes. Each scene was approximately 10 s long. The last frame was frozen and was shown for 45 s (cf. Memmert et al., 2013). Participants were instructed to perform three tasks while imagining they were the player with the ball. First, they were required to loudly name the first decision on how to continue the play that came to their mind as quickly as possible but at least within 3 s (first option generated). Second, they had 42 s to write down this solution on a white piece of paper and as many additional appropriate solutions as they could think of (2^{nd} to n^{th} option generated). Third, participants were required to rank their written solutions from best to worst (final ranking of own options including the option considered best after deliberation which is labelled the "final option" below). There was no time limit for this third task.

Expert rating. Four experts (two German, two Brazilian) each provided a list of all valid solutions for all 25 scenes. They also rated the quality of every scene on a 7-point Likert scale. Video scenes contained at least three and a maximum of seven appropriate possible solutions. Five of the 25 scenes had to be excluded from data analysis because the experts' ratings did not match. That is, it was not possible to identify a single option as the best solution based on the experts' opinions because not even two raters agreed on a certain solution.

For all other scenes at least two raters agreed that a certain option would be the best option (three scenes for which all raters chose the same solution, 10 scenes for which three raters chose the same solution, and seven scenes for which two raters chose the same solution while the other two raters did not agree on another solution). The quality of the options was calculated by averaging the experts' independent evaluations. That is, an option was only considered the best if it was more often designated the best option than every other option, but to quantify the quality of the options, ratings on the Likert scales were averaged across all experts. If an expert did not list a certain option his rating was considered as zero.

To assess the quality of the participants' intuitive decisions, the first answer that was generated within 3 s was compared to the optimal possible solution given by the experts. One point was given for each correct intuitive answer. In addition, we analyzed the dynamic inconsistency, defined as the number of trials in which the first and the best choice were not identical (cf. Raab & Johnson, 2007).

Measures of creativity. We measured the factors originality, flexibility, and fluency using Guilford's (1967) method for evaluating creativity in our soccer-specific option-generation task. Originality was scored by counting the number of valid options (a generated option was considered valid if at least one of the expert raters listed it as possible solution) each participant generated, which were provided by less than 20% of all participants (cf. Plucker, Qian, & Wang, 2011). To determine fluency, the number of all valid possible solutions listed by the participants was used. To be able to determine flexibility, it was necessary to categorize all possible solutions generated by the participants. The categories used were cross, dribbling, shot, lob, short pass, pass through the defenders, and double pass. One point was given for each mentioned category. The three components (originality, flexibility, fluency) of our soccer-specific option-generation task were averaged, after a *z*-transformation of all three values, to produce one creativity score (for a similar procedure, see Memmert et al., 2013).

Cardiac vagal activity. To assess cardiac vagal activity we measured the HRV of the participants using the Faros 180° device (Mega Electronics, Kuopio, Finland), with a sampling rate of 500 Hz. We used two disposable electrocardiogram (ECG) pre-gelled electrodes (Ambu L-00-S/25, Ambu GmbH, Bad Nauheim, Germany). The negative electrode was placed in the right infraclavicular fossa (just below the right clavicle)

while the positive electrode was placed on the left side of the chest, below the pectoral muscle on the left anterior axillary line. We extracted the HRV values using the Kubios software package (University of Eastern Finland, Kuopio, Finland). Artefacts were removed by manually inspecting the ECG signal. We calculated time domain parameters and used the root mean square of the successive differences (RMSSD) as an indicator of cardiac vagal activity (Laborde et al., 2014). We did not statistically adjust cardiac vagal activity for respiration, because this could mask true variations in cardiac vagal activity (Thayer, Loerbroks, & Sternberg, 2011). RMSSD values were log transformed (Ln10) because of their nonnormal distribution (Laborde et al., 2017). Here we consider the cardiac vagal activity measured during the decision-making task.

Results

Relationship of creative and intuitive option generation. To test whether the number of options generated (fluency) in the soccer-specific option-generation task positively related to quality (more-is-more) or negatively related to quality (less-is-more), correlations for the whole sample as well as within the individual subsamples were conducted (Table 2). For the whole sample the total number of generated options in the second task was positively correlated with the quality of the first option, $r(50) = .366$, $p = .009$, and the final option/decision (the own option designated best in task 3), $r(50) = .286$, $p = .044$ (indicative of more-is-more). Surprisingly, there was a negative correlation between the total number of generated options in the second task and the quality of the option generated second, $r(50) = -.306$, $p = .030$. In contrast, there was no correlation between the total number of generated options and how often a participant considered his first option as best as a part of the third task, $r(50) = -.144$, $p = .32$. When we looked at the subsamples more closely, it stood out that there was no correlation between fluency scores and the mean quality of options (all ps > .145) for the German subsample, but the more options German participants were able to generate in total in the second task, the less often they considered their first option best during the third task, $r(26) = -.435$, $p = .026$. For the Brazilian subsample the total number of options generated in the second task was correlated with the quality of the first, the third, and the final option (the own option designated best in task 3). The correlations with the first, $r(24) = .518$, $p = .009$, and the final, $r(24) = .446$, $p = .029$ (more-is-more), options were positive, whereas the correlation with the third option was negative, $r(24) = -.427$, $p = .047$ (less-is-

more). Furthermore, for the Brazilian subsample there was no relation between the total number of options generated and the frequency with which players selected their first option as best, $r(24) = .089$, $p = .68$. That is, Brazilian players who generated more options did not differ from players who generated less options in how often they rated the option they generated first as best option during the third task.

In addition, to further understand the relation of the number of generated options (fluency) and the quality of options, we analyzed the quality of options dependent on their serial position among the generated options. For all players, Brazilian and German participants alike, the quality of the options decreased with their serial position; that is, the later an option was generated, the lower the quality of this option (based on mean expert ratings), $F(4, 28) = 14.99$, $p < .001$, $\eta^2 = 0.680$. Post hoc analyses showed that the quality of generated options differed between all serial positions (all ps $< .004$) and that quality decreased from the first to the last option (see Figure 3). Additionally, Brazilian and German participants considered their first answer the best option in more than 50% of the cases, $t(49) = 18.43$, $p < .001$, $d = -2.606$.

To test more directly whether German and Brazilian players differed in option generation, as the above mentioned correlation patterns suggest, and also to test whether there were other differences between the two subsamples, we conducted a MANOVA with nationality (German, Brazilian) as independent variable and the quality of the first and final option generated, as well as the creativity score, and the percentage of times the first option was considered the best (during the third task) as dependent variables. The analysis indicated that there was no difference between the two nationalities. There was a significant multivariate effect ($V = 0.674$), $F(6, 43) = 14.85$, $p < .001$, $\eta^2 = 0.674$, but no univariate effects, all ps $> .131$.

Cardiac vagal activity. Regarding cardiac vagal activity, the HRV analysis with the full sample did not reveal any significant correlation with how often the first option was considered best (during the third task) as a measure of intuition, with mean quality of any option (generated first to n^{th}), nor with any creativity measure (fluency, flexibility, and originality), all $ps > .05$. To investigate potential subsample differences, we also carried out correlation analyses for the German and Brazilian subsamples separately. It turned out that in the German subsample, cardiac vagal activity correlated significantly positively with how often participants considered their first option best, $r(26) = 0.42$, $p = .037$, but it did not correlate with the mean quality of

options nor any creativity measure ($p > .05$). In the Brazilian subsample, cardiac vagal activity did not correlate with any measure of intuition, mean quality of options, or creativity ($p > .05$).

Additional analyses. Since fluency is one of the factors that determine a person's creativity score, and creativity parameters were positively correlated with each other in both subsamples (all ps < .001), we additionally analyzed the relation between the players' total creativity score, flexibility score, originality score, and their general and intuitive option generation in an exploratory manner. For the whole sample a player's overall creativity score was positively related to the quality of the first (and intuitive) option, $r(50) = .316$, $p = .025$, but not to how often the first option was considered best (during the third task), $r(50) = .-168$, $p = .243$. However, the quality of the second option (not/less intuitive) was negatively correlated with a player's level of creativity, $r(48) = -.31$, $p = .030$. There was no further correlation between creativity scores and options generated subsequently (3^{rd} to n^{th} during task 2) or the final decision (provided during task 3), and there were also no correlations involving originality and flexibility scores at all. With the exception of the positive correlation between creativity and the quality of the first option in the Brazilian subsample, $r(24) = .485$, $p = .016$, all above-mentioned correlations could not be confirmed when looking at the two subsamples separately. That is, for the German subsample there were no correlations between any of the relevant variables.

Discussion

Study 2 explored whether German and Brazilian soccer players differed in their option-generation process in our soccer-specific task. More precisely, by concentrating on option-generation fluency, we tested whether the more-is-more or the less-is-more tenet can describe decision making of German and Brazilian soccer players. Additionally, we investigated if creative players (with fluency as one factor of their creativity score) are good intuitive decision makers as well.

We found that the number of options generated (fluency) in the soccer-specific option-generation task is positively related to the quality of the first (and the final) decision, supporting the hypothesis that the more-is-more approach of creativity research is an important approach to making successful decisions under time pressure in modern soccer. Results also showed that the first option was more often the best option (based on

experts' ratings) when participants were able to generate more options during task 2, which demonstrates the benefit of generating more options in a divergent decision-making task (more-is-more) at least for the Brazilian subsample (cf. Table 2). This is in line with another study that revealed a positive relation between option-generation fluency and the quality of the final choice (Rietzschel et al., 2007). However, a look at Table 2 makes it evident that German participants generating fewer options considered their first option as their best option more often than German participants generating more options. This effect is not significant and close to zero for the Brazilian sample, and consequently there is also no effect for the whole sample. This correlation within the German sample conceptually replicates previous findings in German athletes on Take-The-First heuristic though (Johnson & Raab, 2003). For the Brazilian but not for the German subsample the quality of the first option (as indicated by expert raters) was higher for players who were able to generate more options, compared to players who were able to generate fewer options during task 2. This partially supports the more-is-more approach (i.e., only for the Brazilian subsample), but it also lends support to assumptions regarding culture-specific differences. That is, Brazilian players who were able to provide more options were also generating better intuitive options while no such relation was evident for the German participants, considering that the number of generated options (task 2) was unrelated to the quality of the first option in the German subsample.

On average, 83% of the intuitive (first) options were considered the best option (during the third task), lending support to the hypothesis that the TTF heuristic is a useful approach to making successful decisions under time pressure in the game of soccer. Alternatively, this finding might suggest that the most obvious solution to most of the videos also happened to be the best solution. It was revealed and replicated that intuitive possibilities for actions were higher in quality (based on mean scores provided by experts) than options that were generated later. This indicates that the TTF heuristic seems applicable as a sensible strategy for action selection in soccer. This is in line with another study that showed the use of this approach in soccer (Belling et al., 2015). Regarding the relation between creativity and intuition, results show that players' creativity level was associated with the quality of the first option generated. The results emphasize that creative players can be considered good intuitive decision makers as well.

We did not find that Brazilian players generated more options (had higher fluency scores) nor that their first answers (regarded as intuitive) were significantly better than those of German players. This means that they were neither more creative nor better intuitive decision makers than German players as hypothesized. The low power of this comparison warrants caution and calls for further investigation. Moreover, the present study provides support for a negative relation between the total number of options generated and the frequency with which the first option was selected as best for German players but not for Brazilian players. This finding is interesting and hints at potential cultural differences with respect to the underlying mechanism. Other studies conducted with German handball players (Johnson & Raab, 2003) support the negative correlation, whereas studies conducted with American undergraduate and graduate students with at least 1 year of competitive basketball experience (Hepler & Feltz, 2012) or with American soccer players (Belling et al., 2015) did not report a correlation (i.e., null effect), which is what we found for the Brazilian soccer sample. As there are also methodological differences between the studies though, it cannot be concluded that the mechanism is culture dependent. However, future studies could systematically test whether the mechanism differs in different countries.

Regarding cardiac vagal activity, its hypothesized positive link with intuition and creativity was not found with the full sample. To uncover any subsample specificity, we also ran the analyses separately for the German and Brazilian samples. Like the behavioral data, our findings differ for the German and Brazilian samples. The findings from the German sample are in line with previous findings (Laborde & Raab, 2013; Laborde et al., 2014) where intuition was positively related to cardiac vagal activity. If we link this finding to the neurovisceral integration model (Thayer et al., 2009), this would confirm that intuition as evaluated by TTF relies on executive functioning, contrary to what was suggested by Diamond (2013). Further, in contrast to previous studies (Laborde & Raab, 2013; Laborde et al., 2014), in the current study no link could be found between cardiac vagal activity and the quality of options. This difference might be explained by the fact that different decision-making tests were used, and that the quality of options depended on the expert ratings, which varied from test to test given that different sports were investigated. This may also raise some

reliability issues that hinder cross-test comparisons. The link between creativity and cardiac vagal activity should be further investigated using more standardized tests of creativity (Benedek et al., 2014).

General Discussion

In the present research project, two consecutive studies were conducted addressing the relation between the option-generation processes of soccer players of different cultures related to their decision making in game situations. The objective was to analyze the relation between the concepts of creativity and intuition including two different stereotypes (coaches, players) of two different cultures (German, Brazilian). Study 1 was designed as an online study to investigate possible differences between Brazilian and German coaches in how creativity and intuition—which are both related to decision making—are conceptually grounded in their thoughts. Evidence on cultural stereotypes led us to expect different perspectives on creativity and intuition depending on culture (e.g., Güss & Dörner, 2011; Lyle & Cushion, 2010; Memmert & Roth, 2007; Raab et al., 2001). But instead of testing creativity and intuition theories, the current study rather aimed to understand the similarities and differences of both concepts for coaches of various cultures. Analyzing the qualitative data revealed a substantial overlap for the concepts of creativity and intuition between Brazilian and German coaches. In more detail, coaches used almost the same words to describe the concept of intuition, whereas for creativity only a medium overlap was found. Additionally, our results reveal that coaches' evaluations of intuitive and creative game actions did not differ. On the basis of these results, we assumed similar ratings from Brazilian and German coaches with regard to intuition and creativity for the videos used in the second study.

In Study 2, we explored whether the option-generation fluency tenet more-is-more or the intuition tenet less-is-more holds for decision-making processes in soccer. We tested these conflicting predictions in a sample of German and Brazilian soccer players. This additionally enabled us to explore whether German and Brazilian players differ in their intuitive and creative option generation related to decision making. As a complementary measure, cardiac vagal activity was assessed in Brazilian and German players to investigate the physiological basis of decision making.

We found that the quality of decision making increased as a function of the number of options that were generated in the full sample, providing support for the more-is-more approach, indicated by creativity research (Memmert, 2015). The benefit of generating more options in creativity tasks also indicates that divergent tactical thinking is a sensible method for action selection in soccer. This is supported by a significant correlation between the number of options generated and the quality of the first and the final decision. This demonstrated also the value and importance of the criterion fluency (to generate more than one option) in soccer-specific option-generation tasks (Memmert et al., 2013). Somewhat in contrast however, the findings also suggest that in the present paradigm, the earlier an option was generated in the serial process of option generation, the higher the decision quality of this option. Given the linear decrease in decision quality, we can conclude the first option to be the best choice as predicted by the TTF heuristic, which might be taken as supporting the less-is-more tenet. As a cultural difference, however, it appears that the relations between fluency scores and the quality of the first and the final option existed for the Brazilian but not for the German subsample. Only for the Brazilian subsample there was also a negative correlation between fluency scores and the quality of the third option generated. Cardiac vagal activity was positively related to intuitive but not to creative decisions and only in the German sample, which is in line with the cultural differences observed at the level of cognitive processes.

Although we primarily focused on the factor fluency (more-is-more vs. less-is-more) as a common characteristic of creative and intuitive option-generation processes in Study 2, the demonstrated positive correlation between a player's creativity score and the quality of the first generated option is of particular interest. This finding is strongly related to the connection between finding solutions or options and intuition recently proposed by Zander, Öllinger, and Volz (2016). This view is based on the critique of established theories on dual processes (Kruglanski & Gigerenzer, 2011). In a nutshell, Kruglanski and Gigerenzer (2011) proposed that the different thinking processes are based on identical neural networks and depend on environmental conditions. This unified approach is supported by recent findings from a neuroimaging study (Mega, Gigerenzer, & Volz, 2015). Taking this into account, it seems plausible to assume identical functional principles for intuitive and creative decisions within the same task. In addition, the expertise level of the

decision maker has to be considered. All participants tested in our study had reached a high level of expertise that can be classified as expert level in soccer. Evidence stemming from decision-making and problem-solving research has revealed fundamental differences between experts and novices in how information about a current situation is classified and searched through (Raab & Johnson, 2007). Solving a problem in their field of expertise enables experts to group relevant bits of information, which leads to a fast and correct initial representation of the problem task and subsequently to a fast and correct solution. To conclude, if one considers the combination of expertise level and identical neural networks, our results have the potential to challenge the assumption of serial order effects in generating creative options, which suggests that more creative options could have been generated at the end of the series of produced options in the experimental paradigm.

One possible limitation regarding our study is that expert raters substantially differed in which option they considered best. They also did not fully agree on which options were appropriate or not. That is, it seems questionable if in an environment as complex as in the current study there is one clear option that can unanimously be considered best. Another possible limitation regarding our study might be the heterogeneous sample. In both studies, considerably more German than Brazilian coaches and players took part. Moreover, it is to be noted that the samples from Germany and Brazil were similar, but not perfectly matched. This can be attributed to, among other things, the fact that soccer leagues and teams are not directly comparable in the two countries, so that even the players' game level or the "coaching philosophy" were not directly comparable. By establishing parameters such as the participants' age, their weekly training hours, and their playing experience in years, we tried to select comparable samples in Germany and Brazil. Furthermore, results of the present study demonstrate for the first time a link between soccer players' intuitive and creative option generation related to decision making, but they do not allow any conclusions about possible training effects. A training study could be of interest for future research.

To conclude, the creativity of individual players and their ability to generate the most optimal possible solutions under situational constraints and time pressure are of particular importance for success in the modern game of soccer. Decisions on the pitch have to be made in the shortest possible amount of time with

little information aiming for the best solution possible respectively with the best possible solution expected. Therefore, the ability to intuitively make the optimal decision is of utmost importance for individual players and the whole team. Furthermore, to complete an attack successfully we recommend that players rely on their first intuitive solution (considering that the first option was on average better than the options generated subsequently), which ideally is creative at the same time and therefore difficult for the opposing team to predict.

What Does This Article Add?

Creative and intuitive option generation was investigated in a cross-cultural study design. In two studies, the relation between creative and intuitive decisions in soccer-specific offensive actions was investigated—one study involving German and Brazilian coaches and the other involving soccer players from both countries. We found a conceptual overlap of creativity and intuition for Brazilian and German soccer coaches; accordingly, coaches did not differ in their evaluation of creative and intuitive actions of players from both cultures (Study 1). Three main findings are to be reported for Study 2: First, the total number of generated options was positively correlated with the quality of the first and final option. Second, a higher quality of players' first (intuitive) decisions compared to those generated later was found. Third, results showed a positive correlation between a players' creativity score and the quality of the first generated option for the whole sample. For the first time, the results of the present study demonstrate a link between soccer players' intuitive and creative option generation related to decision making while including two different cultures. In total, both a more-is-more and a less-is-more approach were able to describe facets of the decision-making process, probably also depending on whether decision makers were able to generate the best solution first or not.

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Table 1

Means (and Standard Deviations) of Coaches' Ratings of the Creativity and Intuitiveness of Players' Decisions, by Nationality

Coaches	Players					
	German		Brazilian		Nigerian	
	Creative	Intuitive	Creative	Intuitive	Creative	Intuitive
German	3.62 (0.76)	4.15 (0.53)	3.64 (0.87)	4.21 (0.48)	2.58 (1.34)	3.53 (1.63)
Brazilian	3.74 (1.44)	4.04 (1.05)	4.09 (0.96)	4.24 (1.15)	3.02 (1.56)	4.20 (0.60)

Note. Creativity and intuitiveness were rated on scales of 1 to 7.

Table 2

Correlations Involving the Number of Generated Options in Study 2

	Quality of option based on expert ratings				Participants evaluation of options
	First	Second	Third	Final	First option is considered best (in %)
Number of generated options (Total sample)	.366**	-.306*	-.271	.286*	-.144
Number of generated options (German subsample)	.168	-.213	-.030	.044	-.435*
Number of generated options (Brazilian subsample)	.518**	-.331	-.424*	.446*	.089

Note. Analysis of options generated after option 3 would not be reliable because participants too often did not provide more than three options.

*** Correlation is significant at the 0.05 level. * Correlation is significant at the 0.01 level.*

Figure legends

Figure 1. Response frequency of creativity characteristics generated by German and Brazilian coaches.

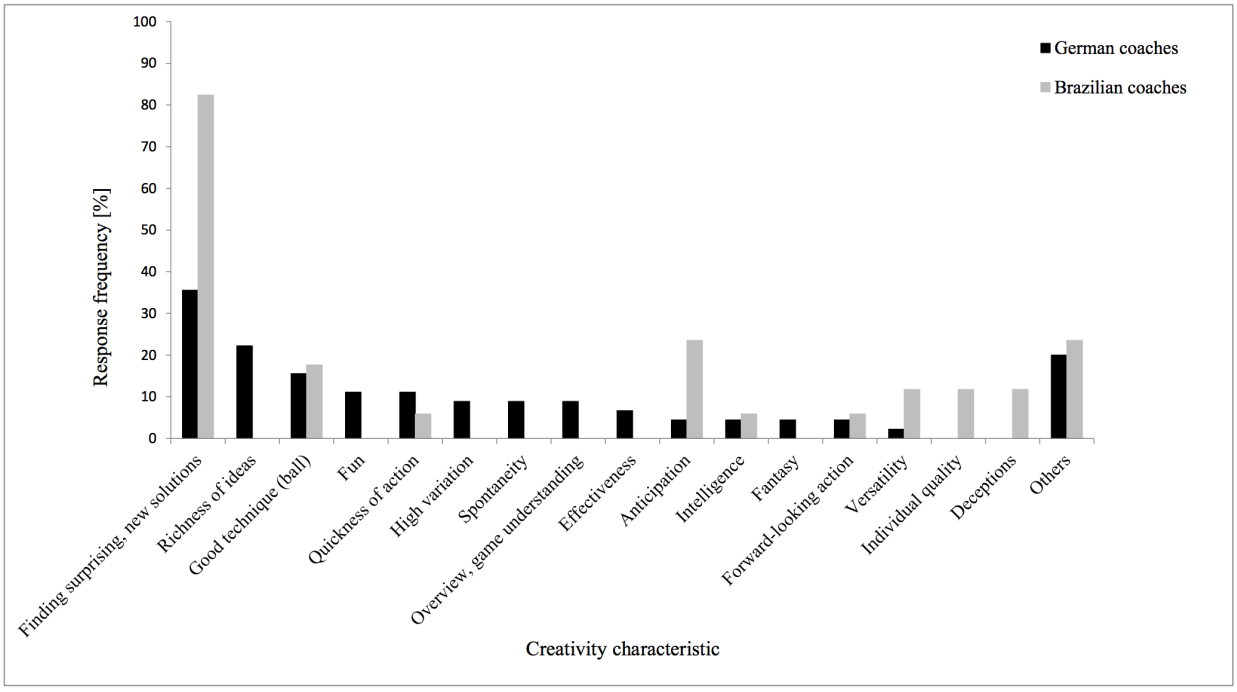


Figure 2. Response frequency of intuition characteristics generated by German and Brazilian coaches.

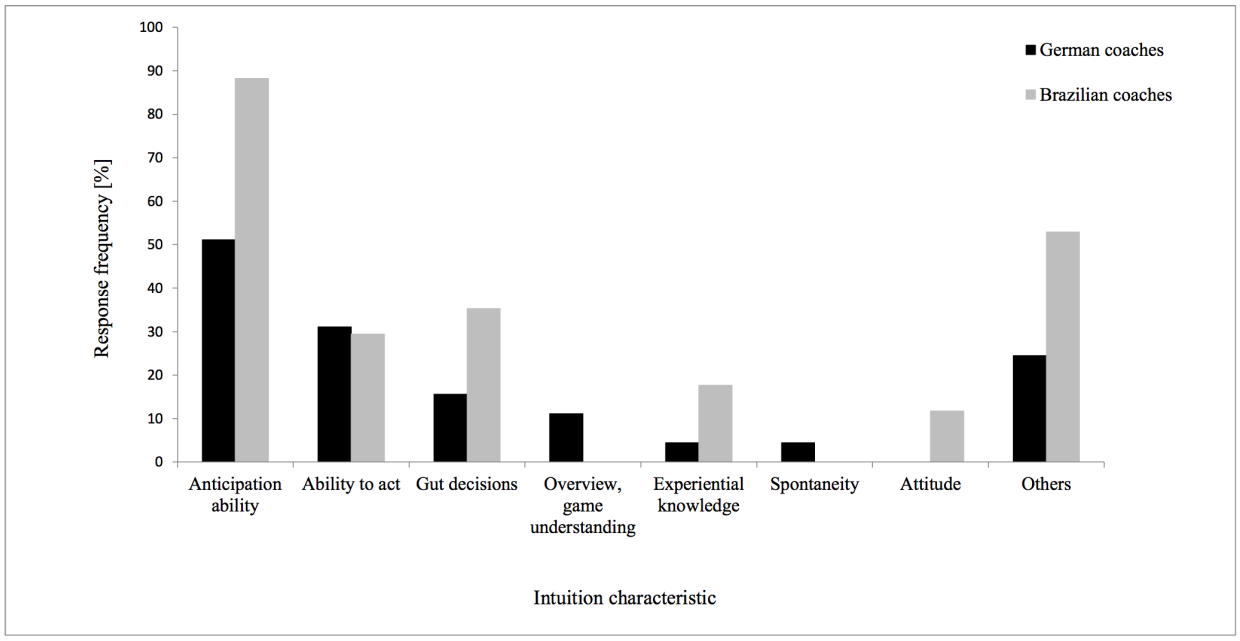
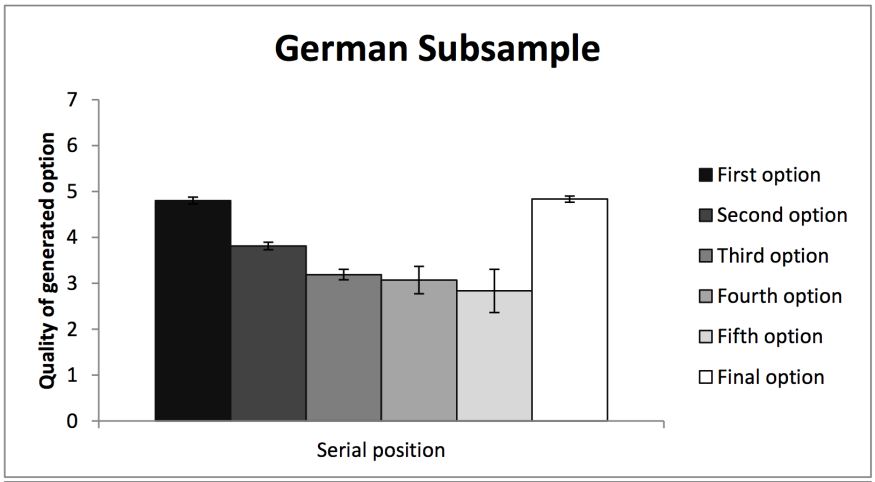
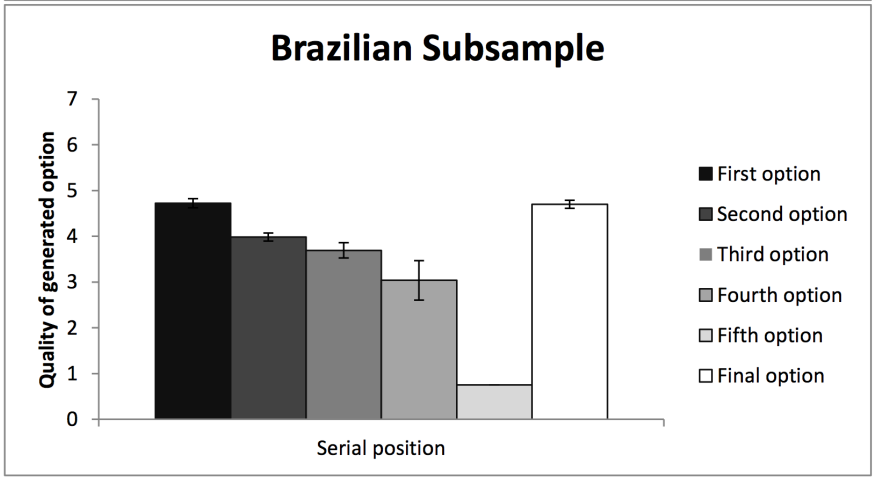


Figure 3. Quality of generated options of German (top) and Brazilian (bottom) soccer players as a function of serial position (error bars = standard error).


German Subsample
Quality of generated option
0
1
2
3
4
5
6
7
Serial position
First option
Second option
Third option
Fourth option
Fifth option
Final option


Brazilian Subsample
Quality of generated option
0
1
2
3
4
5
6
7
Serial position
First option
Second option
Third option
Fourth option
Fifth option
Final option

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