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CHECKING YOUR CHESS! DEVELOPMENT AND VALIDATION OF THE CHESS SELF-EFFICACY SCALE IN A COMPETITIVE SETTING

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Self-efficacy can influence motivation and performance. It has been widely investigated in sports, but not in nonphysical sports, such as chess. Through the first study, we developed the Chess Self-efficacy Scale (CSS) using the critical incident technique. It is a 63-item measure to assess chess players' self-efficacy beliefs. Through the second study, we validated the CSS using exploratory factor analysis to evaluate its factorial structure, which suggests a 38-item solution. Third-order confirmatory factor analysis was used to confirm the structure and assess the presence of two second-order factors and a general third-order self-efficacy factor. Through analysis of variance, we investigated differences among different expertise-level groups. Results confirmed the four first-order factors solution and the second- and third-order factorial structure. The CSS seems to be a valid measure to assess self-efficacy in chess players.

Keywords: Self-efficacy; Chess; Scale; Validation; Elo rating.

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This study aims to develop and validate the Chess Self-efficacy Scale (CSS), an instrument to measure chess players' self-efficacy. This instrument may be suitable for investigating how emotional and motivational factors are related to the achievement of ambitious goals by the players. Self-efficacy (SE) has often been studied in sports given that its influence on performance skills has been repeatedly demonstrated (Bandura, 1997). Chess has been frequently used in psychological research, especially in cognitive psychology, where it is frequently compared to Drosophila in genetics research. It represents the domain in which expert performance has been most intensively studied (Simon & Chase, 1973). Indeed, much research on expertise (Ericsson, 2005; Ericsson & Lehmann, 1996; Rikers & Paas, 2005; Simon & Chase, 1973), intelligence (Bilalić et al., 2007a; Frydman & Lynn, 1992; Grabner et al., 2007), personality (Bilalić et al., 2007b), and memory (Gobet & Simon, 2000; McGregor & Howes, 2002) has been conducted on chess players, using measures like WISC-III (Kaufman, 1994), IST 2000 R (Amthauer et al., 2005), and BFQ-C (Barbaranelli et al., 2003). Generally, people are led to think that to be a strong chess player requires high intelligence. However, José Raul Capablanca, chess world champion in 1921, once said: "Playing chess requires no intelligence at all" (cited in Cranberg & Albert, 1988, p. 159). Instead, several studies (Ericsson et al., 1993; Ericsson & Lehmann, 1996; Rikers & Paas, 2005) comparing experts with novices suggested that both expertise and intelligence can impact performance in expertise-related tasks. Moreover, some studies by de Groot (1946) and Simon and Chase (1973) highlighted the relevance of visuo-spatial pattern recognition for a strong chess player, while Bilalić et al. (2007a) found that other intelligence subscales (e.g., numerical) showed higher correlations with chess skill than visuo-spatial subscales. Research on self-efficacy in sports has historically focused on sports where physical performance is prevalent, such as table tennis, handball, gymnastic, swimming, basketball, softball, and baseball (Dinç, 2011; Hepler & Chase, 2008; McAuley & Gill, 1983;

Stonecypher et al., 2019). Indeed, to our knowledge, to date, only a few studies (e.g., Ijaz et al., 2022; Okurame, 2006) have focused on studying self-efficacy in chess. Nonetheless, no one has used a self-efficacy measure that has been validated on chess players.

This study aims to present and validate a multidimensional CSS devised to assess individuals' efficacy beliefs in four crucial domains for chess performance: task (preparation and game), negative emotions, positive emotions, and problem-solving. We conducted a preliminary study aimed to construct the items and a validation study to assess the psychometric characteristics of the scale. In particular, this validation study was aimed to investigate the factorial structure of the CSS and test differences in SE among groups of chess players differing in their levels according to their Elo[1] rating. Perceived SE is defined as "people's beliefs in their capability to exercise some measure of control over their functioning and environmental events" (Bandura, 2001, p. 10). Bandura (1977) hypothesized that SE affects the choice of activities, effort, persistence, and results. Achieving settled goals on the path toward excellence in sport develops a sense of athletic effectiveness. Choosing distal goals without focusing on the proximal ones makes it challenging to obtain excellent results (Bandura & Schunk, 1981; Schunk, 1991; Stock & Cervone, 1990). Therefore, a fundamental mechanism of self-regulation for athletes is establishing the right goals according to the context. This adaptive capability means that personal performance standards must always have a motivating rather than a debilitating effect.

Personal expectations related to athletic performance success may be a source of anxiety (Gould & Krane, 1992). Anxiety and the consequent deterioration in performance are linked to a lack of sense of effectiveness when adapting to competitive situations is needed. More confident athletes have a high capability to concentrate and adapt even in the riskiest situations. Less confident athletes are more focused on the risks of a possible defeat, the strength of the opponent, and the negative personal and social consequences resulting from it. Management of emotions through SE is essential for preventing the onset of stress and coping with it (Bandura, 1997).

Self-efficacy allows for relieving stress and anxiety through positive coping with stressors. A low sense of self-efficacy has been linked to a higher risk of alcohol and substance consumption and athletic burnout (Gustafsson et al., 2007). Adequate self-control implies avoiding distraction and handling negative thoughts (Highlen & Bennett, 1983). The ability to stay focused on a task in a tense situation requires strong confidence in one's skills, lacking which, athletes may be afraid of mistakes (Bandura, 1997). Even the strongest athlete can make mistakes: cognitive ruminations derived from mistakes constitute a real enemy against which athletes must fight. Cognitive control can help to block mental rumination on errors and failures and to stay focused on performance and goals (Highlen & Bennet, 1983).

The CSS has been developed using a multidimensional approach, providing a multifaceted picture of individuals' efficacy beliefs. According to Bandura (1997, 2006), exploring self-efficacy beliefs in different self-regulatory domains is essential to investigate their interrelationships and understand how individuals orchestrate them to fulfill their goals in challenging and demanding situations. Indeed, chess players may perceive themselves as highly efficacious in accomplishing technical tasks (e.g., analyzing a chess game to the finest details) but less efficacious in managing negative emotions associated with demanding and stressful situations occurring during the competition. A multidimensional conceptualization of self-efficacy has important practical implications because instructors and professional players may use the CSS to gain a 360-degree understanding of self-regulatory capabilities to monitor emotion management and increase problem-solving capabilities, thus coping effectively with problems that may arise during the game. Eventually, this may result in tailoring interventions and training to strengthen individual resources. In the following section, we detail the studies conducted to identify the items forming the CSS and the results of the analyses aimed to investigate its psychometric characteristics.

STUDY 1

METHOD

Participants and Procedure

The first study aims to develop the CSS items pool. First, we wanted to understand how chess players prepare for an important event for which ambitious goals are set, such as winning the tournament. In particular, we were interested in focusing not only on technical aspects but also on emotional ones to develop items that reflect both these dimensions. Participants were recruited by direct contact, and those willing to participate were given a copy of the open-ended questionnaire used in this phase (see below). In order to obtain a representation of all levels of players (from professional to amateur) and not only of a specific group of them, high and medium-high level chess players were recruited for this phase of the study. We reached a sample of 23 participants (18 males) with a mean age of 32. All of the participants have a FIDE[2] official title: Grand Master (*n* = 8), International Master (*n* = 2), FIDE Master (*n* = 6), Candidate Master (*n* = 4), and Woman FIDE Master (*n* = 3). Thanks to great experience derived from participation in many competitions, each of them could provide a wider variety of aspects typical of chess competitions. Using a "bottom-up" approach, the item generation process benefited from implementing the "critical incident" technique (Flanagan, 1954), consisting of three open-ended questions to identify and classify behaviors associated with personal success or failure.

Regarding the critical incident technique, we included a fourth question to better investigate players' feelings, emotions, and thoughts during and at the end of a tournament. Moreover, the four questions were presented in two different scenarios. The first was a positive scenario, so respondents had to recall a particular moment in which they had managed to achieve their goals and then answer the questions: a) "What are the situations and the events (external or personal alike) that preceded the tournament?," b) "Please describe in detail what you did during the tournament to achieve your goal," c) "Please explain why, in your opinion, what you did during the tournament helped to achieve your goal," d) "What were your thoughts, feelings, and emotions during and at the end of the tournament?." The second scenario was, instead, negative. Respondents had to recall a particular moment in which they had failed to achieve their goals and answer the following four questions: a) "What are the situations and the events (external or personal alike) that preceded the tournament?," b) "Please describe in detail what you did during the tournament to achieve your goal, which you did not achieve, nonetheless," c) "Please explain why, in your opinion, what you did during the tournament did not help to achieve your goal," d) "What were your thoughts, feelings, and emotions during and at the end of the tournament?"

Results

In order to identify which specific aspects of chess competitions were important for the players, a qualitative analysis of commonly recurring themes (Braun & Clarke, 2006) was conducted. The authors read the players' answers several times to familiarize themselves with the data; then, events were coded to collect all data relevant to each potential theme; lastly, the structure of a table of themes derived from the players' answers to the proposed questions was defined. Many themes have emerged: the main ones seem to be the importance of maintaining a high level of concentration and having good mental and chess preparation for the tournament. Chess players reported that it is important not only to have good chess training to face difficult situations that may occur during the game but also to engage in relaxing and soothing activities (e.g., listening to music, taking walks, doing physical activity, spending time with other players) in order to cope with stress and negative emotions such as anger, disappointment, and frustration. Other elements were the importance of having a comfortable playing environment, following a healthy diet, and reducing alcohol consumption, and the importance of a daily routine that can help maintain an adequate focus on the goal and high motivation. Moreover, they reported that it was important to try not to focus on previous defeats but, instead, on the next game, trying to recall positive memories (e.g., thinking of loved ones and remembering past successes) to avoid negative performance and failure. For what concerns the themes (especially those related to coping with emotions) addressed in other instruments to measure self-efficacy in other domains (e.g., Barbaranelli et al., 2018; Caprara, 2001), items from these already existing self-efficacy scales were adapted to the chess domains. For themes specific to chess (e.g., those related to game studying and preparation and problem-solving during the game), items were developed ad hoc based on the guidelines developed by Bandura (2001).

Finally, the resulting pool of 63 items was divided into nine hypothetical dimensions: a) *negative emotions*, 14 items regarding the ability to control negative emotions like feelings of guilt due to poor preparation, excessive distraction, and the like (e.g., "How capable are you of managing your anger when you don't get the result you were expecting to achieve?"); b) *positive emotions*, eight items regarding the ability to find comfort in remembering moments of joy when facing difficulties (e.g., "How capable are you of finding solace in happy memories when you run into difficulties?"); c) *introspection skills*, three items concerning the ability to examine reactions due to success and failure (e.g., "How capable are you of analyzing your reactions in the case of either failure or success?"); d) *problem-solving*, six items describing the ability to identify effective solutions to complex positions on the chessboard (e.g., "How capable are you of identifying alternative effective solutions when you are in complex and possibly very disadvantageous positions?"); e) *efficacy in task/preparation*, 11 items regarding the ability to deeply engage in chess activities to obtain settled goals (e.g., "How capable are you of fully committing yourself during the chess training until you reach the goals you set?"); f) *efficacy during the game*, 13 items regarding the ability to pay attention during all phases of a game (e.g., "How capable are you of always conducting the analysis of the game to the finest details?"); g) *self-regulative efficacy*, two items regarding the ability to resist being involved in distracting activities (e.g., "How capable are you of resisting friends' pressure to be involved in activities that might distract you during the tournament?"); h) *social efficacy*, three items regarding the ability to ask advice from persons with greater experience (e.g., "How capable are you of asking more experienced and competent people for advice?"); i) *routine management*, three items regarding the ability to adhere to a reassuring routine (e.g., "How capable are you of not being too swayed if your behavioral routine is not viable or is interrupted?"). Items asked respondents to indicate their degree of confidence in their ability to perform the behavior described by the item using a 5-point Likert-type scale ranging from 1 (*not confident at all*) to 5 (*completely confident*).

Conclusions

Thanks to the experience of the chess players involved in this preliminary study, it was possible to have specific information on the main elements that characterize chess performance in competitions from both the technical and emotional points of view. This made it possible to construct a scale that may eventually be administered to assess self-efficacy in professional players and amateurs. Though the representation of dimensions that characterize different personal spheres are linked both to individuals' internal states and to the game itself, it may be possible to understand which areas players need to implement to achieve better performance. The assessment of the psychometric characteristics of this new scale will be the object of Study 2.

Study 2

Participants and Procedure

The second study aims to validate the CSS. Participants were chess players selected using a convenience sampling procedure. Data were collected in Italy during chess tournaments approved by FIDE. The final sample comprised 371 players (330 males) from all chess categories, with an average age of 44.42 years (*SD* = 16.65). Elo ratings were collected based on the range classification: the range representing the highest number of players (*n* = 118) was from 1600 to 1900 Elo points. Eighty-six point nine percent of the participants reported being of Italian nationality (*n* = 322). Participants that were not fluent in Italian (*n* = 35) completed an English version of the questionnaire. To all participants, the CSS was administered online via a link to the Survey Monkey server.

Measures

Self-efficacy. The Chess Self-efficacy Scale (CSS) comprises 63 items, measuring nine domains of self-efficacy (see Study 1 for a detailed description of the domains). Each item is assessed through a 5-point Likert-type scale (1 = *not confident at all*, 5 = *completely confident*).

Demographics information. Demographics were gathered — gender, age, nationality, educational level, relationship status, Elo FIDE rating, chess title, age at which they started to play chess, age at which they started to play professional chess, hours dedicated to chess training per week, frequency of participation in an official tournament, job.

Data Analytic Strategy

A combination of exploratory and confirmatory factor analyses was used to explore the dimensionality of the item pool devised from Study 1. Because the strategy adopted to identify the "themes" or domains of self-efficacy was substantially bottom-up, and given that for each theme it was developed a different number of items, we decided to use parallel analysis (Horn, 1965) in order to identify the number of plausible factors needed to explain the correlations between the items. Parallel analysis was conducted through the FACTOR software (Ferrando & Lorenzo-Seva, 2017). In particular, parallel analysis in FACTOR is based on minimum rank factor analysis (Timmerman & Lorenzo-Seva, 2011), the default number of random correlation matrices is 500, and the method to obtain random correlation matrices is based on permutation of the raw data (Buja & Eyuboglu, 1992). FACTOR allows comparing real-data eigenvalues with mean as well as with 95th percentile of random correlation matrices. As a conservative approach, we adopted the 95th percentile cut-off. Once an adequate number of nonrandom factors was suggested by parallel analysis, factor loadings were estimated using the principal axis factoring estimator and rotated via Promax oblique rotation with SPSS statistical software. The results from exploratory factor analysis (EFA) were used to identify the more adequate items to be representative of the multiple-factor solution. In order to be considered adequate, an item must show a primary loading above the recommended range of |.30| to |.40| (e.g., Comrey & Lee, 1992; Thompson, 2004) and a difference between the primary and the second-highest cross-loading higher than |.3| (Matsunaga, 2010). EFA was rerun after eliminating these "poorly behaved" items (see Brown, 2015) to identify a set of items that can be univocal measures of every single factor. Then a series of confirmatory factor analyses (CFAs) was conducted to deepen the analysis of scale dimensionality. Following an approach adopted in a previous paper on self-efficacy measurement (Barbaranelli et al., 2018), four different factorial models were tested on the final pool of items selected from EFA: a) CFA; b) hierarchical-CFA, including first-order factors and higher order factor; c) hierarchic exploratory structural equation modeling (ESEM), including first-order and higher order factors; d) bifactor ESEM (B-ESEM), including specific standard error factors and one global standard error factor. This comparative approach strongly capitalizes on the literature on the various sources of multidimensionality (Morin et al., 2016; Sánchez-Oliva et al., 2017) within the framework of B-ESEM (Asparouhov et al., 2015).

Based on Hoyle's (1995) recommendations and according to a multifaceted approach to an assessment of the model fit, we considered the following fit indices: comparative fit index (CFI); Tucker-Lewis index (TLI); root-mean-square error of approximation (RMSEA) along with 90% confidence interval (CI) limits and with the test of close-fit; and standardized-root-mean square residual (SRMR).

The robust maximum likelihood estimator (MLR) included in Mplus 8.9 software was used to take into account multivariate nonnormality (Muthén & Muthén, 1998/2017). Missing values were treated using the default Mplus method of full information maximum likelihood (FIML). For the best-fitting model, we report standardized factor loadings (λ) and uniquenesses (δ). As estimates of model-based reliability, we included the omega coefficient of composite reliability (McDonald, 1970), $\omega = (\Sigma|\lambda_i|)^2/([\Sigma|\lambda_i|]^2+\Sigma\delta_{ii}$. This index is preferred over Cronbach's alpha because it has the advantage of explicitly considering the parameters of the measurement model. Finally, ANOVA was used to examine the differences between players of different Elo rating scores in CSS factors.

RESULTS

Preliminary Items Statistics

Items' distribution characteristics showed mean values between 2.7 (*SD* = 0.78) and 3.9 (*SD* = 1.32) with an average mean of 3.35 (*SD* = 0.98); skewness was between –.81 and .30 (Mean asymmetries = –0.13), and kurtosis between –.95 and .46 (Mean kurtosis = –.401). Therefore, all distributions are normal, and no items are dramatically above or below the expected theoretical mean (= 3).

Exploratory Factor Analysis

Parallel analysis evidenced the presence of four major factors: in fact, while the fourth real-data eigenvalue was 4.4706, the fourth average and 95% artificial eigenvalues were respectively 3.198 and 3.317, the fifth real-data eigenvalue was 3.027 while the fifth average and 95% artificial eigenvalues were respectively 3.099 and 3.218. The first four factors were then extracted and rotated using respectively principal axis factoring and Promax oblique rotation with SPSS statistical software. This solution explained 34.93% of the variance. In the obliquely rotated pattern, several items showed a primary loading lower than the recommended range of |.30| to |.40| (e.g., Comrey & Lee, 1992; Thompson, 2004) or a difference between the primary and the second-highest cross-loading of less than |.3| (Matsunaga, 2010). We then re-ran EFA after eliminating these "poorly behaved" items (see Brown, 2015) to identify a set of items that can be univocal measures of every single factor. The analysis of these 38 items evidenced the following four factors: a) preparation and game loaded by 11 items related to the preparation pregame activity (e.g., studying all possible game variants and strategies to be adopted during the game); b) negative emotions loaded by 14 items related to managing negative emotions occurring before, during, and after the game, and the related stressors; c) problem-solving loaded by eight items related to player's ability to find effective solutions to problems occurring during the game; d) positive emotions loaded by five items related to the ability to find comfort in positive emotions to cope with difficult and stressful moments that can occur during a game. Table 1 presents the rotated factor pattern of this solution. Factor explained 40.59% of the variance. Factor correlations ranged from .14 to .44. EFA solution is equivalent to an ESEM when no covariances between residuals are considered or when equality constraints are not imposed. We thus rerun the analysis using the ESEM within the software Mplus, using MLR estimators. The ESEM/EFA 4-factor solution yielded a significant chi-square (557) = 992, $p < .001$, but good fit indices in RMSEA = .046, p(RMSEA < .05) = .93, 90% CI [.041, .050], and SRMR = .039. The incremental indices CFI and TLI were marginal, being respectively equal to .90 and .87. However, the RMSEA of the null model (the model that does not specify any relation between the variables) was .128: as highlighted by Kenny (see https://davidakenny.net/cm/fit.htm), when the RMSEA of the null/independence model is ≤ .158, and the RMSEA of the target model is ≤ .05, the incremental indices can barely reach the value of .90. Therefore, their interpretation is not recommended. In our case, the RMSEA of the null and of the target models were respectively .128 and .048: therefore, the CFI and TLI cannot be meaningfully interpreted. The factor loading MLR estimates were highly congruent with the PAF estimates obtained in SPSS, with Tucker's (1951) phi congruence coefficients equal respectively to .99, .99, .96, and .95 for the four factors. As demonstrated by Lorenzo-Seva and Ten Berge (2006), values of .95 or above mean that the two factors compared can be considered equal.

Confirmatory Factor Analysis

Following an approach introduced by Morin and colleagues (2016), we further explored the factorial structure of the CSS by testing the following alternative models on our data:

a) Independent cluster model (ICM)-CFA. This model posits four correlated factors, each measured by the corresponding CSS items with all the cross-loadings on unintended factors fixed at zero; this model is more restrictive than the EFA/ESEM one. For each item, the target factor was specified considering factor loading as it emerged in the corresponding factor in EFA. The advantage of this model is in its parsimony. The disadvantage is the possible failure to account for sources of construct-relevant psychometric multidimensionality, namely, items referring to a construct may be validly associated with one or more of the others, and this is often manifested by nontrivial cross-loadings.

b) Hierarchical-CFA, including first-order factors and higher order factors. This model is a variant of model (a) where higher order factors are posited to test the presence of overarching dimensions underlying the responses to multiple items. In particular, considering the substantial correlations between the two factors related to performance (= .44) and the two factors related to emotions (= .43), a CFA model was tested positing a "performance" second-order factor accounting for the correlation between the two "chess-performance" factors, and an "emotion" factor accounting for the correlation between the two "emotional" factors. Finally, a third-order "general self-efficacy" factor was posited, accounting for the variance shared between the two second-order factors.

c) Hierarchical ESEM (H-ESEM) is specified using the ESEM-within-CFA approach (Morin et al., 2016). In contrast to the ICM-CFA model, cross-loadings are not constrained to be fixed at zero. This feature of ESEM enables the limitations of ICM-CFA models to be overcome while remaining within the realm of SEM. As in model b), first-order factors were specified as related to higher order factors posited to test the presence of overarching dimensions underlying the responses to multiple items.

d) Bifactor ESEM (B-ESEM), including specific standard error factors and one global standard error factor. The bifactor ESEM (B-ESEM) model posits one global factor and four orthogonal-specific factors with an orthogonal target rotation. The B-ESEM model is intended to account for two different sources of multidimensionality: one referring to overlapping constructs (through the specification of the ESEM pattern of loadings for specific factors) and one related to the presence of an overarching construct (through the specification of a global factor).

Table 1 presents the results of these four different models as far as fit indices are concerned.

TABLE 1
Goodness of fit statistics for the estimated models

Model	χ^2	*df*	RMSEA	CFI	TLI	SRMR
a. ICM-CFA	1287	659	.051, *p*(RMSEA < .05) = .386 90% CI [.047, .055]	.85	.84	.066
b. Hierarchical -CFA	1289	660	.051, *p*(RMSEA < .05) = .382 90% CI [.047, .055]	.85	.84	.067
c. Hierarchical ESEM	1007	560	.046, *p*(RMSEA < .05) = .900 90% CI [.042, .051]	.90	.87	.043
d. Bifactor ESEM	833	523	.040, *p*(RMSEA < .05) = 1.000 90% CI [.035, .045]	.93	.90	.034

Note. *df* = degrees of freedom; RMSEA = root-mean-square error of approximation; CFI = comparative fit index; TLI = Tucker-Lewis index; SRMR = standardized root-mean-square residual; ICM = independent cluster model; CFA = confirmatory factor analysis; ESEM = exploratory structural equation modeling.

Results of the four factorial models (Table 1) clearly showed that bifactor ESEM was the best model, followed by hierarchical ESEM. However, the two solutions present several problems. Hierarchical ESEM presents a problem of identification because the third-order factor loadings in the standardized solution showed a loading higher than 1 and negative residual variances (this notwithstanding the equality constraints posited on both parameters). Another clue of identification problems is manifested by relatively higher standard errors for the higher order parameters. The issues related to the bifactor ESEM are not of computational nature but are related to the interpretation of the factors. In particular, the loadings on the general factor were generally low, ranging from 0 to .48, with an average of .29, with the exception of the items related to positive emotions, which showed loadings from .55 to .72 with an average of .65. It is hard to interpret this factor as the "general" factor in a bifactor model, while it seems to reflect more the specific positive emotions factor. The three specific factors of preparation and game, negative emotions, and problem-solving are very well captured by the items related to these three self-efficacy domains (with average factor loadings of .55, .53, and .48, respectively). The last specific factor is problematic because it presents negative loadings from two positive emotions items (which show a positive and high loading on the general factor) and positive albeit lower factor loadings from the remaining positive emotions items: the absolute average loading of these items is .39, but as noted above, items showed loadings of opposite sign on the same factor while showing loadings of the same sign on the general factor. The interpretation of this factor is really questionable. All in all, the interpretation of this bifactor solution is truly problematic.

Regarding the two CFA models, both presented an adequate fit as far as the RMSEA and SRMR are concerned (the interpretation of the CFI and TLI is problematic due to the low value of the RMSEA of the baseline model). These two models are nearly equivalent, so it is a matter of convenience whether to consider a 4-correlated factors model or a third-order model. In this second case, the unexplained correlations between the first-order factors are explained by positing the action of higher order latent variables. Table 2 presents items factor loading on the primary factors. Figure 1 shows the third- and second-order factorial structure. These results evidence a general factor of self-efficacy as the "vertex" of a graph-like structure, where the performance and the second-order emotional factors are at the intermediate level vertices, and the primary order factors are the terminal vertices aiming directly at the items measuring players confidence in performing each specific behavior. All factor loadings are significant and high at any level considered, thus confirming a strong internal validity of the factors.

TABLE 2
Factor loadings of primary factors in EFA and CFA

Preparation and game	
Follow the daily routine of studying and games preparation	.679 (.638)
Keep your attention when studying and during your game preparation	.698 (.712)
Do your chess training and preparation with extreme accuracy	.745 (.723)
Organize your study and preparation even when there are setbacks, failures, and urgent situations	.701 (.699)
Increase your efforts in studies and preparation during a difficult time	.680 (.683)
Gather all the information you may need to improve your training activities	.649 (.659)
Always complete your preparatory work in every circumstance	.669 (.706)
Fully commit yourself during chess training until you reach the goals you set	.607 (.692)
Get the highest benefit from the recent technological innovation to improve your chess skills	.515 (.570)
Always conduct the analysis of the game to the finest details	.577 (.606)
Resist friends' pressure to drink beer, wine, or other alcoholic drinks, before, after, or during the game	.411 (.317)
Negative emotions	
Avoid losing heart when you get a negative result	.710 (.725)
Overcome shame when your weaknesses are brought out in front of other people	.667 (.588)
Do not be too disheartened when the way you conducted your game is criticized	.662 (.619)

(table 2 continues)

Table 2 (continued)

(*Negative emotions*)	
Overcome frustration for your failures	.643 (.719)
Hold back the shame of failing in those goals that your friends have achieved	.600 (.613)
Avoid getting upset if some players have inappropriate behavior during the game	.563 (.435)
Manage your anger when you don't get the result you were expecting to achieve	.586 (.636)
Keep your self-control before, during, and after the game, independently from your score	.568 (.523)
Do not lose control over your actions when you are really upset	.577 (.542)
Do not give too much importance to thoughts, gestures, or events that have little to do with the chess game (e.g., superstitious thoughts, always using the same pen, or always wearing the same clothes, etc.)	.456 (.408)
Do not be too swayed if your behavioral routine is not viable or is interrupted	.491 (.492)
Avoid losing heart when your loved ones are far away	.447 (.446)
Keep your feelings of guilt under control when doing something wrong (limited preparation, too much distraction, etc.)	.426 (.472)
Resort to your positive attitude when you go through a difficult time	.484 (.551)
Problem-solving	
Generate new ideas to manage any unexpected event during the game	.763 (.744)
Identify effective alternative solutions when you are in complex and possibly very disadvantageous positions	.684 (.730)
Burst with ideas during the game	.784 (.692)
Identify new solutions rather than keep following the usual ones	.537 (.653)
Rely on your instinct during the game	.593 (.542)
Foresee the potential consequences of the different alternative solutions when facing a problem	.562 (.508)
Take quick decisions when needed	.520 (.540)
Make a deep and effective tactical and/or strategic analysis before taking any decision	.390 (.330)
Positive emotions	
Openly show your satisfaction when you meet the targets you set for yourself	.525 (.415)
Fully express your happiness when you get a positive result	.464 (.355)
Find solace in happy memories when you run into difficulties	.755 (.844)
Gain benefit from recalling happy memories when you are in stressful situations	.729 (.789)
Recall your past successes when you are facing new challenges	.650 (.643)

Note. EFA (exploratory factor analysis) factor loadings are reported outside brackets, whereas CFA (confirmatory factor analysis) factor loadings are reported in brackets.

Reliability

Cronbach's alpha and omega coefficient computed on the factor scale resulting from CFA showed adequate reliability. In particular, the preparation and game factor scale showed a coefficient of .88 (both

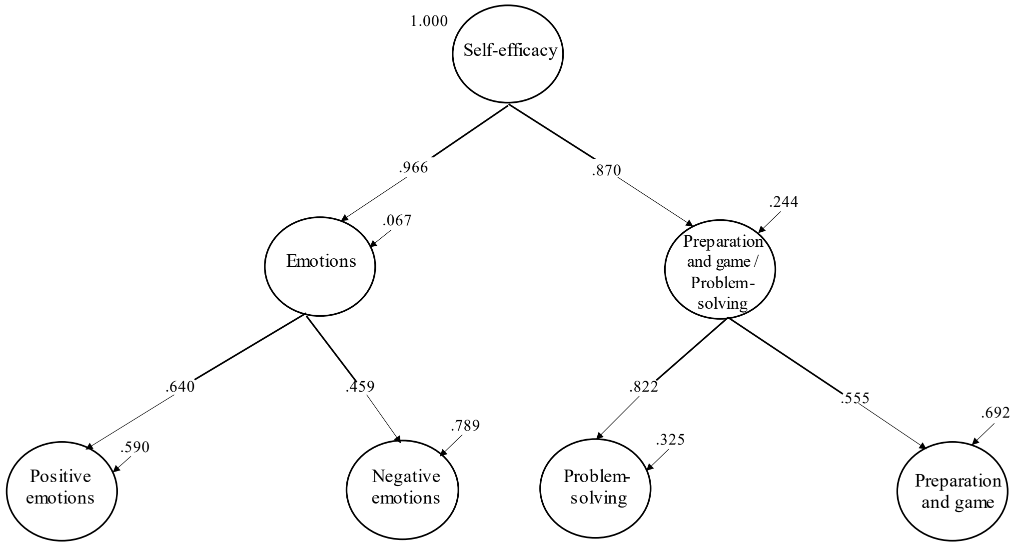

FIGURE 1
Third- and second-order factorial structure

alpha and omega). The problem-solving factor scale showed coefficients of .84 (alpha) and .82 (omega). The negative emotions factor scale showed coefficients of .87 (alpha) and .86 (omega). The positive emotions factor scale showed coefficients of .77 (alpha) and .75 (omega). The performance factor scale showed coefficients of .89 (alpha) and .92 (omega); the emotion factor scale showed a coefficient of .85 (alpha) and .90 (omega). Finally, the general self-efficacy factor scale showed coefficients of .90 (alpha) and .95 (omega).

Criterion Validity

The validity of the solution was examined by means of ANOVA to test differences between the groups of players differing in their Elo rating. To this aim, three different groups of players were defined by the first author (who is an International Chess Arbiter with many years of experience in National and International Chess tournaments). Group 1 comprised 168 weak players (maximum Elo rating of 1900); Group 2 comprised 131 intermediate players (Elo rating between 1901 and 2350); Group 3 comprised 23 strong players (Elo rating greater than 2350). Ten participants were not considered because they did not indicate their Elo rating. The dependent variables in all the ANOVAs were the first-order, second-order, and third-order factor scores derived from the 3-order hierarchical factor analysis presented in Figure 1 and in Table 2. Results related to the first-order factor scores showed a significant difference between the groups in preparation and game factor, $F(2, 319) = 5.304$, $p < .01$, $\eta^2 = 0.032$, and problem-solving factor, $F(2, 319) = 10.321$, $p < .001$, $\eta^2 = 0.061$ as regards first-order factors. Profiles of the three groups on the four first-order factor scores are shown in Figure 2. No significant differences between groups emerged in the two emotional first-order factor scores. A significant difference between the groups (Figure 3) was also found in the second-order preparation and game/problem-solving factor, $F(2, 319) = 8.976$, $p < .001$, $\eta^2 = 0.053$, and emotions factor, $F(2, 319) = 6.068$, $p < .01$, $\eta^2 = 0.037$, as well as in the third-order self-efficacy factor, $F(2, 319) = 6.701$, $p < .01$, $\eta^2 = 0.040$. Tukey-HSD post-hoc analyses conducted after a significant omnibus F test showed that Group 1 (“weak players”) showed lower means in all factor scores than Groups 2 and 3, which in their turn showed no significant differences.

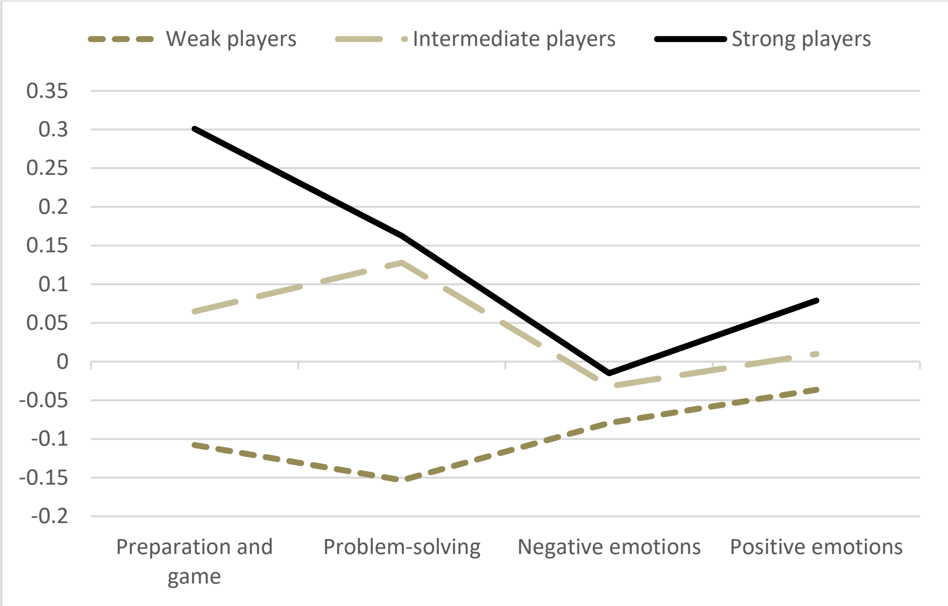

FIGURE 2
Profiles of the three groups of players in CSS first-order factor scores
Note. Factor scores are reported in the vertical axis. The three groups (weak, intermediate, and strong players) are defined in the paragraph devoted to criterion validity.

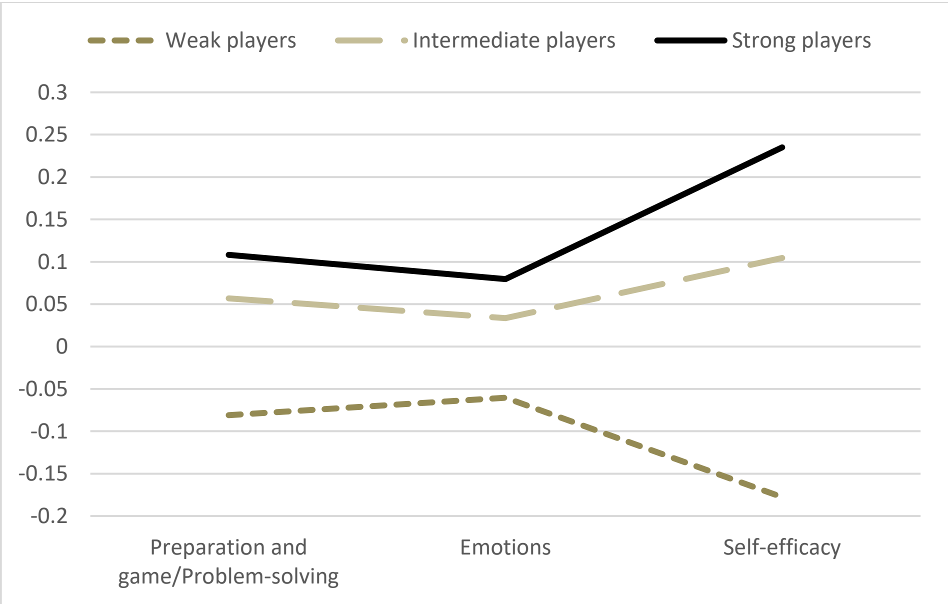

FIGURE 3
Profiles of the three groups of players in CSS second- and third-order factor scores
Note. Factor scores are reported in the vertical axis. The three groups (weak, intermediate, and strong players) are defined in the paragraph devoted to criterion validity.

DISCUSSION AND CONCLUSION

This study aimed to validate the Chess Self-efficacy Scale, an instrument to assess the perceived self-efficacy beliefs of chess players. To develop the CSS, we followed Bandura's (1997) approach, which highlights the relevance of considering various self-regulatory capabilities within specific domains. Despite being officially recognized as a sport by the Olympic Federation and the National Olympic Committees, chess is often not considered as such because the kind of performance and efforts required in this discipline are not strictly physical, but rather mainly of a mental or cognitive nature. However, just like the athletes engaged in physical sports, chess players must not only accomplish technical tasks but also manage their emotions during the competitions; for this reason, it is pivotal to consider both performance-related and emotional domains to get a more in-depth understanding of how the human self-regulatory system operates and impacts on chess players.

Factor analyses partially confirmed the hypothesized dimensions underlying scale items. Only four of the nine hypothesized factors were confirmed: preparation and game, problem-solving, negative emotions, and positive emotions. Compared to the original scale, some items were removed or merged into other dimensions, as suggested by factor loadings. In particular: four items were removed from the negative emotions dimension; three from positive emotions; two from efficacy in task/preparation; eight items were removed from the efficacy during the game, and the remaining were merged into problem-solving (two items) and preparation and game (three items); one item was removed from the routine management dimension, and the remaining two items were merged into negative emotions. In addition, the dimensions of introspection skills, self-regulative efficacy, and social efficacy were removed. We hypothesize that these had an excessively small number of items.

The CSS has proved to be able to capture: players' ability to prepare strategies to be adopted during the game through an in-depth analysis of the game; their ability to manage negative emotions that could occur before, during, and after the game; their ability to find practical solutions for problems that may occur during a game; their ability to find comfort in positive emotions to counteract negative emotions and despondency due to failures. CFA confirmed this 4-factor structure while showing two second-order and general third-order factors. ANOVAs showed significant differences between chess players of different levels, especially in first-order preparation and game and problem-solving factors, significantly lower in weak players than in the intermediate and strong players. Significant differences also emerged in the second- and third-order factors, with the same pattern differentiating "weak" from "intermediate" and "strong" players. The CSS has therefore proven to be a valid tool for assessing chess self-efficacy. Weak players are consequently less efficacious in the preparation, the game itself, and managing emotions.

Some limitations of the present research need to be mentioned. The first is related to the unbalance of gender representation in the sample. Given that chess is historically considered a "male game," it was difficult to find female participants. A second limitation is the use of the same sample for conducting both EFA and CFA. On the one hand, this choice was forced by the impossibility of splitting the sample into two subsamples without the risk of ending with two subsamples too small to conduct factor analyses properly. However, it is essential to underline that CFA was not a simple replica of the 4-factor model emerging from EFA. Indeed, CFA hypothesized the presence of higher order factors explaining the covariance among primary factors. This hypothesis is not testable in EFA: thus, CFA resulted in a data-analytical contribution overcoming the limits of EFA. A third limitation is the generalizability of the results: further studies could consider chess players of other levels and different cultures. And a fourth limitation is the missing data of some participants' Elo rating: some players were afraid to be recognized through their personal rating and they preferred not to indicate it. These missing values lead to the impossibility of assigning these players into any group for the criterion validity analyses.

Future developments of this study may expand the assessment and the study of SE in young chess players: this will imply some revision of items to make them entirely understandable by children aged 8-10 years. Today, chess teaching is increasingly widespread in schools; thus, the applicability of the CSS for the assessment in primary and junior high school is crucial. At the same time, the study of chess self-efficacy would benefit from being framed within the more general context of personality domain. It could be interesting to examine its relationships with personality traits, such as those comprising the so-called Five-Factor Model, to investigate the differential impact of self-efficacy and personality traits on performance. This could eventually prefigure a "process" model where chess self-efficacy would act as a mediator between "distal" personality traits and performance (see in this regard Barbaranelli et al., 2019). The findings of this study suggest some potential practical implications of the CSS. The Chess Self-efficacy Scale could be used in the training phases by competitive players or instructors to understand which areas must be developed to obtain better performance and achieve ambitious goals. It is essential not to limit the training to the mere study of the theoretical variants or to memorizing the greatest possible number of match openings and/or finals. Still, it is also necessary to learn how to manage and use one's emotions, both positive and negative, to avoid being overwhelmed by stress and anxiety in delicate moments of the match or tournament. It is also essential to foster problem-solving skills to cope with problems or unexpected events during the game. The Chess Self-efficacy Scale may find a valid application both in contexts related to the growth of young chess players and in mental coaching contexts for the acquisition of better management of the performance of high-level chess players. In this regard, users of the CSS may capitalize on the 3-stratum structure evidenced by CFA. While the CSS structure consists of four specific domains, a general mastery function informs and influences all chess activities and behavioral manifestations through its performance and emotional facets. Thus, focusing on different levels, a chess trainer or a sport psychologist may plan an intervention to develop specific domains, more general intermediate areas, or a general sense of chess mastery.

NOTES

1. Name of Arpad Emrick Elo, inventor of the rating system that establishes the strength of chess players.
2. Fédération Internationale des Échecs [International Chess Federation].

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