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The Development of a Cognitive Flexibility Scale in Sports: Validation and Reliability

Sporda Bilişsel Esneklik Ölçeğinin Geliştirilmesi: Geçerlik ve Güvenirlik

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ABSTRACT

This study aimed to develop a measurement tool (Cognitive Flexibility in Sports Scale-CFSS) whose validity and reliability have been checked by statistical methods to measure athletes' cognitive flexibility levels. Therefore, from expert opinions, data were obtained from the research groups with the pre-application form (60 items) and post-application form (20 items). The study was conducted with three groups consisting of different individuals. Validity-reliability checks were made with the research groups (1st Group=37 individuals, 2nd Group=241 individuals, 3rd Group=366 individuals). The sub-dimensions obtained from the analyses and the variance loadings they have/explain are as follows: 1. Ability to Produce Alternative Solutions (12.11%), 2. Strategic Flexibility (15.32%), 3. Situational Adaptability (14.97%) and 4. Problem Solving and Decision Making (14.07%). The total variance load of SBEÖ is 56.47%. The fit index values of SBEÖ are CMIN/DF: 2.995, RMSEA:.074, GFI:.89, AGFI:.86, CFI:.91, RMR:.043, NFI:.89, TLI:.89, IFI:.91, DF:164, CMIN:491.139. The criterion validity of CFSS was also checked. The pre-post application process analyses determined that the internal consistency coefficient was within the reference ranges (<.60) in the sub-dimensions and the overall scale. As a result, in this study, the "Cognitive Flexibility Scale in Sports-CFSS", consisting of 20 items and four sub-dimensions, the validity-reliability of which was checked with multiple methods, was developed and presented to the literature.

Keywords: Cognitive flexibility, scale development, sports, validity and reliability.

ÖZ

Bu çalışma ile sporcuların bilişsel esneklik düzeylerinin ölçülebilmesi amacıyla geçerliği ve güvenirliği istatistiksel yöntemlerle denetlenmiş bir ölçme aracının (Sporda Bilişsel Esneklik Ölçeği-SBEÖ) geliştirilmesi amaçlanmaktadır. Bu nedenle uzman görüşleri sonucunda ön-uygulama formu (60 madde) ve son-uygulama formu (20 madde) ile araştırma gruplarından veri elde edilmiştir. Çalışma, farklı bireylerin oluşturduğu üç grup ile yürütülmüştür. Araştırma grupları (1. Grup=37 birey, 2. Grup=241 birey, 3. Grup=366 birey) ile geçerlik-güvenirlik kontrolleri yapılmıştır. Analizler sonucunda ulaşılan alt boyutlar ve sahip oldukları/açıkladıkları varyans yükleri şu şekildedir: 1. Alternatif Çözüm Üretebilme (%12,11), 2. Stratejik Esneklik (%15,32), 3. Durumsal Uyum Yeteneği (%14,97) ile 4. Problem Çözme ve Karar Verme (%14,07). SBEÖ'nün sahip olduğu toplam varyans yükü %56,47'dir. SBEÖ'ye ait uyum indeks değerleri CMIN/DF:2,995, RMSEA:,074, GFI:,89, AGFI:,86, CFI:,91, RMR:,043, NFI:,89, TLI:,89, IFI:,91, DF:164, CMIN:491.139 şeklindedir. SBEÖ'nün ölçüt geçerliği de denetlenmiş ve ön-son uygulama sürecindeki analizlerde iç tutarlılık katsayısının hem alt boyutlar hem de ölçek genelinde referans aralıklarda (<,60) yer aldığı tespit edilmiştir. Sonuç olarak; bu çalışmada 20 madde ve 4 alt boyuttan oluşan geçerliği-güvenirliği birden çok yöntem ile denetlenmiş "Sporda Bilişsel Esneklik Ölçeği-SBEÖ" geliştirilerek alanyazın sunulmuştur.

Anahtar Kelimeler: Bilişsel esneklik, ölçek geliştirme, spor, geçerlik ve güvenirlik.

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Introduction

Cognitive flexibility is a high-level executive function that refers to an individual's ability to quickly adapt to changing environmental conditions, develop alternative ways of thinking, and make strategic decisions in problem-solving processes (Dennis & Vander Wal, 2010). This concept relates to the individual's psychological resilience and behavioral and intellectual adaptation in stressful and uncertain situations (Gabrys et al., 2018). Recently, the importance of cognitive processes in sports has been increasingly emphasized. Sport is widely recognized as a complex phenomenon encompassing a range of positive and negative emotions, including competition, excitement, success, and failure. From the perspective of athletes, sport represents a multifaceted endeavor that combines mental, physical, and tactical aspects aimed at competing and achieving victory (Kara et al., 2025). Especially in intense competitions, skills such as instant decision-making, changing strategies, recovering from errors, and responding quickly to environmental stimuli have become decisive in the performance of athletes (Tenenbaum & Eklund, 2020). In this context, cognitive flexibility is an essential component of sports psychology, affecting individual and team performance. These characteristics, along with cognitive control and flexibility, are seen as crucial keys to coping with stress and contributing to mental well-being (Bedir, 2023).

It is stated that athletes with high levels of cognitive flexibility produce more effective solutions to the difficulties they encounter during training and competition, recover faster from mistakes, and adapt more easily to changing game conditions (Martin & Rubin, 1995; Gürpınar & Tuncel, 2022). This situation reveals that it is essential for athletes to achieve success with their physical competence, mental endurance, and flexible cognitive structure. However, literature reviews disclose the lack of an original and valid Turkish scale to directly measure the cognitive flexibility levels of athletes (Çelikkaleli, 2014; Yarayan et al., 2023). The vast majority of existing scales have been developed for individuals based on clinical or educational purposes and have not been customized for special situations in sports (e.g., competition pressure, change of tactics, coach feedback). In this context, developing a measurement tool that considers athlete-specific situations and has been statistically tested for validity and reliability will contribute to the more reliable conduct of academic studies and the more accurate evaluations by practitioners (coaches, sports psychologists, etc.).

Theoretical Framework

According to Martin and Rubin (1995), cognitive flexibility is the ability to reorganize one's thought processes in response to novel circumstances, come up with alternate answers, and adjust to changing environmental factors. This skill, primarily addressed under executive functions in psychology, is closely related to numerous mental processes such as attention shifting, control mechanisms, decision-making, and problem-solving (Dennis & Vander Wal, 2010; Diamond, 2013).

Individuals with high levels of cognitive flexibility are better able to deal with both internal and external sources of stress (Gabrys et al., 2018). This quality is especially noticeable in athletic pursuits that call for acute awareness of one's surroundings, lightning reflexes, and the ability to make split-second decisions. The ability to quickly adjust one's approach, bounce back from setbacks, think on one's feet, and adapt in the heat of competition are all hallmarks of cognitive flexibility (Moen et al., 2015).

Various scales have been developed in the literature to measure cognitive flexibility. The Cognitive Flexibility Scale, developed by Martin and Rubin (1995), aimed to measure the individual's level of adaptation to social and individual situations; it was adapted to Turkish by Çelikkaleli (2014). The Cognitive Flexibility Inventory, developed by Dennis and Vander Wal (2010) and adapted to Turkish by Gülüm and Dağ (2012) and Sapmaz and Doğan (2013), was structured to be used primarily in cognitive therapy. The Cognitive Flexibility Scale, developed by Bilgin (2009), was prepared based on university students.

Although not a sport-specific example, Yarayan et al., (2023) adapted the Cognitive Flexibility Inventory to athletes and created the “Athlete Cognitive Flexibility Inventory.” However, since this study is based on the Turkish translation and adaptation of an existing scale, it does not sufficiently cover behavioral patterns and competition dynamics specific to the sports context.

Therefore, the lack of a measurement tool originally developed and supported by psychometric validity-reliability analyses

covering situational difficulties specific to sports, such as coach feedback, change in the face of opponent tactics, and decision-making under performance pressure, is striking. Measuring cognitive flexibility in sports in this context contributes to the evaluations of coaches and sports psychologists and provides practical insights for training and performance enhancement. Also, it provides an original and valid data source for academic research (Tenenbaum & Eklund, 2020). The main starting point of this study is to fill this gap in the existing literature and develop an original scale that measures sport-specific cognitive flexibility behaviors. This novel approach has the potential to advance sports psychology significantly.

Purpose of the Study

The studies in the literature on the development or adaptation of a measurement tool to determine the cognitive flexibility levels of individuals are as follows: "Cognitive Flexibility Scale" developed by Martin and Rubin (1995), adapted to Turkish by Çelikkaleli (2014) and to Japanese by Oshiro et al., (2016); "Cognitive Flexibility Scale" developed by Bilgin (2009); "Cognitive Flexibility Inventory" developed by Dennis and Vander Wal (2010), adapted to Turkish by Gülüm and Dağ (2012) and Sapmaz and Doğan (2013); "Cognitive Control and Flexibility Scale" developed by Gabrys et al., (2018) and adapted to Turkish by Demirtaş (2019); It is seen that it is limited to the "Athlete Cognitive Flexibility Inventory" which was adapted into Turkish by Sapmaz and Doğan (2013) and adapted for athletes by Yarayan et al., (2023).

When the literature focused on cognitive flexibility is examined, it can be stated that there is a need for an original measurement tool whose validity and reliability have been statistically checked to determine the cognitive flexibility levels of individuals for sports. Therefore, the study aimed to develop a measurement tool (Sports Cognitive Flexibility Scale-SBEÖ) whose validity and reliability have been checked with statistical methods to measure athletes' cognitive flexibility levels during competition and/or training.

Methods

In this part of the study, detailed information about all stages of the study was provided to ensure clarity and transparency. First, information was provided about the research groups. Then, explanations were made about the item writing (item pool) and the data analysis techniques applied.

Research Groups

This study was conducted with three groups of different individuals to ensure that the participant responses would not be affected and to ensure impartiality (to check the construct validity by other individuals).

The Cognitive Flexibility in Sport Scale (CFSS) was developed and validated through three distinct research groups, each contributing to different phases of the scale's psychometric evaluation. The first research group, consisting of 37 participants, was involved in the initial pre-application phase. In this stage, a 60-item draft version of the scale was read aloud, and participants were asked to evaluate the clarity and comprehensibility of each item. Based on their feedback, six items were revised, and the comprehensibility of the remaining items was confirmed. This process ensured that all items were uniformly understood across individuals.

The second research group included 241 participants who responded to the revised 60-item pre-application form. The purpose of this phase was to examine the structural validity and internal consistency of the scale. Specifically, Exploratory Factor Analysis (EFA) and Monte Carlo Parallelism Test (MCPT) were used to assess the construct validity. At the same time, Cronbach's Alpha Coefficient (CAK) and the Split-Half Test were applied for reliability analysis. Based on the results of these analyses, 40 items were eliminated, resulting in a refined version of the scale consisting of 20 items.

In the final stage, the third research group, comprising 366 participants, was utilized to validate the final 20-item version of the CFSS. This phase included an assessment of criterion validity and further validating the scale's structure using Confirmatory Factor Analysis (CFA). Reliability checks were again performed using Cronbach's Alpha and the Split-Half Test. This sample size exceeds the commonly accepted rule proposed by Nunnally (1978), which suggests that the minimum sample size for scale validation should be at least 10 times the number of items (in this case, 20×10 = 200 participants). Each participant was assigned to only one group to avoid overlapping samples, and random sampling was employed throughout

the study to ensure equal selection probability among individuals (Bustami et al., 2017; Büyüköztürk, 2017).

Writing the Items and Preparing the Pre-Application Form

The literature on cognitive flexibility was reviewed in the item writing process, and previously developed scales focused on cognitive flexibility were evaluated. Then, to check the content and face validity of the 71 written items, the opinions of six academicians with the titles of associate professor and professor in sports sciences and educational sciences were sought. The expert evaluations were completed within two weeks, and the experts decided to revise 21 items and remove 11 items from the scale form. The revised 60-item scale form was submitted to the control of a Turkish Language expert with 15 years of experience, and the pre-application form was finalized. It was deemed appropriate to use the Five-Point Likert type to ensure the comprehensibility of the CFSS, minimize participant indecisiveness, and facilitate its grading and evaluation (Erkuş, 2016).

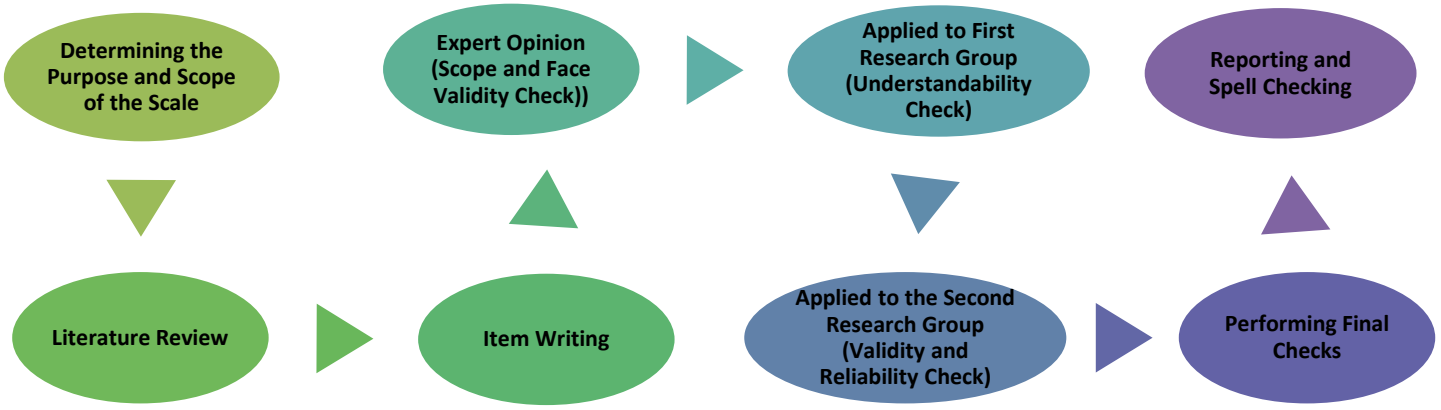
Scoring Levels and Equivalent Values of the CFSS

The Cognitive Flexibility in Sport Scale (CFSS) scoring intervals were determined based on the formula for dividing the total score range by the number of options. Since the CFSS uses a 5-point Likert scale ranging from 1 to 5, four intervals exist between these values. By dividing the total range (4) by the number of options (5), an interval width of 0.80 was obtained (4/5 = 0.80). Thus, each response option corresponds to a scoring range of 0.80 points. The response options and their corresponding score ranges and interpretations are as follows: Scores ranging from 1.00 to 1.80 correspond to the response option “Strongly Disagree” and indicate a Very Low Level of cognitive flexibility. Scores between 1.81 and 2.60 correspond to “Disagree” and indicate a Low Level of cognitive flexibility. Scores between 2.61 and 3.40 correspond to “Partially Agree” and indicate a Moderate Level of cognitive flexibility. Scores between 3.41 and 4.20 correspond to “Agree” and indicate a High Level of cognitive flexibility. Scores between 4.21 and 5.00 correspond to “Strongly Agree” and indicate a Very High Level of cognitive flexibility.

Analysis and Process

The process followed in this study, which was determined based on the stages expressed by Seçer (2015) and Şeker and Gençdoğan (2014) in the development of CFSS, is presented in Figure 1.

Figure 1.
Development Process of CFSS



As seen in Figure 1, the purpose and scope of the study were determined first in the development of the CFSS. Then, the relevant literature was reviewed, an item pool was created, and expert opinions were sought. After the experts had given

their opinions, comprehensibility and validity-reliability checks were performed on the first, second, and third research groups. After the validity and reliability checks, the scale was finalized, the reporting-spelling check stage was started, and the study was concluded.

The data obtained from the second and third research groups with CFSS were analyzed using statistical programs (SPSS/AMOS). While the pre-application analyses were conducted with the data obtained from research group 2, the final application analyses were conducted with the data obtained from research group 3. Therefore, first of all, Kaiser/Meyer/Olkin (K/M/O) and Barlett tests were used to check the adequacy of the sample size obtained with the Pre-application form for EFA.

Then, EFA was applied to check the structural validity of the data obtained in the preliminary application and to determine the sub-dimensions of the scale (Çolakoğlu & Büyükekşi, 2014; Hooper, 2012). Due to the positive correlation between the dimensions in EFA, Direct Oblimin Rotation Technique was used (Brown, 2009; Costello & Osborne, 2005) and items with factor loadings lower than .30 were removed from CFSS because Büyüköztürk (2018) suggested that item factor loadings with a value less than .30 should not be included in the scale. Since Pallant (2017) and Neale and Liebert (1980) suggested that factor loadings with eigenvalues lower than 1.00 should not be included in the evaluation, only dimensions with eigenvalues of 1.0 and above were considered.

To review the structure obtained with EFA during the pre-implementation process, it was deemed appropriate to test it with MCPT (Pallant, 2017), which allows the comparison of eigenvalues with randomly determined eigenvalues.

In the third research group, CFA was conducted using the Post-application form data to verify the CFSS structure determined in EFA. Therefore, χ2/sd, RMSEA, RMR, NFI, IFI, TLI, CFI, AGFI, and GFI fit index values of the Post-application form were determined and compared with the reference values in the literature (Harrington, 2009; Kline, 2011; Schumacher & Lomax, 2004; Seçer, 2015; Şencan, 2005) and shown in Table 1.

Table 1.
Reference values

Fit Indexes	*Rating*	
	Good	*Acceptance*
CMIN/DF	$0<\chi^2/sd\leq 3$	$3<\chi^2/sd\leq 5$
RMSEA	0≤RMSEA≤.05	.05≤RMSEA≤.08
GFI	.90<GFI≤1	.80<GFI≤.90
AGFI	.90<GFI≤1	.80<GFI≤.90
CFI	.95<CFI≤1	.90<CFI≤.94
RMR	0≤RMR≤.05	0.05≤RMR≤.1
NFI	.95<TLI≤1	.90<TLI≤.94
TLI	.95<TLI≤1	.90<TLI≤.94
IFI	.95<TLI≤1	.90<TLI≤.94

CMIN/DF: Chi-Square/Degrees of Freedom, RMSEA: Root Mean Square Error of Approximation, GFI: Goodness of Fit Index, AGFI: Adjusted Goodness of Fit Index, CFI: Comparative Fit Index, RMR: Root Mean Square Residual, NFI: Normed Fit Index, TLI: Tucker-Lewis Index, IFI: Incremental Fit Index.

The reliability of the data obtained with the structure of the CFSS that meets the reference values in Table 1 was checked with Cronbach's Alpha Coefficient (CAK) and two half-tests in both the pre-application and post-application processes. The Cronbach's Alpha Coefficient for the entire CFSS and its sub-dimensions was calculated at this stage.

Interpretation of Cronbach's Alpha Coefficient in CFSS Reliability Analysis

The Cronbach's Alpha Coefficient was used as a primary indicator to assess the reliability of the Cognitive Flexibility in Sport Scale (CFSS). The interpretation of the coefficient values followed established reference standards commonly used in psychometric evaluations: Alpha values between .00 and .40 indicate that the scale is not trustworthy. Alpha values between .41 and .60 are considered low-level trustworthy. Alpha values between .61 and .80 reflect that the scale is trustworthy. Alpha values between .81 and 1.00 indicate high-level trustworthiness.

These reference values were used to interpret the reliability coefficients calculated during the pre-application and post-application phases of the CFSS development. Reliability analysis included calculating Cronbach's alpha coefficients for the

scale and sub-dimensions. The split-half test was also employed as a complementary method to assess internal consistency.

The authors collaboratively carried out all data collection, analysis, and interpretation stages in adherence to established scientific and ethical research principles. Ethics approval for this study was obtained from the Non-Interventional Research Ethics Committee of Kafkas University, Faculty of Health Sciences, on April 13, 2025 (Decision No: 2, Protocol No: 81829502.903/38). Verbal consent was obtained from all the participants.

Results

Due to its nature, the study requires data to be obtained from two different groups, so it was deemed appropriate to present the findings in two separate parts: pre-application and post-application.

Findings -1 (Pre-Application)

In the pre-application process, the analysis used data from the 60-item Cognitive Flexibility in Sports Scale pre-application from the second research group, which consisted of 241 adults actively involved in individual and/or team sports. Therefore, first, Exploratory Factor Analysis was applied to test the structural validity of CFSS (to explain the existing factors/sub-dimensions).

Assessment of EFA Prerequisites via KMO and Bartlett's Test

To determine whether the data obtained from the pre-application of the Cognitive Flexibility in Sport Scale (CFSS) were suitable for Exploratory Factor Analysis (EFA), two preliminary statistical tests were conducted: the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity.

The results yielded a KMO value of .808, which exceeds the commonly accepted threshold of .60 and indicates a meritorious level of sampling adequacy. Bartlett's Test of Sphericity produced a statistically significant result ($\chi^2 = 1906.984$, df = 190, $p < .001$), confirming that the correlation matrix is not an identity matrix and thus suitable for factor analysis.

Together, these results demonstrate that the data obtained from the CFSS pre-application form meet the essential assumptions required to conduct EFA. This supports the appropriateness of applying EFA to explore the scale's factor structure (Field, 2000; Pallant, 2017; Tabachnick & Fidell, 2005; Tatlıdil, 2002).

To obtain healthy results from EFA, it is necessary to ensure that item factor loadings are higher than .30 and that there is no overlap problem (less than .10 difference between item factor loadings) (Karaman et al., 2017; Stevens, 2002), so it was decided to remove a total of 40 items from the CFSS due to the low factor loadings of 28 items and the overlap problem of 12 items before EFA.

Direct Oblimin was used as the rotation technique due to EFA's relationship between the sub-dimensions. The structure, sub-dimensions, item factor loadings, and item correlation values obtained as a result of EFA are presented in Table 2.

According to the EFA results presented in Table 2, it was determined that CFSS has four sub-dimensions consisting of 20 items. The first and second sub-dimensions of CFSS consist of five items each, the third sub-dimension consists of four items, and the last dimension, the fourth sub-dimension, consists of six items. The sub-dimension items were evaluated and named

- Ability to Produce Alternative Solutions- APAS,
- Strategic Flexibility-SF,
- Situational Adaptability-SA,
- Problem Solving and Decision Making-PSDM.

1. Ability to Produce Alternative Solutions item factor loadings are 570-857; 2. Strategic Flexibility item factor loadings are 482-867; 3. Situational Adaptability item factor loadings are 699-776; 4. Problem Solving and Decision Making item factor

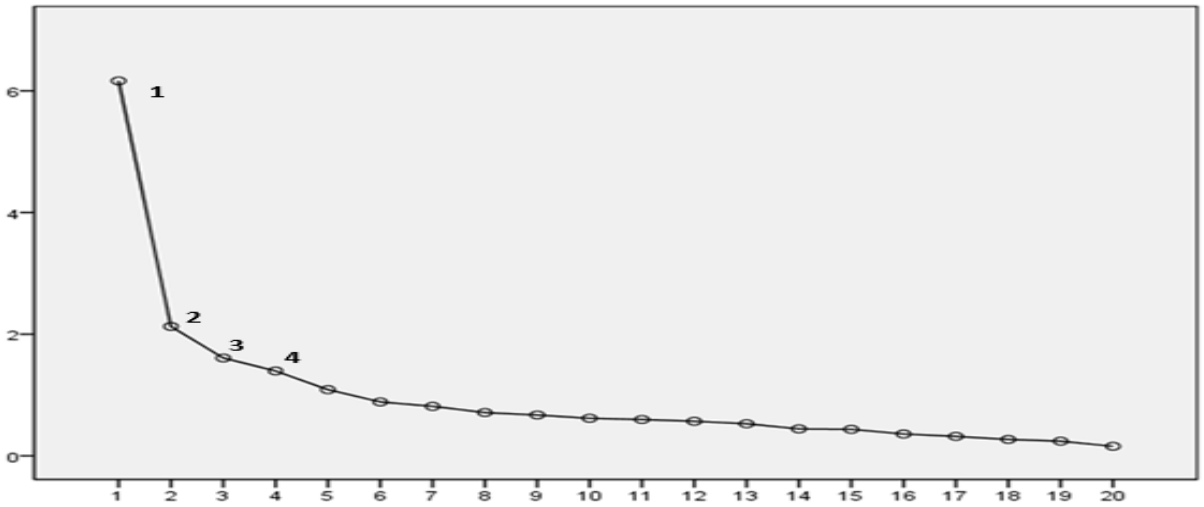
loadings are 485-702, while item correlations are between .402 and .690, which shows that all items are significant for CFSS. All items belonging to the third dimension, CFSS Situational Adaptability, are reverse-coded because they have a negative meaning. This situation is highlighted with (*) in the EFA table.

Table 2.
EFA results of CFSS

	Cognitive Flexibility Scale of Sports - Expressions	Sub-Dimensions				r
		1	2	3	4	
12	I find creative solutions to the challenges I encounter in competition/training. M1	.857				.583
13	I can switch between different playstyles whenever I need to.M2	.777				.550
11	I do not hesitate to apply different techniques suggested by my trainer.M3	.707				.612
6	I do not hesitate to try different methods while learning new techniques.M4	.636				.445
15	I do not hesitate to try different tactics to counter the opponent's/opposing team's strategy.M5	.570				.416
25	I quickly change my playing style after understanding my opponent's/opposing team's strategy. M6		.867			.671
26	I can instantly update my playstyle based on the feedback I hear. M7		.734			.690
27	I quickly identify situations that require changes during competition/training. M8		.704			.443
24	I rearrange my strategy when I encounter unexpected situations during competition/training. M9		.620			.451
23	I have no difficulty in immediately implementing new instructions given by my coach. M10		.482			.402
44	I have difficulty maintaining my performance under challenging circumstances.* M11			.776		.428
31	I have difficulty changing my playing style based on feedback from my coach.* M12			.761		.421
34	I cannot grasp new information when I have to play different positions.* M13			.741		.451
38	I have difficulty working comfortably in different environmental conditions during competition/training.* M14			.699		.486
59	I can stay calm and find a logical solution when encountering a difficult situation. M15				.702	.532
57	When I encounter an unexpected situation during competition/training, I react quickly and do not remain indecisive. M16				.693	.483
58	I evaluate different options when making strategic decisions. M17				.684	.458
46	I easily switch between different solutions to the challenges I face. M18				.645	.402
60	I can make quick decisions about the right move during competition/training. M19				.641	.438
50	I can change and implement my decisions flexibly in competition/training. M20				.485	.426
Variance Loading Values Explained by Sub-Dimensions and Total of CFFS		**12.11**	**15.32**	**14.97**	**14.07**	**56.47**

In addition, when the variance loadings explained by the sub-dimensions obtained as a result of EFA are examined, it is determined that 1. APAS = 12.11%, 2. SF = 15.32%, 3. SA = 14.97%, 4. PSDM = 14.07%, and the total explained variance loading of CFSS is 56.47%. Considering that Pallant (2017) stated that the total variance load explained should be 40%, it can be said that the 56.47% variance load of CFSS is quite sufficient. The Slope Plot (SPL), obtained to present the EFA result in more detail, is given in Figure 2.

Figure 2.
Slope Plot Graph of CFSS



The sub-dimensions in SPL are numbered to help you understand CFSS better. However, the graph shows that the first four values (dimensions) are positioned differently from the other values.

In addition, it was deemed appropriate to test the eigenvalues of the CFSS structure as a result of EFA with the Monte-Carlo Parallelism Test (MCPT). The obtained data are given in Table 3.

Table 3.
CFSS MCPT analysis results

Sub-Dimensions	Eigenvalues-EFA	Eigenvalues-MCPT	Result
1	6.165	1.5368	**Accept**
2	2.127	1.4537	**Accept**
3	1.609	1.3850	**Accept**
4	1.395	1.3042	**Accept**
5	1.088	1.2407	**Reject**

CFSS: Cognitive Flexibility Scale of Sports, MCPT: Monte Carlo Parallel Test, EFA: Exploratory Factor Analysis.

When the MCPT in Table 3 is examined, it was concluded that the structure of the CFSS, consisting of 20 items and four sub-dimensions, was acceptable due to EFA. For the reliability of the CFSS, the Cronbach Alpha Coefficient (α) for all sub-dimensions and the overall scale was calculated. The Split-Half Test (SPT) was applied, and the results are given in Table 4.

Table 4.
Reliability Checks for CFSS Pre-Application

CFSS Sub-Dimensions/General	Number of Items	α
1.APAS	5	.834
2.SF	5	.803
3.SA	4	.761
4.PSDM	6	.776
CFSS-General	20	.873
CFSS First Part	10	.837
CFSS Second Part	10	.762

CFSS: Cognitive Flexibility Scale of Sports, APAS: Ability to Produce Alternative Solutions, SF: Strategic Flexibility, SA: Situational Adaptability, PSDM: Problem Solving and Decision Making

Table 4 shows that the α values of the CFSS sub-dimensions are between .761 and .834. The α value of the entire CFSS is .873. In addition, the Split-Half Test (SPT) applied to the CFSS determined that the first part was .837 and the second part was .762.

It was understood that these values were within the reference ranges of α specified by Can (2018), Özdamar (1997), and Yaşar (2014) and in Table 4 in this study, and that the data obtained with the CFSS-pre-applied form were highly reliable.

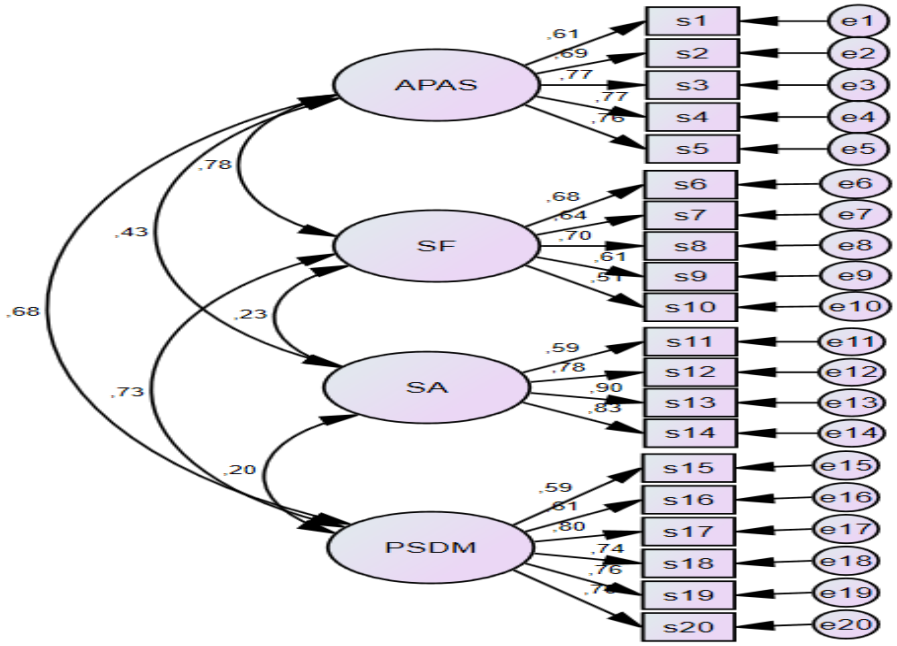
As a result, based on the analysis and evaluations in the preliminary application of the CFSS, it was decided to proceed to the final application, which has a structure consisting of four sub-dimensions and 20 items.

Findings -2 (Final Application)

The structure in the EFA regarding the data obtained from 366 individuals who were actively involved in individual and/or team sports in the final application process, which is the final stage in the development of the CFSS, was checked with CFA. The diagram in CFA is in Figure 3.

Figure 3.

CFA Model and Factor Loadings of the CFSS



CFSS: Cognitive Flexibility Scale of Sports, APAS: Ability to Produce Alternative Solutions, SF: Strategic Flexibility, SA: Situational Adaptability, PSDM: Problem Solving and Decision Making, CFA: Confirmatory Factor Analysis

Figure 3 shows that the item factor loadings related to the four-dimensional structure of CFSS are as follows: 1. Ability to Produce Alternative Solutions (APAS); .61, .69, .77, .77, .76, 2. Strategic Flexibility (SF); .68, .64, .70, .61, .51, 3. Situational Adaptability (SA); .59, .78, .90, .83, 4. Problem Solving and Decision Making-PSDM; .59, .81, .80, .74, .76, 74. As indicated in the figure, the loading values related to all items are greater than .50. Considering that Jöreskog and Sörbom (1996) stated that items with loadings of .50 and above are significant, it was not deemed necessary to remove any items from the scale.

In addition, since the fit index values resulting from the CFA were within the reference ranges specified in Table 5, it was deemed appropriate not to make any modifications. The fit indexes resulting from the CFA are presented in Table 5.

Table 5.
Fit Index Values of CFSS

Fit Indexes	*Evaluation Ranges*		*Obtained Value*	*Interpretation*
	Good	*Acceptable*		
CMIN/DF	$0<\chi^2/sd\leq3$	$3<\chi^2/sd\leq5$	**2.995**	**good**
RMSEA	0≤RMSEA≤.05	.05≤RMSEA≤.08	**.074**	**acceptable**
GFI	.90<GFI≤1	.80<GFI≤.90	**.89**	**acceptable**
AGFI	.90<GFI≤1	.80<GFI≤.90	**.86**	**acceptable**
CFI	.95<CFI≤1	.90<CFI≤.94	**.91**	**acceptable**
RMR	0≤RMR≤.05	0.05≤RMR≤.1	**.043**	**good**
NFI	.90<TLI≤1	.80<TLI≤.90	**.86**	**acceptable**
TLI	.90<TLI≤1	.80<TLI≤.90	**.89**	**acceptable**
IFI	.90<TLI≤1	.80<TLI≤.90	**.91**	**good**
DF	164			
CMIN	491.139			

CFSS: Cognitive Flexibility Scale of Sports, CMIN/DF: Chi-Square/Degrees of Freedom, RMSEA: Root Mean Square Error of Approximation, GFI: Goodness of Fit Index, AGFI: Adjusted Goodness of Fit Index, CFI: Comparative Fit Index, RMR: Root Mean Square Residual, NFI: Normed Fit Index, TLI: Tucker-Lewis Index, IFI: Incremental Fit Index.

When Table 5 examines the fit index values for the CFSS's four-dimensional structure, all values are within the reference ranges. Based on the fit index values, the four-dimensional structure of the CFSS is confirmed/accepted. In addition, the criterion validity of the CFSS was tested by determining the relationship between the sub-dimensions, and the "correlation coefficient-r" reference ranges reached in the relationship analysis were evaluated as low (.10-.29), medium (.30-.49), and high (.50-1.00), as stated by Cohen (1998) and Pallant (2017). Table 6 includes the correlation values reached between the sub-dimensions.

Table 6.
Pearson correlations between sub-dimensions and general score of the CFSS scale

Sub-Dimensions	**1. APAS**	**2. SF**	**3.SA**	**4. PSDM**	**CFSS-General**
1.APAS	1	.627**	.367**	.600**	.841**
		.000	.000	.000	.000
2. SF		1	.166**	.605**	.751**
			.000	.000	.000
3.SA			1	.196**	.624**
				.000	.000
4. PSDM				1	.794**
					.000
CFSS-General					1

CFSS: Cognitive Flexibility Scale of Sports, APAS: Ability to Produce Alternative Solutions, SF: Strategic Flexibility, SA: Situational Adaptability, PSDM: Problem Solving and Decision Making, CFSS: Cognitive Flexibility Scale in Sports

In Table 6, it was determined that there were positive and significant relationships at the .01 level in the CFSS sub-dimensions [(APAS/SF=.627); (APAS/SA=.367); (APAS/PSDM=.600); (APAS/CFSS-General=.841); (SF/SA=.166); (SF/PSDM=.605); (SF/CFSS-General=.751); (SA/PSDM=.196); (SA/CFSS-General=.624); (PSDM/CFSS-General=.794)]. These data show that the CFSS sub-dimensions are consistent with each other and therefore the CFSS provides criterion validity. Cronbach Alpha Coefficients (α) obtained with the results of two half-tests conducted to check the reliability of the data obtained with the CFSS final application form are presented in Table 7.

Table 7.
Reliability checks for the final implementation of CFSS

CFSS Sub-Dimensions/General	Number of Items	α
1.APAS	5	.841
2.SF	5	.760
3.SA	4	.860
4.PSDM	6	.849
CFSS-General	20	.890
CFSS First Part	10	.898
CFSS Second Part	10	.867

CFSS: Cognitive Flexibility Scale of Sports, APAS: Ability to Produce Alternative Solutions, SF: Strategic Flexibility, SA: Situational Adaptability, PSDM: Problem Solving and Decision Making, CFSS: Cognitive Flexibility Scale in Sports

Table 7 shows that the reliability coefficient values of CFSS are between .760 and .898. Since these data are within the reference ranges (α>.60) specified by Can (2018) and Özdamar (1997), it can be stated that the reliability of CFSS is high.

Discussion

The findings obtained during the development process of the CFSS show that cognitive flexibility has a multidimensional structure in sports. Each of the sub-dimensions of the scale provides a functional framework in explaining athletes' reactions to the cognitive challenges they encounter during training and competition.

For example, the “Strategic Flexibility” dimension is related to the ability to change the game plan instantly and, in this respect, overlaps with the modeling of decision-making processes in sports by Tenenbaum and Eklund (2020). In addition, the measurement of the “Situational Adaptability” sub-dimension with reverse-coded items makes an important contribution in identifying inflexible cognitive response patterns. This approach, as stated by Dennis and Vander Wal (2010), makes the distinction between cognitive rigidity and flexibility clearer. The findings show that the CFSS has a theoretically and statistically solid structure. The total explained variance of 56.47% obtained in the exploratory factor analysis is well above the minimum level of 40% suggested by Pallant (2017). This shows that the scale successfully represents sport-specific cognitive processes.

Conclusion and Recommendation

As a result of the research, it was concluded that the “Cognitive Flexibility Scale in Sports-CFSS”, with its structure consisting of 20 items and four sub-dimensions (Alternative solution generation, strategic flexibility, situational adaptability, problem solving and decision making), can be used as a valid and reliable tool in measuring sport-specific cognitive flexibility levels. As a result of exploratory factor analysis (EFA), it was determined that the four-factor structure of the scale explained 56.47% of the total variance. The variance explained by each sub-dimension is as follows, respectively: Strategic Flexibility (15.32%), Situational Adaptability (14.97%), Problem Solving and Decision Making (14.07%), and Alternative Solution Generation (12.11%). The structural suitability of the model was tested with confirmatory factor analysis (CFA) and the fit indices were found at the desired level (CMIN/DF= 2.995, RMSEA = .074, RMR= .043, CFI = .91, GFI = .89).

The scale's general Cronbach Alpha internal consistency coefficient was .873 in the pre-application and .890 in the post-application. The sub-dimension's α values varied between .76 and .86. All these data strongly support the scale's structural validity and internal consistency. Cronbach Alpha values for the scale sub-dimensions ranged between .761 and .834 in the pre-application and .760 and .860 in the post-application, indicating a high level of internal consistency for the measurement tool (Can, 2018). In particular, the fact that the Strategic Flexibility (.803/.760) and Problem Solving and Decision Making (.776/.849) dimensions are consistent across applications and have high correlation coefficients (PSDM/General correlation = .794) reveals that these dimensions have an important place in cognitive flexibility in sports.

The CFA results show that values such as CMIN/DF = 2.995, CFI = .91, TLI = .89, RMR = .043 indicate that the model's fit level is acceptable and even good in some aspects. In addition, positive and significant relationships (p < .01) between the scale sub-dimensions—for example, r = .627 between Alternative Solution Generation and Strategic Flexibility—support that cognitive flexibility has a multidimensional yet integrated structure.

Based on the findings of this study, the following recommendations can be made:

- Sports psychologists, coaches, and sports scientists can use the CFSS to assess the cognitive flexibility levels of athletes and plan intervention programs accordingly.

- Integrating elite athletes into the training process can support the cognitive flexibility levels of those working under high pressure during competition.

- Testing the validity of the CFSS in different age groups, different sports branches (individual vs. team sports), and gender groups will increase the generalizability of the scale.

As a result, the CFSS developed with this study can be used as an original and reliable assessment tool in sports psychology. This scale analyzes athletes' mental toughness and performance levels more holistically. The Turkish and English versions of the CFSS are included in the appendix.

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Hasta Onamı: Çalışmaya katılan tüm katılımcılardan sözlü onam alınmıştır.
Hakem Değerlendirmesi: Dış bağımsız.
Yazar Katkıları: Fikir,-HG*; Tasarım-MK*; Denetleme-EG*; Kaynaklar-HG,MK; Veri Toplanması ve/veya İşlemesi-MK,HG*; Analiz ve/ veya YorumMK,-EG*; Literatür Taraması-HG*; Yazıyı YazanMK,-HG,EG*; Eleştirel İnceleme-EG*
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Informed Consent: Verbal consent was obtained from all the participants.
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Appendix–1.

Cognitive Flexibility Scale in Sports (CFSS) (English Version)

Cognitive Flexibility Scale in Sports (CFSS) (English Version)	**I Strongly Disagree**	**I disagree**	**I Partially Agree**	**I agree**	**I Strongly Agree**
1. I find creative solutions to the challenges I encounter in competition/training.	1	2	3	4	5
2. I can switch between different playstyles whenever I need to.	1	2	3	4	5
3. I do not hesitate to apply different techniques suggested by my trainer.	1	2	3	4	5
4. I do not hesitate to try different methods while learning new techniques..	1	2	3	4	5
5. I do not hesitate to try different tactics to counter the opponent's/opposing team's strategy.	1	2	3	4	5
6. I quickly change my playing style after understanding my opponent's/opposing team's strategy.	1	2	3	4	5
7. I can instantly update my playstyle based on the feedback I hear.	1	2	3	4	5
8. I quickly identify situations that require changes during competition/training.	1	2	3	4	5
9. I rearrange my strategy when encountering unexpected situations during competition/training.	1	2	3	4	5
10. I have no difficulty immediately implementing my coach's new instructions.	1	2	3	4	5
11. I have difficulty maintaining my performance under challenging circumstances.*	1	2	3	4	5
12. I have difficulty changing my playing style based on feedback from my coach.*	1	2	3	4	5
13. I cannot grasp new information when I have to play different positions.*	1	2	3	4	5
14. I have difficulty working comfortably in different environmental conditions during competition/training.*	1	2	3	4	5
15. When I encounter a difficult situation, I can stay calm and find a logical solution.	1	2	3	4	5
16. When I encounter an unexpected situation during competition/training, I react quickly and do not remain indecisive	1	2	3	4	5
17. I evaluate different options when making strategic decisions.	1	2	3	4	5
18. I easily switch between different solutions to the challenges I face.	1	2	3	4	5
19. I can quickly decide on the right move during competition/training.	1	2	3	4	5
20. I can flexibly change and implement my decisions in competition/training.	1	2	3	4	5

***Items to be reverse-coded.**

Sub-dimensions (Items):

Ability to Produce Alternative Solutions: 1, 2, 3, 4, 5

Strategic Flexibility: 6, 7, 8, 9, 10

Situational Adaptability: 11, 12, 13, 14

Problem Solving and Decision Making: 15, 16, 17, 18, 19, 20

Appendix – 2.

Sporda Bilişsel Esneklik Ölçeği (SBEÖ) (Türkçe Versiyon)

Sporda Bilişsel Esneklik Ölçeği (SBEÖ) (Türkçe Versiyon)	**Tamamen Katılmıyorum**	**Katılmıyorum**	**Kısmen Katılıyorum**	**Katılıyorum**	**Tamamen Katılıyorum**
1. Müsabakada/antrenmanda karşılaştığım zorluklara yaratıcı çözümler bulurum.	1	2	3	4	5
2. İhtiyacım olduğunda, farklı oyun tarzları arasında geçiş yapabilirim.	1	2	3	4	5
3. Antrenörümün önerdiği farklı teknikleri uygulamaktan çekinmem.	1	2	3	4	5
4. Yeni teknikleri öğrenirken farklı yöntemleri denemekten çekinmem.	1	2	3	4	5
5. Rakibin/rakip takımın stratejisine karşı koymak için farklı taktikler denemekten çekinmem.	1	2	3	4	5
6. Rakibimin/rakip takımın stratejisini anladıktan sonra oyun tarzımı değiştirmekte hızlıyım.	1	2	3	4	5
7. Duyduğum geri bildirimlere göre oyun tarzımı anında güncelleyebilirim.	1	2	3	4	5
8. Müsabaka/antrenman esnasında değişiklik gerektiren durumları hızla tespit ederim.	1	2	3	4	5
9. Müsabaka/antrenman esnasında beklenmedik durumlarla karşılaştığımda stratejimi yeniden düzenlerim.	1	2	3	4	5
10. Antrenörümün verdiği yeni talimatları hemen uygulamakta zorlanmam.	1	2	3	4	5
11. Zorlayıcı koşullar altında performansımı korumakta zorlanırım.*	1	2	3	4	5
12. Antrenörümden gelen geri bildirimlere göre oyun tarzımı değiştirmekte zorlanırım.*	1	2	3	4	5
13. Farklı pozisyonlarda oynamam gerektiğinde yeni bilgileri kavrayamam.*	1	2	3	4	5
14. Müsabakada/antrenmanda farklı ortam koşullarında rahatça çalışmakta zorlanırım.*	1	2	3	4	5
15. Zor bir durumla karşılaştığımda sakin kalarak mantıklı bir çözüm bulabilirim.	1	2	3	4	5
16. Müsabaka/antrenman esnasında beklenmedik bir durumla karşılaştığımda hızlı tepki verirken kararsız kalmam.	1	2	3	4	5
17. Stratejik kararlar alırken farklı seçenekleri değerlendiririm.	1	2	3	4	5
18. Karşılaştığım zorluklar karşısında farklı çözüm yolları arasında kolayca geçiş yaparım.	1	2	3	4	5
19. Müsabaka/antrenman esnasında doğru hamle için hızlı karar verebilirim.	1	2	3	4	5
20. Müsabakada/antrenmanda kararlarımı esnek bir şekilde değiştirip uygulayabilirim.	1	2	3	4	5

***Ters kodlanacak maddeler.**

Alt Boyutlar (Maddeler):

Alternatif Çözüm Üretebilme: 1, 2, 3, 4, 5

Stratejik Esneklik: 6, 7, 8, 9, 10

Durumsal Uyum Yeteneği: 11, 12, 13, 14

Problem Çözme ve Karar Verme: 15, 16, 17, 18, 19, 20