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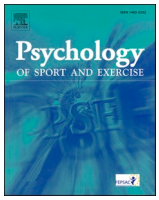

Adverse competition-related cognitions questionnaire (ACCQ): Development and preliminary validation of a measure identifying different factors of athletes' cognitions related to competitions

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ABSTRACT

This research project presents the development and preliminary validation of a German version of the Adverse Competition-related Cognitions Questionnaire (ACCQ) and comprises four studies. In Study 1, 101 athletes and 124 coaches from different team and individual sports generated a large pool of cognitions, which was reduced to an initial item pool of 54 cognitions through a multi-step procedure with different experts. In Study 2, the underlying factor structure of the questionnaire was examined by an exploratory factor analysis ($N_2 = 348$), which revealed six factors (athletic comparison, coach devaluation, devaluation of one's own performance, appreciation by coach and family, inner resistance against competitions, and general exhaustion) with 26 items retained. Subsequently, in Study 3, the results were re-examined with a confirmatory factor analysis (CFA, $N_3 = 419$; CFI = 0.91, RMSEA = 0.06, SRMR = 0.06). In addition, preliminary support for the construct validity (i.e., convergent, divergent, and concurrent validity) of the ACCQ was obtained by examining associations among the ACCQ subscales and theoretical correlates such as social comparison, cognitive interference, irrational performance beliefs, and fear of negative evaluation. In Study 4, a second CFA ($N_4 = 153$; CFI = 0.89, RMSEA = 0.06, SRMR = 0.07) was conducted to test the identified 6-factor solution in a sample of high-performance competitive athletes. With its broad range of factors, the ACCQ provides a useful and valid measure for assessing different adverse competition-related cognitions, offering a wide range of potential applications in research and sport psychology practice.

1. Introduction

Headlines like "One third of German athletes were not fully mentally present in medal fight" (Breuer & Hallmann, 2022), "No one said it openly. But probably the head was not free for unconditional fight, as it is now usual in the league in the duel with seemingly weaker opponents" (Bemmann, 2009), "The Bundesliga final was simply unfortunate in the end because I had exams right afterwards and didn't have a clear mind" (Deutscher Schützen Bund, 2018), repeatedly focus our attention on situations in which athletes experience performance losses in competition due to adverse and distracting thoughts. In other words, these thoughts are perceived as performance limiting. This illustrates their relevance in the context of sports. In addition, the perception of not being mentally strong enough is often the reason that athletes seek sports psychology coaching (Ziemainz et al., 2006). Therefore, it is important to be aware of these aspects and to know that and which demotivating, goal inhibiting, limiting, or stressful thoughts (i.e., perceived performance-limiting thoughts)–occur in athletes before or during competitions, which can affect the athlete's well-being and performance. Consequently, it is important to work with athletes to develop specific strategies for dealing with such thoughts and to support them in their optimal performance development.

Although cognitions play an important role for athletic performance and behavior, it is surprising that measures to capture exclusively performance-limiting thoughts have been lacking so far. While there are several measures of related constructs such as the Automatic Self-Talk Questionnaire for Sports (ASTQS; Zourbanos et al., 2009), the Thoughts Occurrence Questionnaires Sport (TOQS, Röthlin et al., 2017;

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English version: Hatzigeorgiadis & Biddle, 2000), the Irrational Performance Beliefs Inventory (iPBI; Michel-Kröhler & Turner, 2022; English version: Turner et al, 2018), the Questionnaire on Athlete Behavior in Critical Competition Situations (Baumgärtner, 2012), or the Achievement Motives Scale (AMS, Elbe et al., 2005), to name a few, these do not capture sport-specific performance-limiting thoughts at their core. Therefore, the aim of the present research project was to develop a questionnaire to adequately assess performance-related negative cognitions that may occur before or during a competition and potentially affect the athlete's well-being and performance. Since athletes differ in how intensively they experience such thoughts, this questionnaire can contribute to the individual support of athletes in their preparation for competitions. In this way, it should be possible to identify whether performance setbacks may have a mental background in the sense of performance-limiting thoughts. Furthermore, a validated and reliable measure of adverse cognitions related to competitions would help to close the gap between the relevance of this topic and the ability to capture dysfunctional cognitions more specifically, as well as to improve research on the quality of those thoughts and their consequences.

Our process of developing the questionnaire is based on the following working definition, which we evolved to ensure that we exclusively capture performance-limiting thoughts with it: "Adverse and dysfunctional thoughts in competitive sports are demotivating, goal-inhibiting, limiting, or stressful thoughts in active competitive athletes in the competitive or high-performance area that occur in the context of practicing the sport." In principle, these thoughts can occur with varying frequency: Athletes who score higher on the questionnaire are more likely to have adverse thoughts compared to athletes with lower scores. Based on this definition, the item development process was conducted (Study 1), which we describe in detail below. We then report on the development and validation of our new measure - the Adverse Competition-related Cognitions Questionnaire, whose psychometric properties, dimensionality, reliability, and validity were examined in three further studies (Study 2 to 4).

In detail, Study 1 aimed to first generate an item pool of various negative competition-related thoughts together with coaches and athletes, from which the most frequently occurring thoughts were then selected systematically for further analyses. Study 2 focuses on the psychometric properties of the items and the examination of the underlying factor structure of the ACCQ using an exploratory factor analysis (EFA). Study 3 aimed to confirm the identified factor structure using a confirmatory factor analysis (CFA) and to determine the convergent and divergent validity of the ACCQ by examining its position in a nomological network (Preckel & Brunner, 2017). In addition, we examined the concurrent validity, internal reliability, and the test–retest reliability over a four-week interval. Because we relied on a sample with different performance levels in Study 2 and 3, the aim of Study 4 was to test the identified factor solution in a sample of high-performance athletes to address the question of whether adverse competition-related cognitions also play a relevant role at higher performance levels.

2. Study 1: Item development

Coaches are, in addition to parents, partners and friends, a close caregiver for their athletes, in some cases for many years. Moreover, coaches and athletes are mutually interdependent, developing a unit relationship over the course of a common athletic career (Jowett, 2017). Therefore, they are in an ideal position to know and understand the thoughts of athletes. Moreover, they are also able to give a more objective evaluation of the athletic behavior of their athletes through their external perspective. For these reasons, the goal of the first development step was to identify performance-inhibiting and typically adverse thoughts from the coaches' perspective.

2.1. Step 1

Generation of potential adverse competition-related cognitions – the perspective of the coaches. We surveyed 124 coaches from various team and individual sports from the amateur (n = 71) and the competitive sport context (n = 50; for n = 3, assignment was ambiguous). Coaches were asked to indicate which performance-limiting thoughts they "observe" in their athletes in daily sports practice and what they think are typical performance-limiting thoughts that can occur in athletes. If possible, coaches should write down concrete statements made by their athletes. We analyzed the statements or the concrete thoughts by means of a qualitative content analysis according to Mayring (2012) with the software MAXQDA12 (Version 12.0.2; VERBI Software, 2015). This allowed us to proceed systematically and to perform a rule-guided analysis of the coaches' statements and thus draw conclusions about the mindset of the athletes. For this purpose, we followed Mayring's recommendations and performed the following five analysis steps: (1.) determination of the analysis units and coding of text passages that appear important, (2.) development of an inductive category system as well as an evaluation guide, (3.) ensuring that the resulting units are consistent with the research question and reducing text elements that are similar in content or irrelevant, (4.) back-testing of the category system on the source material and determination of inter-coder reliability, (5.) discussion about the final category system among the evaluators (for more detailed information on data analysis as well as differentiated results, see Kröhler, 2019). In total, 470 different thoughts and statements could be identified that could be divided into seven overarching main categories. These were overall daily stress, self-worth, pressure to perform, concerning the current competition, sporting and physical stress, thoughts in the context of training and competition, and worries.

2.2. Step 2

Generation of potential adverse competition-related cognitions – The perspective of the athletes. Based on the content categorization of the coaches' survey, short descriptions and sample items per identified category were prepared, which served as the basis for a subsequent athlete survey. By means of an online survey via a teaching evaluation system (evasys software, 2013) 101 athletes (female: n = 59, male: n = 42) aged between 15 and 30 years ($M = 20.61$, $SD = 3.70$) from different team (n = 31) and individual (n = 70) sports were surveyed. The purpose of this part was to validate the content of the coaches' statements and thoughts and to gain information about the frequency of occurrence of the thoughts. Therefore, athletes were asked to complete the categories with their own concrete thoughts, and to rate them in terms of their frequency on a 7–point scale ranging from "never" to "always" in different contexts (training, competition, general). This survey resulted in a pool of 788 thoughts reported by the athletes.

2.3. Step 3

Selection of thoughts, item-pool reduction process, and item development. From the original pool of thoughts, we selected thoughts according to the frequency of occurrence in competitions independent of the assigned categories. More precisely, only thoughts whose occurrence was rated as often, very often, or always were considered. This reduced the original pool to 342 thoughts. A further reduction to 97 thoughts was achieved by following three strategies. First, we excluded tasks or thoughts that were not sport-specific, for example, "The school grades have to be better", because we intended to develop a sport specific questionnaire and task irrelevant thoughts are already captured in the TOQS (Röthlin et al., 2017). Second, we combined thoughts with a similar wording, for example, "Everyone is better than me!", "The others are better than me anyway", "They are better than me" to "The others are much better than me". Third, we merged thoughts that conveyed the

Table 1
Biographic and sports-related information separated by studies.

	Study 2 ($N = 348$; f = 152, m = 165, d = 1)	Study 3 ($N = 419$; f = 242, m = 177)	Study 4 ($N = 153$; f = 103, m = 49, d = 1)
Sample characteristics	*M (SD)*	*M (SD)*	*M (SD)*
Age	27.83 (10.94)	23.50 (7.58)	21.44 (5.74)
Age range	18–69	16–67	15–38
Discipline-specific training/week	3.33 (1.77)	4.04 (2.35)	4.15 (1.45)
Additional training/week	2.28 (1.46)	2.37 (1.60)	2.00 (1.48)
Training hours/week	9.53 (4.63)	10.88 (5.24)*	12.06 (5.99)
Competitions/year	18.44 (14.62)	16.87 (11.40)	26.66 (16.30)
Experience (in years)	14.45 (9.61)	12.54 (6.10)	12.60 (4.37)
Performance level (n)			
1	28	31	56
2	21	43	45
3	43	41	0
4	38	94	52
5	128	191	0
6	89	19	0

Note. M = mean, SD = standard deviation, f = female, m = male, d = divers. Performance level (PL) corresponds to the athletes' assignment either to a squad (e.g., A-, B-, C-squad) or to a league (e.g., 1st Bundesliga, 2nd Bundesliga, 3rd League): first PL (A-squad/Olympia-squad or 1st Bundesliga), second PL (B-/C-squad equivalent to perspective or supplementary squad or 2nd Bundesliga), third PL (Junior squad [NK1 & NK2], C-/DC-squad not belonging to perspective-squad or third highest league), forth PL (D-squad or forth highest league), fifth PL (another squad or another level below) and sixth PL (no squad status or no league status), *n = 409.

same content (e.g., "I feel sick today", "I don't feel so good today", "I don't feel so fast today" to "I don't feel good at all today") but were formulated differently by the athletes. After item reduction, we formulated these 97 thoughts into questionnaire items according to the guidelines of Bühner (2011) and presented them to an expert panel consisting of five independent raters. Our expert panel consisted of two athletes (one team athlete and one individual athlete), one psychotherapist and sports psychologist, one sports scientist and sports psychology expert, and one psychologist with experience in psychological test development and adaptation. Moreover, four of the experts were from academia, including three from the field of sports psychology. The purpose of this expert panel was to review the content-based evidence of the formulated items according to guidelines of the American Educational Research Association (2014), and reduce them to those that best reflect the construct and context being measured. To this end, the items were rated by all five experts according to comprehensibility, reality conformity (meaningful in terms of content), and practicability in terms of item structure and length on a scale from '0' (*strongly disagree*) to '10' (*strongly agree*). In addition, the experts were able to make comments, suggestions for improvement or recommendations for the item wording. This third development step made it possible to reduce the number of items to 73. A final review by the first and last author as well as another expert led to the further exclusion of three items, so that the final item pool consisted of 70 items, 54 items related to athletes in general and 16 items which were specific to team sports. Here, we focused our analyses on the 54 athlete-related items, which were progressed to statistical validation analysis. For this first statistical analysis sample size of five participants per item is recommended (DeVellis, 2012) resulting in a minimum sample of 270 participants.

3. Study 2: Identifying the underlying factor structure of the ACCQ

Study 2 aimed to reduce the 54 items to a practical measure length of approximately 20–30 items, with a minimum of three to five items per scale to achieve adequate internal consistency (Costello & Osborne, 2005; Fabrigar et al., 1999) and to test the factor structure of the initial item pool. To this end, we conducted an item analysis, followed by an exploratory factor analysis (EFA) to reduce the items to their underlying dimensions.

3.1. Methods and materials

3.1.1. Procedure

Participants for our study were recruited in two ways with different data collecting methods. First, athletes from various team and individual sports were invited to the study via e-mail through their respective clubs or sports associations throughout Germany. They completed a questionnaire battery online via SoSci-Survey (Leiner, 2019), which included the 54 items from our questionnaire as well as other variables that were not relevant for the current study. Second, sport students at the Johannes Gutenberg-University Mainz completed the survey questions in paper-pencil format during their classes and answered only the 54 items of our questionnaire as well as biographical and sports-related questions. The completion of the study was carried out in compliance with the Declaration of Helsinki (World Medical Association, 2013) and ethical approval was granted from the local Review Board of the Johannes Gutenberg-University Mainz. Participants were informed about the nature and the procedure of the study and gave written consent before completing the questionnaires. Participation was voluntary and participants received no incentives. Participation requirements were a minimum age of 18 years and experience in sports competitions.

3.1.2. Participants

Overall, Study 2 comprised 348 athletes from different team- and individual sports. Table 1 displays biographical and training-related information of the sample.

3.1.3. Measures

We used the 54 items of the preliminary version of the ACCQ, which were rated on a 5-point scale ranging from '1' (*never*) to '5' (*almost always*). Athletes have received the following instructions: "The following are a series of thoughts that may occur during a competition. A competition usually begins with the immediate preparation for the competition, which starts with entering the competition area, but no earlier than the morning of the competition, and ends with the completion of the competition. Please indicate on a 5-point scale from *never* to *almost always* how often the listed thoughts generally occur for you during a competition (incl. immediate competition preparation)."

3.1.4. Data analyses

We performed statistical analyses using R Studio (R Core Team, 2019).

To identify the item characteristics for the item pool of our new

measure, we first conducted an item analysis and subsequently an EFA, to identify the factor structure of our new measure. We applied three criteria for the item analysis: a) items should cover the full range of the response format, b) a minimum corrected item-total correlation coefficient (item discrimination reflecting the extent to which an item and the scale as a whole measure a consistent attribute) of 0.30, and c) Cronbach's alpha without given item.

Because significantly less than 10 % of the data in the dataset were missing (missing values: n = 21), mean imputation for missing data points was applied (Watkins, 2018). Before performing the EFA, we tested various requirements: First, we checked the Kaiser-Meyer-Olkin (KMO) criteria as a measure of sampling adequacy. KMO-values can be calculated for each item and as an overall value. According to Kaiser (1974; see also Bühner, 2011) values >. 70 are medium, >0.80 are good and values > 0.90 are very good. Second, we applied the Bartlett's test to examine whether the population correlation matrix resembles an identity matrix. A significant result indicates that the correlations between variables are (overall) significantly different from zero. Subsequently, we used different methods for factor extraction: We applied a scree-plot analysis based on eigenvalues and a parallel analysis based on actual and simulated data of the eigenvalues (Tabachnick & Fidell, 2013). In addition to the assumptions for conducting an EFA, we tested for multivariate normality. Moreover, we applied an oblique (oblimin) factor rotation because we assumed that the individual factors were dependent on each other. We retained items that had factor loadings of at least 0.40 (Field et al., 2012) on the intended scale and had no

Table 2
Results of the explorative factor analysis of the competition-related cognition questionnaire.

Nr.	Items	F1	F2	F3	F4	F5	F6	h^2
1	Ich bin schlechter als die anderen. *I am worse than the others.*	.73						.60
2	Meine sportliche Leistung ist zu schlecht. *My athletic performance is too poor.*	.72						.54
3	Ich bin nicht gut genug. *I am not good enough.*	.69						.60
4	Die anderen waren sportlich schon immer besser als ich. *The others have always been better than me athletically.*	.61						.40
5	Ich kann keine gute Leistung abrufen. *I can't perform well.*	.47						.46
6	Mein Trainer versteht mich nicht. *My coach doesn't understand me.*		.78					.63
7	Mein Trainer gibt mir gar keine Rückmeldung. *My coach doesn't give me any feedback at all.*		.75					.63
8	Mein Trainer weiß nicht wovon er redet. *My coach doesn't know what he's/she's talking about.*		.70					.47
9	Mein Trainer hat mich nicht gut genug vorbereitet. *My coach didn't do a good enough job preparing me.*		.65					.43
10	Mein Trainer lobt mich nicht genug. *My coach doesn't give me enough praise.*		.57					.49
11	Ich darf mir keine Fehler erlauben. *I can't allow myself to make mistakes.*			.77				.62
12	Wenn ich jetzt einen Fehler mache, dann war alles umsonst. *If I make a mistake now, it was all for nothing.*			.70				.50
13	Das hat das letzte Mal schon nicht geklappt. *That didn't work the last time either.*			.49				.51
14	Ich bin total nervös. *I am so nervous.*			.44				.44
15	Ich darf nicht versagen. *I am not allowed to fail.*			.43				.45
16	Im Training hat es so gut geklappt und jetzt kann ich es nicht umsetzen. *It worked so well during training, but now I can't implement it.*			.40				.44
17	Ich bin mental nicht stark genug. *I am not mentally strong enough.*			.40				.44
18	Mein Trainer soll stolz auf mich sein. *My coach should be proud of me.*				.92			.84
19	Meine Eltern sollen stolz auf mich sein. *My parents should be proud of me.*				.65			.48
20	Ich will meinen Trainer nicht enttäuschen. *I don't want to disappoint my coach.*				.64			.51
21	Ich habe keinen Spaß mehr an Wettkämpfen. *I don't enjoy competitions anymore.*					.84		.76
22	Ich möchte nicht länger an Wettkämpfen teilnehmen. *I no longer want to participate in competitions.*					.76		.63
23	Ich bin kein Wettkampftyp. *I am not the competitive type.*					.55		.43
24	Ich schaffe das alles nicht. *I can't do all of this.*						.71	.74
25	Ich kann nicht mehr. *I can't go on any longer.*						.70	.49
26	Mir ist alles zu viel. *It's all too much for me.*						.64	.54
	Eigenvalue	2.97	2.57	2.63	2.01	2.09	1.78	
	Proportion explained variance	11 %	10 %	10 %	8 %	8 %	7 %	
	Cronbach's alpha (α)	.83	.83	.83	.79	.76	.78	
	Composite reliability (ρ)	.83	.83	.84	.81	.79	.79	

Note. F1 to F6 = Factor 1 to Factor 6, h^2 = communality. Note that only the German version has been validated. The English items have not yet been validated but have already been translated according to good practice principles for the translation and cultural adaptation process (Wild et al., 2005).

substantial cross-loadings (≥0.32) on other existing factors (Costello & Osborne, 2005). In addition, we used the communality (h^2) with $h^2 > 0.40$ representing the minimum estimate of reliability (Bühner, 2011; Costello & Osborne, 2005) and a factor should consist of at least three items to be considered solid (Costello & Osborne, 2005; Fabrigar et al., 1999).

Finally, we computed internal reliability coefficients (Cronbach's α) for each factor. Although Cronbach's alpha is well known and widely used, it has been criticized because of some drawbacks (McNeish, 2018). Therefore, we additionally reported composite reliability (ρ; Fornell & Larcker, 1981; Li & Harmer, 1996), which assesses reliability via a ratio of the variability explained by items compared with the total variance of the entire scale (Bentler, 2007; Geldhof et al., 2014). According to Nunnally and Bernstein (1994), coefficients of composite reliability and Cronbach's alpha greater than 0.70 indicate good reliability of test scores (see also Ab Hamid et al., 2017).

3.2. Results

3.2.1. Item analysis

We removed one item from the original item pool that did not cover the full response format and four other items that had low item discrimination (<0.30).

3.2.2. Exploratory factor analysis

Prior to the EFA of the remaining 49 items, we determined Kaiser-Meyer-Olkin (KMO) criteria as a measure of sampling adequacy. The overall KMO-value was 0.91 and all KMO-values of the individual items were ≥0.79 and are thus in the medium to very good range (Kaiser, 1974; see also Bühner, 2011). Bartlett's test of sphericity ($p < .001$) indicated the suitability of the dataset for factor analysis. Because our data did not meet the assumption of multivariate normality (Mardia Kurtosis = 38.34, $p < .001$), we used a robust maximum likelihood estimation. Applying the above-described methods for factor extraction, we obtained the following results: Scree-plot analysis revealed that six factors had an eigenvalue above 1. The parallel analysis indicated the extraction of eight factors, where two eigenvalues of the original data were very close to the randomly generated eigenvalues. This suggests that these factors cannot be considered more relevant than a random factor and consequently must be discarded (Matsunaga, 2010). Consequently, we calculated an EFA with six factors. We proceeded in a stepwise approach and removed items that showed no or low factor loadings, items that showed substantial cross-loadings to another factor and finally, items that showed low communality. First, 13 items were deleted because they did not meet the criterion of a minimum factor loading of 0.40. Next, we removed on item because it had significant cross-loading. Subsequently, another seven items were removed because they showed low communality ($h^2 < 0.40$). As the ultimate goal was to finally come up with an economic, valid and reliable questionnaire at the same time, two further items were excluded due to similar formulations. Accordingly, 26 items were extracted across six factors, which showed a common explained variance of 54 %. Table 2 displays the six derived factors with the respective items and their factor loadings, communalities (h^2), the percentage of variance explained by each component, the eigenvalues, and the Cronbach's α-coefficients as well as composite reliability (as measures of internal consistency).

In terms of content, the underlying factors of the six-factor solution can be described as follows: Factor 1, labelled 'Athletic comparison' ("Sportlicher Vergleich"), consists of five items (e.g., "I am worse than the others.") and measures the tendency of athletes to compare themselves or their performance with others. The higher the values for this factor, the more often the athlete's comparison is negative. The five items in the second factor, labelled 'Coach devaluation' ("Abwertung des Trainerverhaltens") refer to thoughts related to the communication with the coach or the perceived competence of the coach (e.g., "My trainer doesn't give me any feedback at all."). The higher the values, the more likely there are problems in the coach-athlete relationship. Factor 3, 'Devaluation of one's own performance' ("Abwertung der eigenen Leistungsfähigkeit") comprises seven items. The factor consists of thoughts concerning the retrieval of performance and the current state of the athlete (e.g., "If I make a mistake now, it was all for nothing."). The higher the values on this factor, the more frequently there is a devaluation of one's own performance. Factor 4, labelled 'Appreciation by coach and family' ("Wertschätzung durch Trainer und Familie") consists of three items that address the athlete's expectations regarding the appreciation of his or her athletic performance by the coach or parents (e.g., "My parents should be proud of me."). The higher the values on this factor, the more often an athlete feels the need to fulfill the (supposed) expectations of others. The next three items describe different types of escape thoughts and can therefore be summarized under the factor 'Inner resistance against competitions' ("Innerer Wettkampfwiderstand"; e.g., "I no longer want to participate in competitions."). Accordingly, higher values mean more frequent internal competition resistance of the athlete. The last and sixth factor also consists of three items related to the athlete's 'General exhaustion' ("Allgemeine Erschöpfung", e.g., "I can't go on any longer."). The higher the values, the more often athletes feel exhausted before or during a competition.

3.3. Discussion Study 2

The aim of Study 2 was to reduce the 54-item pool to a practical measure length of approximately 20–30 items, with a minimum of three to five items per scale and to test the factor structure of this initial item pool. To do this, we conducted an item analysis and subsequently an EFA to reduce the items to their underlying dimensions. Factor extraction procedures revealed that the original list of items can be reduced to six factors. The six-factor solution showed a convincing factor structure and conceptual coherence, that is item loadings of at least 0.40, no cross loadings ≥0.32, communalities ≥0.40, and no factors with fewer than three items. Whether the factorial validity of the six-factor solution can be replicated in other athlete samples will be tested in Study 3 using a CFA in a new and independent sample of athletes.

4. Study 3: confirmation of the identified factor solution, nomological network, concurrent validity, and test re-test reliability

In Study 3, we carried out a CFA to confirm the factorial structure of the ACCQ obtained in Study 2 with data collected from a separate and independent sample of athletes. To further assess the construct validity of the ACCQ, we investigated the convergent and divergent validity of the measure by examining its position in a nomological network (Preckel & Brunner, 2017), consisting of the ACCQ and other theoretically related constructs. In that respect, we expected the subscale 'Athletic comparison' of the ACCQ to positively correlate with social comparison (Social Comparison Scale, [INCOM]; Schneider & Schupp, 2011) as well as 'Performance worries' (subscale of the Thought Occurrence Questionnaire [TOQS]; Röthlin et al., 2017). We further expected a negative relationship between the 'Coach devaluation' subscale of the ACCQ and the coach-athlete relationship (Coach-Athlete-Relationship Questionnaire [CART-Q]; Walter et al., 2023), as well as interpersonal satisfaction and satisfaction with the coach (according to Alfermann et al., 2013; Jowett & Ntoumanis, 2004). Moreover, 'Devaluation of one's own performance' was hypothesized to be positively associated with irrational performance beliefs (Irrational Performance Beliefs Inventory [G-iPBI-2]; Michel-Kröhler & Turner, 2022). In addition, we assumed that the subscale 'Appreciation by coach and family' of the ACCQ is positively correlated with fear of negative evaluation (Brief Fear of Negative Evaluation Scale – Revised [BFNE-R]; Reichenberger et al., 2016) and 'Inner resistance against competition' was positively correlated with 'Sport devaluation' (Athlete Burnout Questionnaire [ABQ];

Gerber at al., 2018) and escaping thoughts (TOQS). Further, we expected the general exhaustion to be positively related to all three subscales of the ABQ (i.e., 'Emotional/physical exhaustion', 'Sport devaluation', and 'Reduced sense of accomplishment'). Finally, we expected a positive association between all subscales of the ACCQ and competition-related rumination (Sports Competition Rumination Scale [SCRS]; Michel-Kröhler et al., 2023) as well as negative relations to athletes' self-efficacy (General Self-efficacy scale [GSE]; Hinz et al., 2006) and self-esteem (Single-Item Self-Esteem Scale [G-SISE], Brailovskaia & Margraf, 2018). In addition, we determined the internal reliability using two different measures, namely Cronbach's alpha and composite reliability. Next, we examined the test–retest reliability over a four-week interval to test the stability and the reproducibility of our measure. Finally, we tested the concurrent validity of the ACCQ through correlations with athlete satisfaction and the tendency to choke under pressure.

4.1. Methods and material

4.1.1. Procedure

Athletes from various team and individual sports throughout Germany were invited to participate in the study by e-mail via their respective clubs or sports associations as well as social media channels and private contacts. Additionally, sports students from different universities were contacted via e-mail through their respective academic offices. The study was conducted online via SoSci-Survey (Leiner, 2019), and was carried out in compliance with the Declaration of Helsinki (World Medical Association, 2013). Ethical approval was granted from the local Review Board of the Johannes Gutenberg-University Mainz. Participation requirements were a minimum age of 16 and active participation in competitions. Participants were informed about the nature and the procedure of the study and gave written consent before completing the questionnaires. Participation was voluntary and athletes had the option of either receiving compensation of 10 euros and donating another 5 euros to charity or donating the entire amount of 15 euros.

Furthermore, the athletes could voluntarily participate in the follow-up survey one month later. For this, they were automatically sent another link via SoSci-Survey (Leiner, 2019), as well as a reminder to participate after one week.

4.1.2. Participants

Generally, CFA is a large-sample technique (Kline, 2016), but as a rule of thumb some minimum recommendations such as 5:1, 10:1 to 20:1 ratios of the number of cases (*N*) to the number of estimated parameters (q) were suggested for CFAs (Kyriazos, 2018). Therefore, our goal was to achieve a sample size of 400, thus providing sufficient size between the three recommendations.

Overall, 430 athletes completed the online survey. We removed data from seven athletes because of critical speed (relative speed index values > 2) in the processing of the online survey, data from one athlete because of double participation and another three athletes because they indicated not to participate in competitions, although this was a requirement for study participation. Consequently, the final sample consisted of 419 athletes from different team and individual sports. Table 1 displays biographical and training-related information of the sample.

4.1.3. Measures

We used the German versions of the below described questionnaires. In Table 3, mean values, standard deviations, 95 % confidence intervals (95 % CI) as well as Cronbach's alpha (α) of the respective scales are

Table 3
Mean (M), standard deviation (SD), Cronbach's alpha (α), inter-correlations for the ACCQ subscales as well as correlations of all study variables used separated by three different analyses.

		M (*SD*)	α	1	2	3	4	5	6	7
	Construct validity in terms of Inter-correlations of the ACCQ subscales									
1	Athletic comparison	12.40 (4.20)	.84	–						
2	Coach devaluation	9.60 (3.96)	.84	.23***	–					
3	Devaluation of one's own performance	18.47 (5.91)	.84	.70***	.27***	–				
4	Appreciation by coach and family	8.85 (3.07)	.74	.24***	.19***	.39***	–			
5	Inner resistance against competitions	5.24 (2.37)	.78	.44***	.25***	.43***	.10*	–		
6	General exhaustion	6.42 (2.63)	.72	.62***	.27***	.57***	.23***	.46***	–	
7	Composite score (ACCQ)	60.99 (15.63)	.90							
	Construct validity in terms of nomological network									
8	Social comparison: Ability (INCOM)	10.49 (2.78)	.77	.36***	.03	.36***	.26***	.20**	.26***	.37***
9	Social comparison: Opinion (INCOM)	10.10 (2.78)	.72	.28***	.07	.33***	.26***	.19*	.25***	.34***
10	Coach-Athlete-Relationship (CART-Q)	62.66 (11.47)	.93	−.09	−.55***	−.08	.13	−.12	−.08	−.20**
11	Satisfaction with coach	5.45 (1.31)	.73	−.12	−.57***	−.11	−.06	−.13	−.11	−.24***
12	Interpersonal satisfaction	5.69 (1.24)	.84	−.13	−.45***	−.12	.01	−.16	−.10	−.24***
13	Irrational performance beliefs (G-iPBI-2)	68.54 (11.15)	.89	.40***	.17	.50***	.41***	.19**	.34***	.51***
14	Fear of negative evaluation (BFNE-R)	38.13 (11.62)	.95	.36***	.17*	.47***	.41***	.24***	.31***	.49***
15	Performance worry (TOQS)	18.95 (6.62)	.80	.66***	.20**	.59***	.19*	.41***	.46***	.63***
16	Task-irrelevant thoughts (TOQS)	12.09 (5.83)	.82	.23***	.03	.16	.12	.22***	.23***	.22***
17	Escaping thoughts (TOQS)	12.02 (6.75)	.91	.46***	.28***	.41***	.05	.61***	.59***	.55***
18	Emotional/physical Exhaustion (ABQ)	12.77 (4.00)	.88	.15	.10	.15	.07	.17*	.34***	.22***
19	Reduced sense of Accomplishment (ABQ)	13.18 (3.66)	.79	.62***	.30***	.54***	.12	.46***	.45***	.62***
20	Sport devaluation (ABQ)	11.72 (4.28)	.77	.24***	.22***	.17*	.09	.35***	.27***	.30***
21	Competition-related rumination (SCRS)	20.70 (6.80)	.91	.54***	.24***	.64***	.36***	.31***	.40***	.63***
22	Self-efficacy (GSE)	28.81 (4.08)	.84	−.44***	−.08	−.44***	−.08	−.32***	−.37***	−.43***
23	Self-esteem (G-SISE)	3.47 (0.98)	–	−.51***	−.16*	−.45***	−.17*	−.32***	−.35***	−.49***
	Concurrent validity of the ACCQ									
24	Satisfaction general (L-1)	7.78 (2.11)	–	−.34***	−.09	−.36***	−.18**	−.20***	−.34***	−.38***
25	Satisfaction sport-specific (L-1S)	7.17 (1.98)	–	−.39***	−.15*	−.32***	−.09	−.31***	−.23***	−.37***
26	Choking under Pressure	3.88 (1.92)	–	.53***	.14*	.55***	.17**	.37***	.31***	.53***

Note. ACCQ = Adverse competition-related cognition questionnaire. To determine the inter-correlations of the individual factors of the ACCQ and to calculate the nomological network and concurrent validity, we performed three independent correlation analyses each. *$p < .05$, **$p < .01$, ***$p < .001$; composite reliability (ρ) scores for the respective subscale of our ACCQ were: ρ = 0.84 (Athletic comparison), ρ = 0.84 (Coach devaluation), ρ = 0.83 (Devaluation of one's own performance), ρ = 0.77 (Appreciation by coach and family), ρ = 0.81 (Inner resistance against competitions), ρ = 0.73 (General exhaustion), ρ = 0.90. *p*-values were corrected for multiple testing using Holm's method.

presented. Unless otherwise stated, we report the sum score of the scale used.

4.1.3.1. Adverse competition-related cognitions. We used the previously identified 26 items from the preliminary final version of the ACCQ, which were presented in a randomized order and applied the same instructions and response format as in Study 2.

4.1.3.2. Social comparison. The short form of Social Comparison Scale (INCOM, Schneider & Schupp, 2011, English original version by Gibbons & Buunk, 1999) measures the athletes' self-comparisons with others. The INCOM scale consists of two subscales with three items each, namely 'Comparisons on abilities' (e.g., "I always pay a lot of attention to how I do things compared with how others do things.") and 'Orientation towards others' opinions' (e.g., "I always like to know what others in a similar situation would do."). Athletes rated the items on a 5-point scale ranging from '1' (*strongly disagree*) to '5' (*strongly agree*). Cronbach's α in the original study was 0.83 (Gibbons & Buunk, 1999).

4.1.3.3. Coach-athlete relationship. To capture the relationship between coaches and their athletes we applied the athlete version of the Coach–Athlete Relationship Questionnaire (CART-Q; Walter et al., 2023; English original version by Jowett & Ntoumanis, 2004). The CART-Q consists of three subscales: 'Commitment' (three items, e.g., "I feel close to my coach."), 'Closeness' (four items, e.g., "I trust my coach."), and 'Complementarity' (four items, e.g., "When I am coached by my coach, I am ready to do my best."). Items are rated on a 7-point scale ranging from '1' (*do not agree at all*) to '7' (*fully agree*). Cronbach's α in the original study was 0.86 for 'Closeness', 0.80 for 'Commitment', 0.85 for 'Complementarity', and 0.93 for the total scale (Walter et al., 2023).

According to Jowett and Ntoumanis (2004), we used two further items to measure the interpersonal satisfaction ("Do you feel satisfied by your overall coach–athlete relationship?", and "Do you think your athlete/coach feels satisfied by your coach–athlete relationship as a whole?"), and another two items according to Alfermann et al. (2013) to measure athletes' satisfaction with their coach ("How satisfied are you with your coach?", and "How satisfied are you with the training you receive?"). All four items are rated on the same 7-point scale as the CART-Q items. For the analysis, an average of the respective two items was calculated.

4.1.3.4. Athlete burnout symptoms. We used the Athlete Burnout Questionnaire (ABQ, Gerber at al., 2018, English original version by Raedeke & Smith, 2001) to detect clinically relevant burnout symptoms in athletes. The ABQ consists of three subscales with five items each, namely 'Emotional/physical exhaustion' (e.g., "I feel physically worn out from sport."), 'Sport devaluation' (e.g., "I'm not into sport like I used to be."), and 'Reduced sense of accomplishment' (e.g., "I am not achieving much in sport."). Items are answered on a 5-point scale ranging from '1' (*almost never*) to '5' (*almost always*). Cronbach's α in the original study was 0.80 for 'Emotional/physical exhaustion', 0.78 for 'Sport devaluation', and 0.78 for 'Reduced sense of accomplishment' (Gerber at al., 2018).

4.1.3.5. Cognitive interference. The Thought Occurrence Questionnaires Sport (TOQS; Röthlin et al., 2017; English original: Hatzigeorgiadis & Biddle, 2000) consists of 17 items and measures the interference of own thoughts with concentration on three subscales: 'Performance worries' (e.g., "That I'm not going to achieve my goal today."), 'Task-irrelevant thoughts' (e.g., "About what I'm going to do later in the day."), and 'Thoughts of escape' (e.g., "That I want to get out of here."). Athletes responded on a 5-point scale ranging from '1' (*almost never*) to '7' (*almost always*). Cronbach's α in the original study was 0.74 for 'Performance worries', 0.78 for 'Task-irrelevant thoughts', and 0.88 for 'Escaping thoughts'.

4.1.3.6. Irrational Performance Beliefs. We used the 20-item Irrational Performance Beliefs Inventory (G-iPBI-2, Michel-Kröhler & Turner, 2022; English original: Turner & Allen, 2018) to assess performance related irrational beliefs in our sample. The G-iPBI-2 consists of four dimensions, namely 'Primary irrational beliefs' (PIB; e.g., "I must not be dismissed by my peers."), 'Low frustration tolerance' (LFT; e.g., "I can't bear not getting better at what I do."), 'Awfulization' (AWF; e.g., "It's terrible if the members of my team do not respect me."), and 'Depreciation' (DEP; e.g., "I am a loser if I do not succeed in things that matter to me."), each measured with five items. Athletes rated the different statements on a 5-point scale from '1' (*strongly disagree*) to '5' (*strongly agree*). Cronbach's α in the original study was 0.77 for PIB, 0.84 for LFT, 0.78 for AWF, 0.92 for DEP, and .92 for the total scale (Michel-Kröhler & Turner, 2022).

4.1.3.7. Fear of negative evaluations. We assessed the Brief Fear of Negative Evaluation Scale – Revised (BFNE-R; Reichenberger et al., 2016; English original: Watson & Friend, 1969) to test the fear of negative evaluation as a cognitive characteristic of the social phobia. Athletes indicated on a 5-point scale ranging from '1' (*not at all characteristic for me*) to '5' (*extremely characteristic for me*) how characteristic 12 statements were for them (e.g., "I am afraid that others will not speak positively about me."). Cronbach's α in the original study was 0.94 (Reichenberger et al., 2016).

4.1.3.8. Competition-related rumination. The Sports Competition Rumination Scale (SCRS; Michel-Kröhler et al., 2023*)* consists of eight items and captures rumination about competition-related problems (e.g., "I can't stop thinking about competition-related problems."). Athletes responded on a 5-point scale ranging from '1' (*does not apply at all*) to '5' (*fully applies*). Cronbach's α in the original study was 0.92 (Michel-Kröhler et al., 2023).

4.1.3.9. General self-efficacy. We used the General Self-Efficacy Scale (GSE, Hinz et al., 2006; English original by Schwarzer & Jerusalem, 1995), which was designed to assess athletes' general sense of perceived self-efficacy with the aim to evaluate coping with daily hassles as well as adaptation after experiencing all kinds of stressful life events. The GSE consists of ten items (e.g., "I can always manage to solve difficult problems if I try hard enough.") and is rated on a 4-point scale ranging from '1' (*not at all true*) to '4' (*exactly true*). Cronbach's α in the original study was 0.92 (Hinz et al., 2006).

4.1.3.10. Self-esteem. We captured athletes' global self-esteem with the single-item self-esteem scale (G-SISE, Brailovskaia & Margraf, 2018; English version by Robins et al., 2001). The item ("I have high self-esteem.") was rated on a 5-point Likert scale ranging from '1' (*not at all true of me*) to '5' (*very true of me*).

4.1.3.11. Choking under pressure. We assessed the athletes' perceived tendency to choke under pressure in competition with one item (i.e., "What is your tendency to choke under pressure in competitions?"; adapted from Iwatsuki et al., 2018) using an 11-point scale from '0' (*never choke*) to '10' (*always choke*).

4.1.3.12. Satisfaction. We captured athletes' satisfaction with their life with the short scale Life satisfaction (L-1; Beierlein et al., 2014), which asked with one item "How satisfied are you at present, all in all, with your life?". To ask about athletes' satisfaction with their overall athletic development, we slightly modified the L-1 into "How satisfied are you at present, all in all, with your athletic development?" (L-1S). Athletes rated both items on an 11-point scale ranging from '0' (*not satisfied at all*) to '10' (*completely satisfied*).

4.1.4. Data analyses

We performed statistical analyses using R Studio (R Core Team, 2019).

4.1.4.1. Data screening. First, we checked our data for univariate and multivariate normal distribution using Shapiro–Wilk-test for univariate normality and Mardia's coefficient for multivariate normality ("mvn"-package; Korkmaz et al., 2014). The analyses revealed neither a normal distribution for the individual items nor a multivariate normal distribution of the data (Mardia Kurtosis = 26.82, $p < .001$; Mardia, 1970; Tabachnick & Fidell, 2013). Thus, we considered the data suitable for confirmatory factor analysis (CFA) using robust maximum likelihood estimation (MLR), that computes standard errors and model fit indices that are robust in relation to the relative non-normality of observations (Hu et al., 1992). Second, we screened data for outliers (standardized *z* values > 3.29; Tabachnick & Fidell, 2013; Mair & Wilcox, 2020), and winsorized outliers at time 1 ($n = 16$ from 10,894 cases <0.01 %), and at time 2 ($n = 1$ from 6162 cases <0.01 %).

4.1.4.2. Confirmatory factor analysis. A CFA was conducted to test the six-factor structure of the ACCQ and to evaluate factor loadings, error variances, and modification indices. We assessed the goodness of model fit with multiple fit indices and reported the χ^2-test statistic, the Root Mean Square Error of Approximation (RMSEA) and its confidence interval (90 % CI), as well as the Standardized Root Mean Square Residual (SRMR), the Comparative Fit Index (CFI), and the Tucker Lewis Index (TLI). RMSEA-values less than 0.08 indicate an acceptable model and less than 0.06 indicate a good model (Hu & Bentler, 1999). For the SRMR index, values should be < 0.05 for a good fit and <0.10 for an acceptable fit. Regarding CFI und TLI index, values > 0.90 are indicative of a good model fit (Hu & Bentler, 1999).

In addition, Bentler and Bonett (1980) suggested that the hypothesized factor model should be compared to other models. Therefore, we tested four different models. In the first model a one-factor solution was tested, that is all the items were loaded on one factor (Model 1). In the second model, a six-factor solution was tested based on the results of the EFA. The factors were set uncorrelated (Model 2). In the third model, the six factors were free to correlate (Model 3). In Model 4, a higher-order model, the six first-order factors were designed to load on a second-order factor, namely an overall adverse competition-related cognition factor. The six low-order factors were allowed to correlate with each other. According to Marsh (1987), the hierarchical model is supported when the fit of a higher-order model is identical or very similar to the fit of the corresponding first-order model. Nevertheless, it is recommended to report the Average extracted variance (AVE, Fornell & Larcker, 1981), in addition to the standard indices of model fit. The AVE should be > 0.50 and measures the ability of the higher-order factor to explain the variance in the lower-order factors. Furthermore, loadings on the higher-order factor should be greater than 0.70 (see also Credé & Harms, 2015).

4.1.4.3. Correlational analyses. We conducted three independent Pearson correlation analysis to examine (1.) the inter-correlations of the ACCQ subscales, (2.) the nomological network of the ACCQ and theoretically related constructs, and (3.) the concurrent validity. We corrected *p*-values for multiple comparisons using Holm's method for each analysis. The following criteria according to Hinkle et al. (2003) to evaluate the correlation coefficients were applied: very high (.90–1.00), high (0.70–0.90), moderate (0.50–0.70), and low (<0.50).

4.1.4.4. Reliability analyses. We computed Cronbach's alpha and the composite reliability as measures of internal consistency (for more details see Data Analyses Study 2). In addition, we examined the test–retest reliability over a month interval to test the stability and the reproducibility of our measures and calculated intra-class correlation coefficients (ICC). According to Koo and Li (2016), values greater than 0.90 are excellent, values between 0.75 and 0.90 are good, values between 0.50 and 0.75 are moderate, and values less than 0.50 describe a poor reliability.

4.2. Results

4.2.1. Factorial validity

Due to the non-normal distribution of our data, we applied robust maximum likelihood estimation with Yuan-Bentler scaled test statistic (Hu et al., 1992). The fit indices for the four models are presented in Table 4. Model 3, the six-factor intercorrelated solution, achieved the best model fit indices. Standardized factor loadings ranged from 0.46 to 0.86 and were above the recommended minimum of 0.40 (Tabachnick & Fidell, 2013) and error variances were between 0.26 and 0.79. Model 4, the 6-factor higher-order model, achieved a slightly worse but still comparable model fit. The AVE was >0.50 for all factors except for 'Devaluation of one's own performance' (AVE = 0.43), and loadings on the higher-order factor were between 0.37 ('Coach devaluation') and 0.92 ('Devaluation of one's own performance').

4.2.2. Nomological network

Descriptive statistics and correlations are summarized in Table 3.

As expected, the subscale 'Athletic comparison' from the ACCQ was positively correlated with both subscales of the Social Comparison Scale (INCOM) and the subscale 'Performance worries' of the TOQS. The stronger the tendency to compare oneself to others in sports, the stronger the general tendency to compare oneself in social contexts and to worry about one's own performance. Furthermore, the ACCQ subscale 'Coach devaluation' was low to moderate associated with coach-athlete relationship (CART-Q), satisfaction with the coach and interpersonal satisfaction, such that more coach devaluation is related to less satisfaction (both interpersonal and with the coach) and a worse coach-athlete relationship. The subscale 'Devaluation of one's own performance' from the ACCQ was positively correlated with irrational performance beliefs (G-iPBI-2). Those who reported greater devaluation of their own performance also reported greater irrational performance beliefs. Furthermore, as expected, the ACCQ subscale 'Appreciation by coach and family' was positively associated with fear of negative evaluation (BFNE-R), in the way that the higher the wish for appreciation by the coach or the family the higher the fear of negative evaluation. The subscale 'Inner resistance against competitions' from the ACCQ was also positively related with 'Escaping thoughts' (TOQS) and 'Sport devaluation' (ABQ), indicating that the higher the inner resistance of an athlete against competitions, the higher the escaping thoughts and the general sport devaluation. The ACCQ subscale 'General exhaustion' was positively correlated with a 'Reduced sense of accomplishment', 'Emotional

Table 4
The fit indices for the four alternative confirmatory factor analysis models (N = 419).

Models	χ^2 test statistic	CFI	TLI	RMSEA (90 % CI)	SRMR	AIC
Model 1	1968.875 (299), **	.614	.580	.120[.115, .125]	.107	29992.292
Model 2	1426.850 (299), **	.741	.719	.098[.093, .104]	.235	29389.886
Model 3	683.903 (284), **	.909	.896	.060[.054, .066]	.058	28613.362
Model 4	731.957 (293), **	.900	.889	.062[.056, .067]	.063	28524.893

Note. Model 1: one-factor solution; Model 2: six-factor solution –uncorrelated; Model 3: six-factor solution –factors free to correlate; Model 4 six-factors –second-order factor. χ^2 = Chi-Square; CFI = Comparative Fit Index; TLI: Tucker Lewis Index; RMSEA: Root Mean Square Error of Approximation; 90 % CI: confidence interval; SRMR = standardized root mean square residual; AIC = Akaike information criterion. $^{**}p < .001$.

Table 5
Means (M), standard deviations (SD), Cronbach's alphas (α) and intra-class correlation coefficients (ICC) with their confidence interval (95 % CI) for the respective subscales and the composite adverse competition related cognition score.

Factor	*M*	*SD*	*α/ρ*	ICC[95%CI]
Athletic comparison	12.03	4.28	.88/ .88	.776[.720, .820]
Coach devaluation	9.88	3.88	.86/ .86	.698[.626, .758]
Devaluation of one's own performance	17.99	6.07	.88/ .88	.792[.739, .835]
Appreciation by coach and family	8.81	2.93	.72/ .75	.675[.599, .739]
Inner resistance against competitions	5.65	2.71	.80/ .83	.776[.720, .822]
General exhaustion	6.65	2.69	.73/ .78	.692[.619, .753]
Composite score (ACCQ)	61.00	16.32	.91/ .92	.808[.759, .848]

Note. $N = 237$; ACCQ = Adverse competition-related cognition questionnaire.

and physical exhaustion', and 'Sport devaluation' (ABQ). Those who reported higher general exhaustion also reported higher levels on the three dimensions of the ABQ. Finally, as expected, all subscales of the ACCQ were consistently correlated with athletes' competition-related rumination, self-efficacy, and self-esteem, such that more adverse competition-related cognitions were associated with more competition-related rumination and less self-efficacy and self-esteem.

To summarize, all correlations matched our expectations concerning the position of the ACCQ subscales in the nomological network.

4.2.3. Scale reliability

We calculated Cronbach's alpha coefficients as well as composite reliability as measures of internal consistency of the ACCQ and its subscales. Table 5 shows that all alpha coefficients as well as composite reliability coefficients were in a good range ($\alpha > 0.70$, Nunnally & Bernstein, 1994, see also Table 3). Regarding the test-retest reliability, ICC coefficients of the ACCQ subscales ranged from 0.674 (appreciation by coach and family) to 0.792 (devaluation of one's own performance). Thus, values of all subscales were in a moderate to good range (Koo & Li, 2016), which indicated the acceptability of temporal reliability or repeatability of subscales in the ACCQ over a 4-week-intervall. Further, the ICC for the composite scores of the ACCQ with 0.808 [0.759, 0.848] confirmed the test–retest reliability of the measure.

4.2.4. Concurrent validity of the ACCQ

We used concurrent validity in this study to evaluate the test-criterion relationships (AERA, 2014) between adverse competition-related cognitions and satisfaction with life in general and athletic development in particular as well as the tendency to choke under pressure. Pearson's correlation coefficients indicated significant low to moderate correlations between all subscales of the ACCQ (except coach devaluation) and choking under pressure, indicating the more athletes experienced adverse competition-related cognitions, the higher the tendency to choke under pressure (see Table 3). Moreover, results indicated significant low and negative associations with satisfaction with life (exception coach devaluation) as well as satisfaction with one's own athletic development (exception appreciation by coach and family). According to this, the satisfaction of athletes in both areas is higher, the lower their adverse competition-related cognitions.

4.3. Discussion Study 3

Study 3 aimed at confirming the 6-factor structure of the ACCQ through confirmatory factor analysis. In addition, we took further steps to assess its reliability and validity, by (1.) determining the position of the ACCQ in a nomological network to investigate its convergent and divergent validity, (2.) examining the concurrent validity with correlations between the ACCQ and its subscales and athletes' satisfaction and the tendency to choke under pressure, (3.) determining internal consistencies of the subscales and total score using two measures (Cronbach's α & composite reliability) and, finally, (4.) investigating test-retest reliability using intra-class correlation coefficients.

Construct validity in terms of factorial validity was supported through CFA. Moreover, internal consistencies and test–retest reliability were adequate, and the nomological network confirmed that our measure correlated in the expected directions with measures of other similar and dissimilar constructs (e.g., social comparison, interpersonal aspects between coach and athlete, irrational performance beliefs, fear of negative evaluation, performance worries, sport devaluation, competition-related rumination, self-efficacy, and self-esteem). In addition, correlations between the ACCQ and athletes' satisfaction as well as their tendency to choke under pressure lend support to the concurrent validity of the ACCQ.

We conducted different CFAs, to exclude the possibility that alternative models achieve a better model fit and to fully support the decision for our final model. Results showed a good fit to Model 3 and thus confirmed the 6-factor structure of the newly developed ACCQ. In addition, standardized factor loadings for all subscales were higher than the recommended value of 0.40 (Tabachnick & Fidell, 2013), indicating at least 20 % variance overlap for each item. Model 4, the higher-order factor model showed a slightly different but comparable fit. Average extracted variance of five from six factors were above the recommended value of 0.50. However, because of loadings on the higher-order factor that do not all exceed the recommended value of 0.70, it must be assumed that additional information for predicting important outcomes may be lost if all manifest variables are simply aggregated to calculate a score that reflects only the higher-order construct (Credé & Harms, 2015). Due to the variety of factors and the associated different information, we therefore recommend that the assessment always be made at the factor level and that the total score only be used for a quick initial overview.

Moreover, construct validity with respect to the position of the ACCQ and its subscales in a nomological network was supported by low to moderate correlations with several measures from general psychological and sport psychology constructs. Further results demonstrated the internal stability and the temporal stability of the ACCQ over a period of one month. Although we asked how frequently the listed thoughts occur in athletes in general immediately before or during a competition, this may mean that athletes experience little or no adverse competition-related cognitions during individual competitions, but are generally strongly influenced by them, or vice versa. For example, certain thoughts might be relatively stable in one season or preparation period (sometimes consisting of several weeks or months) but change in the next season or period (possibly also depending on the results achieved or a change of coach/team).

Finally, the correlations between the ACCQ and athletes' satisfaction and between ACCQ and athletes' tendency to choke under pressure could be considered as evidence for the concurrent validity of the ACCQ. Taken together, these findings strongly support the 6-factor structure of the ACCQ as well as their validity and reliability in a German sample of athletes.

5. Study 4: Confirmation of the identified 6-factor solution in a sample of high-performance competitive athletes

The aim of Study 4 was to test the identified 6-factor solution from Study 2 and 3 in a sample of high-performance competitive athletes to thereby address the question of whether adverse competition-related cognitions also play a relevant role in higher performance domains. Therefore, we collected data from athletes who competed at the highest level and conducted a second CFA to confirm the factor structure in this

sample.

5.1. Methods and materials

5.1.1. Procedure

Athletes from three different sports (soccer, handball, dancing sports) were contacted to participate in the study by their coaches or sport psychologists. The study was conducted online via SoSci-Survey (Leiner, 2019), as well as in a paper-pencil format before the training session and in compliance with the Declaration of Helsinki (World Medical Association, 2013). Athletes completed the final 26-item version of the ACCQ (see Measures Study 3) and answered training- and competition-related questions as well as biographical questions. To be able to examine the factor structure in a competitive athletic sample, we primarily selected athletes who were active at the highest performance levels. In addition, participation requirements were a minimum age of 15 and active participation in competitions. Participants were informed about the nature and the procedure of the study and gave written consent before completing the questionnaires. For athletes under the age of 16, written consent from a parent or legal guardian was also required. Participation was voluntary and athletes did not receive any compensation.

5.1.2. Participants

One-hundred-fifty-three athletes from three different sports (soccer: n = 73, dancing sports: n = 47, handball: n = 33) participated in the study. Table 1 displays biographical and training-related information of the sample.

5.2. Results

The analyses for the normal distribution of the data showed neither a normal distribution for the individual items nor a multivariate normal distribution of the data (Mardia Kurtosis = 8.45, $p < .001$; Mardia, 1970; Tabachnick & Fidell, 2013). Therefore, as in Study 3, we used a robust maximum likelihood estimation (MLR) and screened data for outliers. Overall, 10 values were detected with a standardized z value > 3.29 (n = 10 from 5.967 cases; <0.01 %; Tabachnick & Fidell, 2013; Mair & Wilcox, 2020).

Results of the initial CFA revealed only a partial acceptable fit to the expected six-factor solution, $N = 153$, $\chi^2(284) = 456.37.20$; $p < .001$, CFI = 0.884, TLI = 0.867, SRMR = 0.076, RMSEA = 0.064 (90 % CI: 0.053, 0.074). Therefore, we decided to perform a second CFA in which we considered the proposed modification in the form of a covariation of the residuals of Item 11 and 12. The result of the second CFA showed a slightly better model fit compared to the first model and is closer to the recommended model fit indices. $N = 153$, $\chi^2(283) = 442.34$; $p < .001$, CFI = 0.893, TLI = 0.877, SRMR = 0.075, RMSEA = 0.061 (90 % CI: 0.050, 0.072). Standardized factor loadings ranged from 0.41 to 0.85 except for Item 37, which had a factor loading of 0.38. Error variances were between 0.27 and 0.86.

5.3. Discussion Study 4

Study 4 aimed at testing the identified 6-factor-solution in a sample of high-performance competitive athletes to test whether in this kind of specific sample the ACCQ is equally valid and reliable. The results of the CFA showed a lower model fit compared to Study 3 but were still in the acceptable range. However, this only applies to two out of four fit indices; the CFI and TLI were slightly below the recommended value of 0.90 (Hu & Bentler, 1999). In addition, we allowed the error variance of Item 11 ("I can't allow myself to make mistakes.") and Item 12 ("If I make a mistake now, it was all for nothing.") to correlate due to their affinity in terms of content. Both items relate to cognitions about failures and potential consequences, which is part of the devaluation of one's own performance subscale. Moreover, Item 23 ("I am not the competitive type.") showed a very low factor loading. This could be due to the fact that this item is highly sensitive to the performance level. The sample from Study 4 was particularly selected to include competitive athletes only, whereas samples from Study 2 and 3 were broader in terms of performance level. Accordingly, it can be assumed that one must be a competitive type to achieve and then maintain a certain level of performance, resulting in lower variance in that item.

Furthermore, the sample investigated in Study 4 limits the generalizability of results in some other ways. First, the gender distribution differed from that in Study 2 and 3 in that the sample of Study 4 included twice as many women as men, whereas they were roughly equally distributed in Study 2 and 3. Second, the sample of Study 4 included only team athletes, whereas athletes from team and individual sports were mixed in Study 2 and 3. Therefore, future studies should consider the aspect of sport type and examine measurement invariance for team and individual athletes as well as male and female athletes.

6. General discussion

The aim of the present research project was to develop a novel measure for assessing different, mainly adverse competition-related cognitions of athletes, the Adverse Competition-related Cognition Questionnaire (ACCQ), and to test its psychometric properties and validity. In the first study reported here, we describe the process of item development from scratch (i.e., from the generation of various negative and dysfunctional thoughts), ending up with an initial pool of 54 items. In Study 2, we used psychometric indicators and EFA to reduce the initial pool of 54 items to a practical measure length of 26 items. The EFA resulted in a 6-factor solution, which consists of the following factors: athletic comparison, coach devaluation, devaluation of one's own performance, appreciation by coach and family, inner resistance against competitions, and general exhaustion. In Study 3, we revealed further evidence for the validity of the 26-item ACCQ using a larger sample of competitive athletes. From the four models examining the factorial validity using a CFA, the two models that accounted for the relationship between the six factors (Model 3 and 4) best fitted the data. Associations between ACCQ scales and indicators of social comparison, performance worries, functional coach-athlete relationship, irrational performance beliefs, and fear of negative evaluation, sport devaluation, escaping thoughts, competition-related rumination, self-efficacy, and self-esteem attest to the validity of the new measure. Moreover, the ACCQ was internally reliable, and its test-retest reliability was confirmed through the temporal stability and the reproducibility over a four-week interval. The results of Study 4 demonstrated that the ACCQ can also be applied to competitive athletes at higher performance levels.

6.1. Limitations and future research

Some potential shortcomings should be considered prior to adopting the ACCQ. The development of the ACCQ is based on cross-sectional data and self-reports. Athletes do not have perfect access to their cognitions and therefore, thoughts that occur spontaneously in a given situation are difficult to capture (De Muynck, et al., 2020). Consequently, the construction of a new questionnaire depends on how well the athletes can remember their thoughts. Therefore, a bias, for example, due to memory effects in the form of remembering or forgetting processes, as well as selective perception cannot be ruled out in our survey, (Döring & Bortz, 2005). Nevertheless, we attempted to overcome these limitations through an elaborate item selection process and multi-perspective approach. However, further studies could use prospective designs and observational measures to determine whether the ACCQ predicts real-life preparatory actions and sport performance outcomes. Moreover, future studies should also examine differences in adverse competition-related cognitions across age, gender, performance level, sport-type, and sport psychological experience, to gain even more information for a suitable application. In addition, we have translated

the items of the ACCQ into English according to the principles of good practice for the translation and cultural adaptation process (Wild et al., 2005). Future studies to validate the English version of the ACCQ are warranted to provide a questionnaire that can also be used with English-speaking athletes. This is particularly important for high performance team sports where athletes from different nations form a team. Finally, although our questionnaire is already relatively short (26 items), it would be conceivable to shorten the questionnaire further in order to increase the athletes' investment in the long term and reduce the burden (Horvath & Röthlin, 2018).

6.2. Advantages and application of the ACCQ

A major advantage of the newly developed ACCQ is that we developed it from scratch with the support of different stakeholders from competitive sport (i.e., athletes, coaches, sport psychologists, psychologists, and sport scientists). Through this multi-perspective approach, we were able to show that, first, there is a high overlap in the perception of dysfunctional thoughts and their potential influence on performance between the different stakeholders (see also Kröhler, 2019). Second, this approach helps to increase the quality of the questionnaire as well as to ensure that it captures thoughts relevant to sport practice. Therefore, for many research questions in the context of competitive sport, the ACCQ offers the possibility to capture competition-related dysfunctional thoughts and thus to investigate possible relationships with athletic performance.

Unlike other sport-specific measures that capture athlete self-talk or thoughts, the ACCQ includes a coach factor that largely captures athlete-coach relationship, or rather coach behavior. The need for such a subscale is underlined by the results of a recent survey with German high-performance athletes who partly participated in the Tokyo Olympics. Here, a large proportion (67–72 %, $N = 1122$; Breuer & Hallmann, 2022) of the athletes stated that they were not satisfied with their coaches' expertise and leadership style, as well as their training planning, control and organization and mental presence. This is supported by another study by Zourbanos et al. (2010), who stated that situational variables such as coach behavior can have an impact on athletes' self-regulation. Thus, the ACCQ offers the possibility to capture potential complications with the coach at an early stage (e.g., at the beginning of coach-athletes relationship, or at the beginning of a preparatory period for a competition), thereby providing the opportunity to work on a coach-athlete interaction over the course of a season, for example, so that optimal athlete performance development can occur.

In summary, the ACCQ is a reliable and easy to complete questionnaire. The ACCQ can provide information that is relevant both in a scientific, research context and for coaching (i.e., it can provide insights into the individual thoughts of athletes). In detail, due to the diversity of factors, the ACCQ is on the one hand suitable for initial "screening" and can support the identification of thoughts that may occur in athletes immediately before or during a competition. Based on an initial assessment of adverse competition-related cognitions, certain aspects can be further explored or deepened. For example, if necessary, other measurement tools could be used that are more specific to a certain aspect (e.g., if an athlete has a high score on the coach devaluation subscale, the CART-Q could be used to obtain detailed information about the coach-athlete relationship as well as potential problems). On the other hand, the ACCQ can also be applied systematically over a longer period (e.g., at different times in the season) to capture potential changes in athletes' personal, training, or competition-related conditions. Finally, if an athlete shows weaknesses in competition but performs well in training, we recommend using other questionnaires besides our questionnaire, such as the WAI-T (Wettkampf-Angst Inventar [Competition Anxiety Inventory], Brand et al., 2009), the SCRS or G-iPBI, to allow trainers/practitioners to identify underlying or deep-seated performance-limiting factors in more detail (i.e., anxiety/worry, rumination or irrational beliefs).

7. Conclusion

With its broad range of factors, the Adverse Competition-related Cognition Questionnaire (ACCQ) provides a useful and valid measure for assessing different adverse competition-related cognitions, offering a wide range of potential applications in research and sport psychology practice. Moreover, the different ACCQ factors could be directly linked to several significant research areas in sport psychology such as self-confidence, communication, motivation, stress, and anxiety. These links further support the importance of adverse cognitions in the context of competitive sport.

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CRediT authorship contribution statement

Alena Michel-Kröhler: Conceptualization, Investigation, Formal analysis, Writing – original draft. **Michèle Wessa:** Conceptualization, Writing – review & editing. **Stefan Berti:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings will be available after publication.

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Supplementary data

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