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German version of the Talent Development Environment Questionnaire (TDEQ-5)

Supplementary Information

The online version of this article (https://doi.org/10.1007/s12662-022-00850-x) contains supplementary material, which is available to authorized users.

Introduction

Talent development (TD) is a complex and dynamic process which influences the development of athletes in a multidimensional way, with the ultimate goal of maximizing their potential. Researchers used to emphasize various sources of influence on talent development. The focus of respective models lies, for example, on the early years of expertise development due to practice (Coutinho, Mesquita, & Fonseca, 2016), on athlete variables like motivation and physiology, and/or on social influences, coaches, parents, and clubs in particular (Gulbin, Croser, Morley, & Weissensteiner, 2013). In the following, we will concentrate on environmental variables, and—as some models of athlete development (see Gulbin et al., 2013; Li, Wang, & Pyun, 2014) tend to rely on Gagné's Differentiated Model of Giftedness and Talent (DGMT)—we will shortly introduce this model first and afterwards proceed to the environmental aspects of athlete talent development in particular.

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In the DGMT, Gagné (2020) distinguished between giftedness and talent. Giftedness is understood as the possession of natural abilities in any given domain (e.g., sensorimotor), which places someone in the top 10% of their peers. On the other hand, talent describes the mastery of skills through systematic training in a given field (e.g., sport; see Gagné, 2020). As such, talent is seen as influenceable over time, both through individual effort on the part of the person and through systematic support tailored to the person by the environment (Gulbin et al., 2013). Indeed, Collins and MacNamara (2017, p. 6) emphasize the high importance of achieving an optimal fit of "developing abilities in an appropriately challenging environment." This highlights that "rather than focusing merely on intrapersonal factors such as athletes' physical traits, key TD environmental factors should be identified and enhanced" (Li et al., 2015, p. 1831).

A crucial factor for such an athlete's sport development pathway is the talent development environment (TDE), which refers to an organized system influencing the progression of athletes (Li et al., 2014; Martindale, Collins, & Daubney, 2005). This means that environmental variables should combine into a system with the goal of improving athletes' performance and at the same time encourage their personal development. Most importantly, "this encompasses a more holistic ecological approach by examining the broader developmental context or environment in which athlete development takes place rather than focusing solely on the individual athlete" (Coutinho et al., 2016, p. 286). Over the past 15 to 20 years, there has been an increase in the number of researchers investigating the nature and structure of effective TDEs (e.g., Henriksen, Stambulova, & Roessler, 2010a, b; Martindale, Collins, & Abraham, 2007). Based on a literature review, Li et al. (2014) present a taxonomy of important environmental variables. Based on Gagné's DGMT they distinguish three categories, namely milieu, individuals, and provisions. Milieu includes, among other things, sport culture and sport policy. Individuals is synonymous with social agents in the personal environment of the athlete, i.e., parents, coaches, and peers. Provisions focus on long-term development, quality preparation, and effective communication between coaches, managers, and club staff on the one hand and athletes on the other.

Interestingly, quantitative and qualitative research alike have shown that there are a number of factors that consistently seem to characterize successful environments across different contexts, sports, and cultures. Considering qualitative research, there are a number of studies that present key aspects of successful environments. For example, Martindale et al. (2007) studied a multisport sample of UK-based expert talent development coaches and found through interviews that four key principles emerged through effective environments. These

included clear long-term aims and methods, wide-ranging coherent support and messages, an emphasis on appropriate development not early success, and individualized and ongoing development opportunities. Since then, a number of case studies of effective talent development environments across different cultures, sports, and contexts have found wider support for these key principles (e.g., Aalberg & Sæther, 2016; Gledhill & Harwood, 2015; Henriksen et al., 2010a, b, 2011, 2013; Larsen, Alfermann, Henriksen, & Christensen, 2013; Schacht & Kiewra, 2018; Seanor, Schinke, Stambulova, Ross, & Kpazai, 2017). As such, the features of successful athletic talent development environment case studies summarized by Henriksen and Stambulova (2017) include a focus on long-term development, strong and coherent organizational culture, integration of efforts, training groups with supportive relationships, proximal role models, support for sporting goals by a wider environment, training that allows for diversification, and support for the development of psychosocial skills.

Qualitative research has highlighted important principles of best practice, and usefully exemplified context-specific examples of how these principles have been implemented in various sport environments. Quantitative work has investigated the relationship between the environment and important developmental outcomes. This quantitative work has been made possible through development and use of the Talent Development Environment Questionnaire (TDEQ) (Martindale et al., 2010). The TDEQ was developed as a monitoring tool, "emphasizing the generic environmental features useful for facilitating the development of excellence across sports, stage/age, gender, and culture" (Martindale et al., p. 1216), to assess the perceived environment in the eyes of young developing athletes. The holistic key features were identified using a triangulated approach, including a literature review (Martindale et al., 2005), interviews with expert talent development coaches working within the United Kingdom, and interviews with developing athletes embedded within the talent

pathway (Martindale et al., 2007). As outlined above, this led to four main areas on which effective talent development should be based, namely long-term aims and methods, wide-ranging coherent messages and support, emphasis on development not early success, and individualized and ongoing development.

Originally, 135 items were created based on these key factors which were further assessed by a panel of experts (sport psychologists, talent coaches) and by 82 developing athletes, aged 13 to 20 years (commenting on comprehensibility, relevance, and similarity of items). This process led to a 68-item questionnaire which was completed by 590 "junior athletes with identified potential" (Martindale et al., 2010, p. 1212), aged 13 to 21 years. The conducted exploratory factor analysis of this version with oblique rotation, principal axis factoring extraction, and reliability tests resulted in a 59-item seven-factor structure, the TDEQ-7 (Martindale et al., 2010). The internal consistency (Cronbach's alpha) of the seven factors ranged from 0.62 to 0.98.

The questionnaire has been further developed since its first publication, and in its most recent English language version (Li et al., 2015) it consists of 25 items with a five-factor structure (TDEQ-5), namely (1) long-term development focus (LTD), (2) communication (COM), (3) alignment of expectations (AOE), (4) holistic quality preparation (HQP), and (5) support network (SN). LTD describes (coaches' or clubs') initiatives to facilitate athletes' long-term success. COM is concerned with the extent to which the coach communicates effectively with the athletes. AOE is focused on setting and communicating goals that are relevant for the athletes' sport development. HQP includes interventions (e.g., mental skills training) for holistic development, and SN is focused on the social network (e.g., parents, professionals) that is available to the athlete. The five factors are described in greater detail in ◘ **Table 1**, including the items. The 25 items of the TDEQ-5 are each answered on six-point Likert scales from 1 ("strongly disagree") to 6 ("strongly agree"). Three of these factors (LTD, COM, HQP) correspond to the

provision category presented by Li et al. (2014), the individual environment is exemplified by the factors SN and AOE.

To date, research using the TDEQ-7 or the TDEQ-5 has included investigation of the role of the talent development environment in predicting important outcomes such as progression and athlete motivation. For example, Martindale, Collins, Douglas, and Whike (2013) found that the TDEQ factors *quality preparation* and *understanding the athlete* were significant predictors of the progression rates of academy athletes to professional status. Other research investigating the relationship between the environment and athlete characteristics such as stress and wellbeing (Ivarsson et al., 2015, Thomas, Gastin, Abbott, & Main, 2021), mental toughness (Li, Martindale, & Sun, 2019), burnout (Li, Wang, & Pyun, 2017; Thomas et al., 2021), and motivational attributes (e.g., Wang, Sproule, McNeill, Martindale, & Lee, 2011, 2016) have highlighted the significance and positive role of environmental factors such as *long-term development focus, communication, support network*, and *holistic quality preparation*. In a longitudinal study with three points of measurement during one year, 195 Swedish young male soccer players filled in the TDEQ-7 and measures of wellbeing. The perceived TDE at time 1 was categorized into three classes of high ($n = 28$ players), moderate ($n = 118$), and low quality ($n = 51$). A high TDE level was "characterized by a climate where the coach and the club have a clear and communicated vision for the players' football development. The players have, with assistance from the coach been able to set clear performance goals, which are continuously evaluated and have a long-term development focus" (Ivarsson et al., 2015, p. 18). In addition, the TDE was rated higher in communication, understanding the athlete, and the support network than the TDE of moderate or low quality. The differences between the three TDE groups remained similar over the whole observation period. In addition, players with a high-quality TDE experienced less stress and increased subjective well-being over time (Ivarsson et al., 2015). This mental health

development could be traced back to the TDE quality.

In a study with 92 Norwegian (U19) male academy soccer players who were affiliated either with highly ranked (top-five) or low-ranked (bottom-five) clubs filled in the TDEQ-5. Independent of club quality, the players reported a highly supportive club environment with a focus on long-term development and social support. But significant differences emerged in the three other TDE dimensions of HQP, communication, and alignment of expectations, with higher scores for the highly ranked club environments (Gangsø, Aspvik, Mehus, Høigaard, & Sæther, 2021).

Research has also focused on capturing relevant information about the relative strengths and weaknesses of specific talent development environments in order to inform applied practitioners, coaches, and others responsible for the development and management of such environments (e.g., Gangsø et al., 2021; Gesbert, Crettaz von Roten, & Hauw, 2021; Gledhill & Harwood, 2019; Mills, Butt, Maynard, & Harwood, 2014; Thomas et al., 2021). Indeed, taking this a step further, Hall, Jones, and Martindale (2019) highlighted the utility of the TDEQ to not only identify relative strengths and weaknesses, but also to guide the development and evaluation of evidence-based interventions within elite sport contexts. A summary of research studies conducted so far with the different versions of the TDEQ can be found in Electronic Supplement Table ESM 1. When summarizing this research, it becomes obvious that it was undertaken for one or more of the following reasons: (1) developing a quantitative and valid measuring instrument for the TDE. This initiative started with the TDEQ-7 (Martindale et al., 2010, 2013) and its modifications (TDEQ-5 in particular; Li et al., 2015). This process of measurement optimization and of adaptation to different languages and cultures (Caribbean culture, Chinese, French, Greek, Polish, Spanish) is still ongoing and is the main objective of our study. (2) Another focus of research deals with the question of which aspects of athlete development (e.g., personality,

mental health, performance) could be influenced by or traced back to the TDE. In this tradition, studies were undertaken in a number of countries, like China (Li et al., 2017), Greece (Andronikos et al., 2021), Korea (Wang et al., 2016), Singapore (Wang et al., 2011), Sweden (Ivarsson et al., 2015), and the United Kingdom (Mills et al., 2014). (3) Finally, the objective of research may focus on intervention in the field of talent environments by improving those aspects that are rated low (Gesbert et al., 2021; Hall et al., 2019). This research is quite rare to date and should definitely be expanded, preferably in combination with longitudinal designs and with measures of athletes' variables like psychological skills or mental toughness.

The usefulness of measuring talent development experiences from an evidence-based perspective using the TDEQ has been shown through both enhancing our understanding of TDEs and also through driving applied practice. As such, it is perhaps unsurprising to see a number of translations of the TDEQ and TDEQ-5 emerging in the literature. These include Spanish (Brazo-Sayavera, Olivares, Andronikos, & Martindale, 2017), Portuguese (Costa, Grazina, Miragaia, Crisóstomo, & de Carvalho, 2017), Swedish (Ivarsson et al., 2015), Korean (see Wang et al., 2016), Chinese (Li, Martindale, Wu, & Si, 2018), Polish (Siekańska & Wojtowicz, 2017), Norwegian (Gangsø et al., 2021), and French versions (Gesbert et al., 2021). However, to date, there exists no German TDEQ translation. Given the influence and renowned quality of sports in German speaking countries, namely Austria, Germany, and Switzerland, it seems pertinent to expand the possibilities of TDEQ-related research in these sports contexts.

In conclusion, it is widely agreed that environmental factors play a significant role in talent development. Nonetheless, attempts to systematize environmental influences are rare (for an exception, see Larsen et al., 2013). Therefore, questionnaires like the TDEQ, which enable quantification of the quality of environmental factors (Martindale et al., 2010), are an important contribution to inves-

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German version of the Talent Development Environment Questionnaire (TDEQ-5)

Abstract

The quality of the talent development environment and how it supports youth athletes has been identified as one major factor of success. Nonetheless, in psychological talent assessment there is a lack of standardized instruments addressing environmental aspects. One well-known questionnaire is the Talent Development Environment Questionnaire (TDEQ; Martindale et al., 2010). Until recently, the TDEQ had been translated into several languages, but not into German. Within this study, the five-factor, 25-item TDEQ-5 (Li, Wang, Pyun, & Martindale, 2015) was systematically forward and backward translated and administered to 276 German youth athletes from different sports, aged between 13 and 21 years (mean [M] = 16.01; standard deviation [SD] = 2.1). In addition, 63 of these athletes completed both the German and English TDEQ-5 to test for quality of translation. Confirmatory factor analysis revealed that the five-factor structure was acceptable according to the chi-square test to degrees of freedom ratio (1.9), root mean square error of approximation (0.058), and standardized root mean square (0.061). The comparative fit index (CFI) of 0.88 and the Tucker-Lewis Index of 0.86 was slightly below the 0.90 cut-off value. The reliabilities of the TDEQ-5 factors were considered moderate to satisfactory (α = 0.62 to 0.75). In conclusion, the German TDEQ-5 appears to be an applicable tool for use in research and applied settings but needs further analysis. In particular, we encourage future research to test the construct validity and ecological validity of the German TDEQ-5 and suggest practitioners to utilize the tool to test and drive applied interventions within talent development environments.

Table 1 Description of factors (Li et al., 2015), English items and German translations, means (M) and standard deviations (SD) of items, factor loading estimates (FL), and corrected item total correlations (r_{it}) per subscale for German items

Factor	Item (English; German)	M	SD	FL	r_{it}
Long-term development (LTD)					
The extent to which developmental programs are specifically designed to facilitate athletes' long-term success (e.g., fundamental training and rounded development, ongoing opportunities, and de-emphasis of winning)					
LTD1	My training is specifically designed to help me develop effectively in the long term. *Mein Training ist speziell für eine effektive und langfristige Entwicklung entworfen*	2.61	1.18	0.69	0.44
LTD2	My coach emphasizes that what I do in training and competition is far more important than winning. *Mein Trainer betont, dass meine persönlichen Leistungen im Training und Wettkampf wichtiger sind als zu gewinnen*	3.14	1.46	0.33[a]	0.28
LTD3	I spend most of my time developing skills and attributes that my coach tells me I will need if I am to compete successfully at the top/professional level. *Ich verbringe die meiste Zeit damit, an Leistungsparametern zu arbeiten, die mein Trainer als wichtig erachtet, um auf höchstem Niveau konkurrieren zu können*	3.11	1.36	0.52	0.34
LTD4	My coach allows me to learn through making my own mistakes. *Mein Trainer erlaubt mir eigene Fehler zu machen, um daraus zu lernen*	2.01	1.03	0.47	0.44
LTD5	I would be given good opportunities even if I experienced a dip in performance. *Mir würden auch bei einem Leistungseinbruch weiterhin gute Möglichkeiten geboten werden*	2.49	1.16	0.51	0.42
Alignment of expectations (AOE)					
The extent to which goals for sport development are coherently set and aligned (e.g., goal setting, goal review, and individualized goals)					
AOE1	My coach takes time to talk to my parents about me and what I am trying to achieve. *Mein Trainer nimmt sich Zeit, um mit meinen Eltern über meine Entwicklung und Ziele zu*	4.01	1.51	0.56	0.51
AOE2	The advice my parents give me fits well with the advice I get from my coaches. *Die Ratschläge meiner Eltern passen gut zu den Ratschlägen meines Trainers*	2.91	1.22	0.36[a]	0.32
AOE3	My progress and personal performance is reviewed regularly on an individual basis. *Mein Fortschritt und meine persönlichen Leistungen werden regelmäßig und individuell mit mir besprochen*	3.24	1.36	0.68	0.54
AOE4	I am involved in most decisions about my sport development. *Ich werde in die meisten Entscheidungen über meine sportliche Entwicklung miteinbezogen*	2.13	1.16	0.48	0.36
AOE5	I regularly set goals with my coach that are specific to my individual development. *Ich vereinbare regelmäßig spezifische und individuelle Entwicklungsziele mit meinem Trainer*	3.79	1.32	0.77	0.59
Communication (COM)					
The extent to which the coach communicates effectively with the athlete in both formal and informal settings (e.g., development path, rationale for training, and feedback)					
COM1	My coach and I regularly talk about things I need to do to progress to the top level in my sport (e.g., training ethos, competition performances, physically, mentally, technically, tactically). *Mein Trainer und ich reden regelmäßig über potenzielle Entwicklungsbereiche, um auf das höchstmögliche Niveau zu kommen (z.B. Trainingsmoral, Wettkampfleistungen, physische, mentale, technische, taktische Fähigkeiten)*	3.02	1.35	0.78	0.65
COM2	My coach and I talk about what current and/or past world-class performers did to be successful. *Mein Trainer und ich reden darüber, was Spitzenathleten machen und gemacht haben, um erfolgreich zu sein*	3.33	1.36	0.48	0.45
COM3	My coach and I often try to identify what my next big test will be before it happens. *Mein Trainer und ich versuchen frühzeitig zu erkennen, was die nächste Herausforderung darstellen könnte*	2.82	1.22	0.71	0.60
COM4	My coach explains how my training and competition program work together to help me develop. *Mein Trainer erklärt mir, wie meine Trainings- und Wettkampfpläne zusammenspielen, um meine Entwicklung bestmöglich zu unterstützen*	2.68	1.26	0.66	0.50

tigate and identify key factors of talent development. As such, the aim of this study was to translate the TDEQ-5 into German and test its psychometric properties with a sample of elite youth athletes across different sports.

Methods

Participants

Participants consisted of German-speaking elite athletes between the age of 13 and 21 years (mean [M] = 16.01; standard deviation [SD] = 2.1). Regarding performance level, inclusion criteria were set as having a squad status or performing at a high level in order to make sure that the athletes had a professional talent environment. The current talent development system in Germany at elite level in Olympic sports has been organized in the form of a squad system for over 30 years (Güllich, 2020), aiming to develop elite athletes to represent Germany at inter-

Factor	Item (English; German)	M	SD	FL	r_{it}
Table 1 (Continued)					
Holistic quality preparation (HQP) The extent to which intervention programs are prepared both inside and outside of sports settings (e.g., caring coach, clear guidance, mental preparation, and balanced life)					
HQP1(R)	My coach rarely talks to me about my well-being. *Mein Trainer und ich sprechen kaum über mein Wohlbefinden*	2.89	1.32	0.72	0.58
HQP2(R)	My coach doesn't appear to be that interested in my life outside of sport. *Mein Trainer scheint nicht sonderlich an meinem Leben außerhalb des Sports interessiert zu sein*	3.08	1.42	0.58	0.42
HQP3(R)	My coach rarely takes the time to talk to other coaches who work with me. *Mein Trainer nimmt sich kaum die Zeit, sich mit meinen anderen Trainern auszutauschen*	2.50	1.39	0.55	0.48
HQP4(R)	I don't get much help to develop my mental toughness in sport effectively. *Ich bekomme wenig Unterstützung, um meine mentale Stärke effektiv zu entwickeln*	3.36	1.54	0.52	0.44
HQP5(R)	I am rarely encouraged to plan for how I would deal with things that might go wrong. *Ich werde selten dazu aufgefordert, mich damit zu beschäftigen, wie ich mit Misserfolgen umgehen würde*	4.07	1.33	0.33[a]	0.29
HQP6(R)	The guidelines in my sport regarding what I need to do to progress are not very clear. *In meiner Sportart ist nicht ganz klar, was ich machen muss, um mich weiterzuentwickeln*	2.05	1.12	0.39[a]	0.36
HQP7(R)	I am not taught that much about how to balance training, competing, and recovery. *Mir wird nicht ausreichend gezeigt, wie ich Training, Wettkampf und Erholung ausgeglichen kombinieren kann*	3.02	1.34	0.54	0.47
Social network (SN) The extent to which a coherent, approachable, and wide-ranging support network is available for the athlete in all areas (e.g., professionals, parents, coaches, and schools)					
SN1	Currently, I have access to a variety of different types of professionals to help my sports development (e.g., physiotherapist, sport psychologist, strength trainer, nutritionist, lifestyle advisor). *Aktuell kann ich auf eine Vielzahl von verschiedenen Experten zurückgreifen, die mir bei meiner sportlichen Entwicklung helfen (z. B. Physiotherapeut, Sportpsychologe, Athletiktrainer, Ernährungsberater, Laufbahnberater)*	3.48	1.53	0.52	0.46
SN2	I can pop in to see my coach or other support staff whenever I need to (e.g., physiotherapist, psychologist, strength trainer, nutritionist, lifestyle advisor). *Mein Trainer und andere Experten im Betreuerteam sind immer ansprechbar (z. B. Physiotherapeut, Sportpsychologe, Athletiktrainer, Ernährungsberater, Laufbahnberater)*	1.76	1.01	0.45	0.36
SN3	My coaches talk regularly to the other people who support me in my sport about what I am trying to achieve (e.g., physiotherapist, sport psychologist, nutritionist, strength and conditioning coach, lifestyle advisor). *Meine Trainer tauschen sich regelmäßig mit den anderen Experten hinsichtlich meiner Ziele aus (z. B. Physiotherapeut, Sportpsychologe, Athletiktrainer, Ernährungsberater, Laufbahnberater)*	3.78	1.43	0.72	0.50
SN4	Those who help me in my sport seem to be on the same wavelength as each other when it comes to what is best for me (e.g., coaches, physiotherapists, sport psychologists, strength trainers, nutritionists, lifestyle advisors). *Alle, die mir helfen, sind auf der gleichen Wellenlänge, wenn es darum geht, was das Beste für mich ist (z. B. Trainer, Physiothera-peuten, Sportpsychologen, Athletiktrainer, Ernährungsberater, Laufbahnberater)*	2.48	1.08	0.58	0.47

[a]Factor loading under 0.4

national competitions (Emrich, Pitsch, & Güllich, 2008). Especially in team sports, talent promotion most often takes place at clubs' youth academies and gifted players are additionally sent to representative teams or they join sessions at a regional base (for talent promotion in Germany see Güllich & Emrich, 2012a). Consequently, besides squad status, competing at a high-performance level was chosen as an alternative inclusion criterium which matches the inclusion criteria in the above-described study of Martindale et al. (2010).

The link to the questionnaire was distributed to eligible athletes by multiple sport institutions, sport clubs, sport associations, and coaches previously contacted by one of the authors. In total, 588 respondents started the survey and provided consent to participate. However, 312 respondents terminated the questionnaire early or did not complete it according to the criteria for data analysis, leading to an average response rate of 47%. This response rate is in line with the average response rate regarding online surveys (Saleh & Bista, 2017).

The final sample consisted of $N = 276$ respondents (177 female athletes, 99 male athletes). The participants had a mean age of 16.01 years (SD = 2.1). They participated in various individual and team sports such as field hockey (126); basketball (91); soccer (12); American football (8); badminton and track and field (each 7); judo (6); rowing and golf (each 3); fencing, handball, gymnastics,

and taekwondo (each 2); and tennis, volleyball, inline hockey, sailing, and table tennis (each 1). In total, 70.3% ($n = 194$) of all participants currently had a squad status including "Olympic squad," "perspective," "supplementary," "junior," and "federal state squad" (see Deutscher Olympischer Sportbund, 2017). Additionally, 29.7% ($n = 82$) did not have a squad status but competed at a high-performance level (minimum: regional level; "federal state league").

Measures

Translation of the TDEQ-5 into German

The 25 items of the TDEQ-5 (Li et al., 2015) were translated into German based on the recommendations of Banville, Desrosiers, and Genet-Volet (2000). This included a two-step process. The first step included preparation of a preliminary version. First, two bilingual native German researchers in sport science and sport psychology with in-depth knowledge about the area of research independently conducted two forward translation versions of the TDEQ-5. The two versions were then discussed by the researchers with the aim of producing a single version, conceptually and semantically equivalent to the original questionnaire and easy to understand. In the next step, the combined German version was translated backward into English by two native English speakers (a professional interpreter and an expert in this area of research) who are fluent in German, creating a single backward translation. The next step included evaluation of the preliminary version and the preparation of an online version. Any misunderstandings and inaccuracies of the translation process were discussed and, if necessary, questions were revised in the German translation to retain the meaning of the original questionnaire's items. To give an example, the item "My coach allows me to learn through making my own mistakes" (LTD4) was first translated to "*Mein Trainer erlaubt mir zu lernen, indem ich meine eigenen Fehler mache*," but then, in the process of backward translation and as a result of expert discussion,

adapted slightly to "*Mein Trainer erlaubt mir eigene Fehler zu machen, um daraus zu lernen*" (◘ Table 1).

The resulting preliminary German language questionnaire was then administered to a sample of 17 respondents for pretesting (athletes, coaches of different sports) to determine whether the translation was easy to understand, clear, and comprehensible. Like in the original English version of Martindale et al. (2010), each item could be answered on a six-point Likert scale (1 = strongly agree/*stimme völlig zu*, 2 = agree/*stimme zu*, 3 = agree a little bit/*stimme ein bisschen zu*, 4 = disagree a little bit/*stimme eher nicht zu*, 5 = disagree/*stimme nicht zu*, 6 = strongly disagree/*stimme überhaupt nicht zu*). Participants were asked to go through the survey with a comment function and mention any obscurities they perceived. There were no comments that led to a change of the translated TDEQ-5 according to this pretest. Therefore, we kept this German language version in the online survey. The list of the final English and German items is presented in ◘ Table 1.

Besides the TDEQ-5, demographic information including age, gender, type of sport, coaches, support staff, squad status, and competition level were collected.

Procedure

The study was approved by the ethics committee of the second author's university. Consent was requested at the start of the online survey; in case participants were under 18 years, parents additionally gave their consent. The collection of data was done according to the current German data privacy act.

The full survey was digitalized using www.soscisurvey.de (SoSci Survey GmbH, Marianne-Brandt-Str. 29, D-80807 München). The inquiry period was from October 12, 2020, until December 23, 2020. An email was sent containing the link to the survey as well as a flyer using a QR code as a direct link to the survey. Participants were explicitly addressed according to the inclusion criteria and the translation of the TDEQ was named as the primary aim of the study. The items of the TDEQ questionnaires were randomized for

both the German and English versions. The 25 items were partitioned into five items per page. Contact information of the third author was available for questions and queries. After completing the German version of the TDEQ-5, participants were thanked and additionally asked whether they were able and willing to also complete the English version of the questionnaire. This was done in order to get some further information on the quality of translation. A subsample of $n = 63$ athletes agreed. To check the language skills, participants were asked to state their highest English skill level. Of these, 58.8% had learnt English at school for at least 5 years, and 41.2% had a higher skill level which included, e.g., having been abroad in an English-speaking country for at least 1 year, studying English, or English being their second mother tongue.

Data analysis

To assess the quality of the translation, the answers of the $n = 63$ participants who also filled out the English version were analyzed using Pearson correlations and deviations of answers of more than one point on the Likert scale. A correlation of lower than ±0.5 in addition to a deviation >20% was rated as critical. Reliability of the five TDEQ-5 factors was also examined using the Cronbach's alpha coefficient. Values of 0.70 or above are deemed acceptable (Hair, 2010). A minimum requirement of 250 participants was a priori identified to conduct the confirmatory factor analysis (CFA) in accordance with common guidelines estimating the number of participants to items ratio 10 to 1 (Hair, 2010; Wolf, Harrington, Clark, & Miller, 2013).

The main analysis including the CFA was conducted using IBM SPSS Amos 26 Graphics (IBM Corp., Armonk, NY, USA) to test the factorial validity of the TDEQ-5. The assessment of the model data fit was based on commonly recommended indices which have previously been used in assessing the psychometric properties of the TDEQ (Li et al., 2015). These include the χ^2/df, comparative fit index (CFI), standardized root mean square residual (SRMR), and root mean square error of approximation
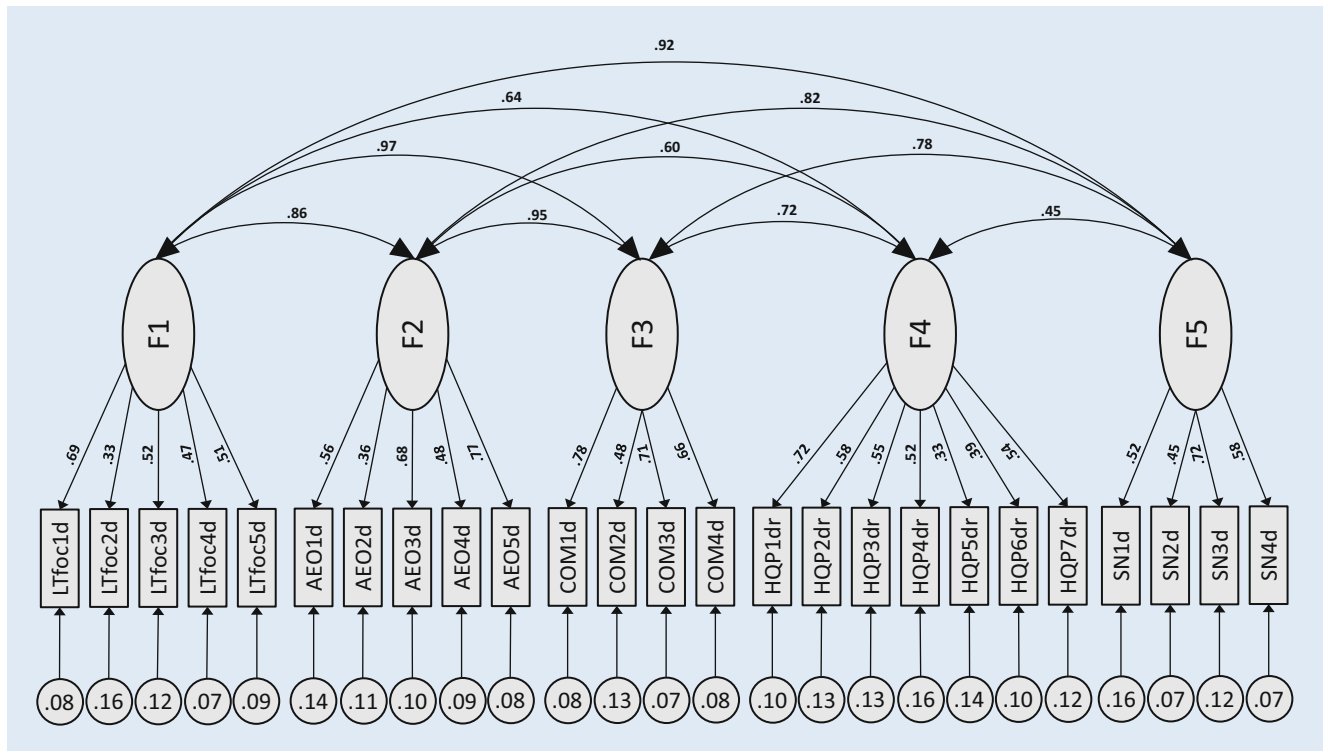
Fig. 1 ▲ Results of the confirmatory factor analysis of the German TDEQ-5. Notes. The bottom line gives information on the residual variances. The factors F1 to F5 correspond to the following factors: F1 = long-term development (LTD); F2 = alignment of expectations (AOE); F3 = communication (COM); F4 = holistic quality preparation (HQP); F5 = social network (SN). The item numbers of the factors (e.g., LTfoc1d to LTfoc5d) correspond to the item numbers of the questionnaire (e.g., LTD1 to LTD5) as shown in ▫ **Table 1**

(RMSEA). Additionally, factor loading estimates were calculated. For the χ^2/df, a value smaller than 3.0 indicates an adequate fit (Kline, 2016). A good model fit (χ^2) would provide a non-significant result at a 0.05 threshold (Barrett, 2007). The CFI and the TLI reference values for a good fit are at 0.9 (Hooper, Coughlan, & Mullen, 2008). RMSEA cut-off values close to 0.06 and a stringent upper limit of 0.07 generally seem to be accepted. SRMR well-fitting models that obtain values less than 0.05 and values as high as 0.08 are deemed acceptable (Hooper et al., 2008). The factor loading estimates should be above 0.4 (Brown, 2015; Pituch & Stevens, 2015) and ideally greater than 0.7 (Hair, 2010).

Results

Descriptive statistics

The full range of the six-point Likert scale had been used for each item. ▫ **Table 1** displays all five factors and 25 items in English (Li et al., 2015) and in the German translation. Based on the German sample of $N = 276$, means and standard deviations are provided as well as factor loading estimates and item-total correlations for the German version of TDEQ-5. Higher values represent lower agreement with the items.

Overall, the majority of items had an acceptable level of factor loading estimates, using the cut-off value of 0.40. The analysis revealed four items lying below the recommended value (see ▫ **Table 1** for factor loadings): items LTD2 (0.33), AOE2 (0.36), HQP5 (0.33), and HQP6 (0.39).

Confirmatory factor analysis

Model fit

The applied model with five factors and 25 items did not meet all of the thresholds of the utilized model fit indices. The model showed an acceptable fit based on the χ^2 (d$f = 265$) = 509.52 ($p < 0.001$), χ^2/df (1.9), RMSEA (0.06) [0.05; 0.065], and SRMR (0.06). However, the CFI (0.88) and the Tucker–Lewis index (TLI; 0.86) were both slightly below the acceptable 0.90 reference value. ▫ **Figure 1** shows the standard estimates and the CFA model.

Reliability

The internal consistency values for the factors alignment of expectations (0.70), communication (0.75), and holistic quality preparation (0.72) were acceptable and equal or above the 0.70 value, whereas the α-coefficients for the factors long-term development focus (0.62) and support network (0.66) are below 0.70 and, thus, these two subscales may have limited applicability and require further improvement.

Comparison of the German and English versions

To compare the two versions, the deviation, shown as the percentage of answers deviating by more than 1 point (on the six-point Likert scale) between the results

of the English and the German TDEQ-5, as well as the Pearson correlations (r), were calculated. Only item 1 ($r = –0.09$, deviation 34.8%), item 3 ($r = 0.23$, deviation 36.5%), and item 5 ($r = 0.34$, deviation 30.2%) of the factor holistic quality preparation did not meet the criteria set in advance (see remarks on data analysis). All other items had a satisfactory similarity of answers and a moderate (four items between $r = 0.54$ and $r = 0.63$) to high (18 items between $r = 0.65$ and $r = 0.91$) correlation. Consequently, for future research, we revisited the items HQP1, HQP3, and HQP5 and rephrased them after discussing with the experts who had been involved in the translation process (see ◘ **Table 1**).

In an attempt to improve the model fit, two items (LTD 2 and AOE 2) were deleted. The items were chosen due to their low factor loadings in addition to an improvement of the factors' reliability if the items are removed. A second CFI was conducted with this respecified 23-item five-factor model. These changes slightly improved the model fit when looking at the CFI (0.881), but still did not achieve a value above the recommended threshold. Additionally, the χ^2 ($df = 199$) $= 4206.20$ ($p < 0.000$), χ^2/df (2.1), RMSEA (0.064), and SRMR (0.064) got weaker. Based on these results, the deletion of single items did not improve the model fit.

Discussion

Within this study, the TDEQ-5 (Li et al., 2015) was translated into German and applied to a sample of $N = 276$ elite youth athletes in different sports in order to test its structure. Additionally, evaluating the quality of the translation, $n = 63$ athletes also filled in the original English version, allowing for an analysis and discussion of the single items.

The review of guidelines for cross-cultural adaptation of questionnaires by Epstein, Santo, and Guillemin (2015) suggests that there are several methods available. Although there is no general consensus, most of them will achieve comparable results and the choice is a matter of preference and logistics (Epstein et al., 2015). The translation and eval-

uation were carried out based on common guidelines for translating questionnaires and inventories using a cross-cultural translation technique (Behr, 2018; Banville et al., 2000). In this context, back translation was considered not as a quality tool, but as a documentation tool (Son, 2018) that can help to better understand the meaning of the items in the language in question (here: German). This was helpful for rephrasing the three items of *holistic quality preparation* (items HQP 1, 3, 5) having a low or negligible correlation as well as the highest deviation in answers. This resulted in revising these items as a suggestion for future use of the German version. The HQP items may have led to the participants' impression that the items did not meet their experiences or did not reflect the reality in their sport environment. Also, we should mention that all items of the HQP factor were inversely formulated which could have contributed to a suboptimal understanding of the meaning of the items and—accordingly—also of the answering scales. In addition, the translation may have been conducted too closely along the original item text even though the perceived environment could differ between the British and German culture. This "harmonization" of the items (Wolf, Schneider, Behr, & Joye, 2016) and a literal translation of items that may not correspond to the German TE could have led to a misunderstanding and/or a lack of understanding on the part of the German participants. All in all, the HQP items seem to combine a variety of coach behaviors which could contribute to more heterogeneity than can be found in the other four subscales.

These considerations lead to the question of equivalence of the environmental factors as they are assessed with the TDEQ. Do these factors have the same meaning (conceptual equivalence) and do they serve the same intentions (functional equivalence) for German athletes as for British (Chinese, Brazilian, Swiss etc.) athletes? Or, stated in other words, do we measure the most important environmental dimensions in German elite sports (which is assumed to be the intention of the TDEQ-5) and do these dimensions serve the same functions? One

hint is the study of Güllich and Emrich (2012b) with 1557 athletes from different Olympic sports. They could show that athletes who specialized at a later age and, in consequence, had experienced a focus on long-term development and had realized more deliberate practice and competitions, were more successful than athletes with earlier specialization. In terms of TDE, this supports the assumption that the factors of LTD and HQP are important parts of a successful development in high level sports. Considering the other three factors, AEO, COM, and SN, there are so far not enough data available and we need to conduct more research with talented young German athletes in the future. We recommend considering cultural differences in TE regarding conceptual and functional equivalence.

CFA revealed that the five-factor structure was partly acceptable by meeting some but unfortunately not all criteria. The reference values of CFI and TLI did not meet the accepted quality of more than 0.90. When deleting two items from the analysis that loaded quite low on the respective factors, the picture did not change. Therefore, it should be a task of future studies to improve the model fit. The reliability of the TDEQ-5 subscales was moderate to adequate (0.62–0.75). These values are lower than those of the original TDEQ-5 (Li et al., 2015, Table 2) where they are reported to exceed 0.80 for each of the five subscales. One explanation for the model fit not being fully adequate might be the fact that athletes from a broad range of sports and performance levels were included in the study. Different settings in sport organizations and different cultures have to be taken into account and to expect a model fit across sport organizations and national cultures might be quite ambitious (Epstein et al., 2015). In fact, TDEQ translations in other languages showed a less than optimal fit for either the seven-factor structure (Polish: Siekańska & Wojtowicz, 2017) or one of the subscales (Spanish: Brazo-Sayavera et al., 2017; French: Gesbert et al., 2021). This may be attributed either to differences in cultural traditions or in the professional support system for developing talents, or both. Therefore, given the

generic nature of the TDEQ, more information on specific talent environments is needed—no matter whether across sports or across cultures. Indeed, as an example, there have previously been calls for the development of a soccer-specific TDEQ (e.g., Gledhill & Harwood, 2019; Mills et al., 2014), and recent work has highlighted the importance of examining and understanding the environment across different age levels within an academy setting (e.g., Gesbert et al., 2021).

It appears that future research aiming to develop more context-specific versions of the TDEQ across sport and culture would enhance the utility of the TDEQ in those settings. From an applied perspective, including qualitative evaluation, efforts to contextualize the TDEQ findings are an important part of the process of identifying and targeting areas of most need for any particular context (e.g., Hall et al., 2019). In that way, the TDEQ could help to identify characteristics of an empowering climate and helpful support systems in the long-term development of youth athletes. Future work focusing on understanding the priority for environments within broader talent development pathways (e.g., elite, sub-elite, and amateur levels) may aid efforts to build coherent systems, enhancing the quality of environments throughout the pathway to maximize the talent pool and the developmental experience for all involved. Indeed, measurement tools such as the TDEQ based on the goal/level of the environment may be particularly useful.

For the comparison between the German and English versions, the English language knowledge of our participants was tested only as a self-rating. To the best of our knowledge, such a design of asking participants with knowledge of both languages to fill out both versions has not been considered in any of the previously reported studies. Still, as this direct comparison between two language versions is rarely done, it can be regarded as helpful in clarifying semantic aspects in translating items, and therefore should be encouraged in similar research moving forward. In those studies, the language skills of the participants could be assessed more precisely than we did in our study, e.g., by asking for certified levels of English language skills.

Apart from that, several limitations need to be mentioned. First of all, the heterogeneity of our sample with regard to the types of sport could have contributed to lower values of the CFI and of some subscale reliabilities. On the other hand, the heterogeneity of our sample can also be regarded as an advantage because the questionnaire may have greater external validity and can be used in various sports. The heterogeneity could even be expanded by administering the questionnaire to, for example, disabled athletes from paralympic sports (Radtke & Doll-Tepper, 2014). Another limitation is the age group of our sample. Quite a few athletes were still in their pubertal phase, which is well known to be critical with regard to physical, psychological, and performance development. Adolescents may be regarded as a vulnerable group that is particularly prone to sport career dropout during this phase (Larsen & Alfermann, 2017). Even though the original version was developed with young athletes of similar age, the question remains how stable and reliable the environment can be perceived by our participants. This aspect could be studied empirically in future studies. For example, possible differences in the perception of the TDE between participants of different age groups (e.g., preadolescence, adolescence, postadolescence) could be investigated. This might also contribute to a better understanding of the needs of the different age groups.

Another limitation is the answering rate. Even though the response rate can be seen as average, a higher answering rate would definitely be desirable. As most of the studies validating the TDEQ have been applied as paper and pencil tests and not online (see Table ESM1), the functional equivalence of the procedure has yet to be proven. In addition, it could be helpful to collect data with reverse answering scales to those used here. When lower scores correspond to less and higher scores to more agreement (which may correspond more to common sense), this could help to increase the reliability of the subscales.

Despite the limitations of this study, the authors would like to encourage further studies applying the German version of the TDEQ-5, especially combining it with other questionnaires on talent environment to test its construct validity. Also, youth academy ratings evaluating talent environment or evaluations of coaches, staff, or parents could be added to test its ecological validity. For further exploration of the TDEQ-5 validity from an applied perspective the descriptive analyses on an item level would allow insights into the athletes' perceptions of environmental factors and social support, as well as insights into interactions of the stakeholders in talent development as perceived by athletes. This type of TDEQ analysis has proven useful in evaluating strengths and weaknesses across a range of environments (e.g., Gangsø et al., 2021; Gesbert et al., 2021; Gledhill & Harwood, 2019; Mills et al., 2014; Thomas, Abbott, Gastin, & Main, 2020; Thomas et al., 2021), and also in helping those responsible for effective talent development programs to design, deliver, and monitor evidence-based interventions across time. Future work on improving the validity and context specificity of the TDEQ, and also on developing its role and usefulness in helping to manage and develop the quality of environments in real-world athletic settings, would be highly appreciated.

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Declarations

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