Multidimensional Performance Characteristics in Talented Male Youth Volleyball Players

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The purpose of this study was to determine whether anthropometric, physical, psychological, and skill test results could be used to discriminate between male junior volleyball players of varying ability. A total of 66 elite and nonelite male Estonian volleyball players aged 16–17 years were measured for anthropometric and physical variables and sport-specific skills. In addition, the players' provided self-reports of dispositional achievement goals, perceived sport competence and enjoyment and their game intelligence was measured. Selected youth players scored better than nonselected youth players on physical (explosive strength), technical (passing and spiking), and cognitive (game intelligence) characteristics and reported higher mastery-approach goals, perceived sport competence and enjoyment of sport. The most discriminating variables were game intelligence, mastery approach goals, perceived sport competence and passing technique. These results suggest the important role of multidimensional performance measures in selecting and developing young male volleyball players.

Structured talent identification and development programs have been developed for several sports, in particular athletics, rowing, gymnastics, field hockey and soccer, where success has been related to anthropometric, physiological and motor skill attributes (3,25,34,46). According to Williams and Reilly (50), research should adopt a multidisciplinary approach to talent identification. Recently, Vaeyens et al. (46) suggested that when researchers will concentrate on a combination of anthropometric, physical, and physiological measures, their predictive value has proven problematic in the majority of team sports. For example, Gabbett and coworkers demonstrated that subjective coach evaluation of passing and serving technique, but not physiological and anthropometric data, discriminate between successful and unsuccessful talent-identified junior volleyball players (20). In addition, an increasing number of researchers have argued that potentially important psychological variables are often overlooked within talent identification models (1,34,46).

Research suggests that successful elite athletes posses a range of psychological characteristics including the ability to cope with anxiety and obstacles, self-confidence, competitiveness, intrinsic motivation, and the ability to set and achieve

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goals (22,40). Termed "Psychological Characteristics of Developing Excellence", or PCDEs, these factors allowed aspiring elites to optimize development opportunities, adapt to setbacks and effectively negotiate key transitions encountered along the pathway to excellence (29). However, relatively little scientific evidence has been accumulated thus far as to which skills are required at different stages, for different activities, or even idiosyncratically for different individuals.

Motivation is a construct that underpins much of the literature on personal characteristics of talent identification and numerous authors have attested to its important role in the development of sport expertise (1,12,13,34). According to achievement goal theory, it is assumed that people judge their competence and define successful accomplishment via at last two different goal perspectives- task and ego goals (32). People who are strongly task oriented tend to demonstrate their competence in a self-referenced manner and focus on realizing personal improvement, task-mastery and learning. Individuals who have a strong ego orientation have a tendency to want to demonstrate high competence relative to other people (38). Recently, the valence dimension of competence has been integrated into the achievement goal literature to create a 2×2 achievement goal framework (15). The 2×2 achievement goal framework comprises four distinct achievement goals: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance. In the limited studies that have been done in sport contexts, mastery-approach goals have been found to be positively linked to the belief that sport competence can be developed ant competence valuation, and negatively related to state anxiety and motivation (7,9). Performance-approach goals have been found to correlate positively with the belief that one's level of sport competence is fixed, perceptions of performance climate, and competence valuation and negatively link to state anxiety. Performance-avoidance and mastery-avoidance tend to correlate with a network of negative achievement-related processes and outcomes, including state anxiety and amotivation (7,9). Further, perceived competence is considered to be a primary antecedent of goal adoption. High perceived competence is posited to orient individuals to the possibility of success, and to facilitate the adoption of approach goals. In contrast, low perceived competence is supposed to orient individuals to the possibility of failure to facilitate the adoption of avoidance goals (15).

Enjoyment has been recognized as a key factor for motivated behavior and sustained involvement in youth sport (40,41,48). Enjoyment as "a positive affective response to the sport experience that reflects generalized feelings such as pleasure, liking and fun" (41, p. 6) is the theoretical definition used in this study (10). Enjoyment is also a component of achievement goal theory (32) and an important outcome in its own right as young athletes who enjoy participating in their sport have more meaningful sport experience and more likely to continue participation (48).

To solve a problem effectively in a sport-challenging context, the performer has to perceive the environment, anticipate the on-going activity, make a decision, and respond as quickly and as accurately as he or she is capable of doing (42). Game intelligence in team sports reflects a player's ability to use cognitive processes (ability to read the game, having strong tactical awareness) during games when they have to execute a game plan against the other team (18). Therefore, by applying a multidimensional design of talent identification in ball games such as

volleyball, the cognitive ability to solve tactical problems should be assessed in addition to motor, motivational and technical variables (18,42).

The purpose of this study was to determine whether anthropometric, physical, psychological, and skill test results could be used to discriminate between male junior volleyball players of varying ability. Based on previous research (19,20,28), we expected that volleyball skills and explosive strength but not anthropometric characteristics would discriminate between junior volleyball players of different levels. With regard to psychological variables, we anticipated that youth national team players exhibited higher levels of game intelligence, mastery- and performance approach goals, perceived sport competence and enjoyment when compared with nonselected players.

Method

Participants

Sixty-five junior volleyball players (mean age, 16.7 ± 0.7 years) participated in this study. An initial invitation to participate in the current study was sent to coaches of 5 volleyball clubs located in Tallinn and Tartu (Estonia). All five clubs agreed to participate and all male volleyball players aged 16–17 years were invited to participate. Participants were assigned into two groups according to playing level: selected—players on the U16 and U18 national youth team; and nonselected—players on regional teams.

Measures

Anthropometric and Physical Characteristics.   Anthropometry included the recording of stature, body mass and standing reach stature. Stature was measured using a Martin metal anthropometer (A&D Instruments Ltd, UK) to the nearest 0.1 cm and body mass was measured using calibrated digital scales to the nearest 0.1 kg. Standing reach stature was measured using a metal anthropometer. Players were requested to stand with feet flat on the ground, extend their arm and hand, and mark the standing reach stature. Upper-body muscular strength and endurance was evaluated using the 30-s sit-ups test from the EUROFIT test battery (17). The agility of players was evaluated using the Illinois agility run (39) and explosive power was measured using vertical jump test. Participants performed the jumping test on the mobile contact timing mat system (Newtest OY, Finland). Players were instructed to execute all vertical jumps with their hands on the hips to diminish upper body movement and standardize the movement pattern. The highest value obtained from three attempts was used.

Volleyball Skills.   Each player performed four volleyball skills (spiking, passing, setting and serving) in an indoor stadium. After a standardized warm-up players performed six attempts of each skill. Two video cameras (Sony, HDR-XR520VE), positioned approximately 5 m from the player, were used to film each skill. For spiking and setting skills, players were filmed from the side and front of the player. Players' accuracy was based on the ability to hit specific targets. The players' technique was subjectively evaluated from video footage by two expert coaches using standardized technical protocols (20).

Psychological Testing.   *Dispositional achievement goals* in sport were measured via the 12- item Achievement Goals Questionnaire for Sport (AGQ-S; 6). The AGQ-S was designed to tap athletes' ways to strive for demonstrating high competence or avoid demonstrating incompetence in the athletic domain. Study participants responded on a scale ranging from 1="not at all like me" to 7="completely like me". The AGQ-S is comprised of four subscales tapping the emphasis placed on mastery-approach goals (e.g., "It's important to me to perform as well as I possibly can"), mastery-avoidance goals (e.g., "I worry that I may not perform as well as I possibly can"), performance-approach goals (e.g., "It's important to me to do well compared to others"), and performance-avoidance goals (e.g., "I just want to avoid performing worse than others").

Perceived sport competence was assessed using the athletic subscale of the Self-Perception Profile for Children (24). This subscale consists of 6 items organized in a structured alternative response format with possible scores ranging from one to four. For example, "Some kids wish they could be a lot better at sport but other kids feel they are good enough at sport." Validity and reliability for this subscale has been established for children and adolescents (49).

The enjoyment subscale of the Satisfaction/Enjoyment/Boredom in Sport scale (11) was employed to ascertain athletes' levels of enjoyment when participating in their sport. Five items assessed enjoyment (e.g., "I usually find playing my sport interesting"). Responses were scored on a scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Evaluation of Game Intelligence.   Participants' game intelligence was evaluated individually using two indices. Firstly, two highly experienced coaches observed the players during 2 home league games and evaluated decision making, positioning, anticipation and timing skills of players. More specifically, the coaches evaluated players' ability to: (a) make the right move without the ball in offense; (b) make the right move without the ball in blocking and defense; (c) anticipate in advance offensive procedures made by the opposing team; (d) get into position so that the setter could pass him the ball accurately. Players´ decision making and action during the games were subjectively rated on a 10-point Likert scale, with 10 being a maximum score. Secondly, decision making was assessed using videotaped games in laboratory conditions. Players were tested individually in an isolated laboratory room while seated in a comfortable chair in front of a large screen (3×2.5m). Each player was seated 3 m from the screen and watched preselected videos of the game situations where the setter of the opposite team was preparing to set the ball. The task of the player was to decide, to which zone of the court (zone 1, zone 3, zone 4, zone 5, zone 6) the setter of the opposite team would next pass the ball. In total, 20 video-assessments of setter actions were used by each player. Players' ability to predict correctly the direction of the opposing setter's pass was assessed on 20-point scale (each correct answer gave 1 point; a wrong answer gave 0 points).

All instruments were translated from English to Estonian by two bilingual sport psychology experts following recommended back-translation procedures (e.g., 4). The subscales were then back- translated into English and discrepancies between the original versions and back-translations were subsequently examined for their linguistic equivalence by a two experts and the first author. A final version of the Estonian instruments was finally agreed upon (The Estonian measures are available from the first author upon request).

Procedures.   All players were informed of the procedures of the study before providing their verbal consent to participate. The clubs and coaches gave permission for this study, and all procedures were in accordance with the ethical standards of the Medical Faculty of the University of Tartu. The players completed physical tests and assessment of volleyball skills on indoor gyms where they usually trained. Evaluation of players' game intelligence was administered under laboratory conditions. The measurements took place at the beginning of the competitive season (from September to October). Anthropometric measurements and psychological questionnaires were completed before the testing of physical abilities. Date of birth, playing position, cumulative years of volleyball experience, and hours of volleyball and additional practice were also recorded.

Statistical Analysis.   Internal consistency coefficients (Cronbach alphas) of all psychological scales were measured. Differences in the anthropometric characteristics, physical tests, volleyball skills, game intelligence and motivational variables of the selected and nonselected players were compared using an independent *t* test and the Mann-Whitney nonparametric *U* test. If a comparison was significant, pairwise comparisons with a Bonferroni adjustment were used to identify differences between specific pairs. To interpret the scores, effect sizes between two groups were calculated. Effect sizes around 0.20 are considered small, around 0.50 moderate and around 0.80 large (5).

Normality of distribution and homogeneity of variance were assessed using Shapiro-Wilk's and Levene's tests, respectively. Stepwise discriminant function analyses were conducted to determine the ability of different physical, psychological and volleyball skill variables to distinguish between groups and subsequently predict group membership. The assumptions underlying discriminant function analysis are associated with linearity, univariate and multivariate normality, homogeneity of variance-covariance matrices, sample sizes, and multicollinearity and singularity (44). The data from five participants were omitted from further analysis due to the presence of univariate and multivariate outliers. Following the removal of outliers, the assumptions of linearity and homogeneity of variance-covariance matrixes were met. Levels of multicollinearity between variables were checked by Pearson's correlation coefficient, variance inflation factor, and detection tolerance values.

Results

Good internal consistency reliability was found in the current study for the mastery-approach goals scale ($\alpha = .77$), mastery-avoidance goals scale ($\alpha = .75$), performance-approach goals scale ($\alpha = .78$) and performance-avoidance goals scale ($\alpha = .74$). This 6-item subscale displayed acceptable internal consistency ($\alpha = .80$). In the current study, the subscale demonstrated high internal consistency ($\alpha = .83$).

Examination of group means for anthropometric and physical characteristics and volleyball skill (Table 1) found that selected players showed higher scores in vertical jump, agility, spiking technique and passing technique. Selected players had higher mean scores for game intelligence, mastery-approach goals, perceived sport competence and enjoyment and lower performance avoidance goals (Table 2). Selected athletes reported high mastery-approach goals, perceived sport competence and enjoyment and moderate levels of mastery-avoidance, performance-approach and performance-avoidance goals.

Table 1 Descriptive Statistics of Anthropometric, Physical and Skill Results for Selected and Nonselected Volleyball Players

	Selected (n = 31)		Nonselected (n = 35)		
	Mean	*SD*	**Mean**	*SD*	**Effect size**
Body mass (kg)	74.3	8.7	72.2	9.6	0.24
Stature (m)	1.92	0.09	1.87	0.10	0.55
Standing reach stature (cm)	244.8	11.6	241.6	12.4	0.28
Vertical jump (cm)	53.5	12.6	45.4	14.7*	0.70
Agility (s)	10.17	0.86	10.58	0.98*	0.47
Sit-ups (30 s)	24.6	7.4	23.6	8.6	0.13
Spiking technique	3.7	1.1	3.2	1.4*	0.45
Serving technique	3.8	0.9	3.5	1.3	0.27
Setting technique	3.5	0.8	3.2	1.1	0.37
Passing technique	3.8	0.8	3.3	1.2*	0.62
Spiking accuracy	10.5	4.9	10.2	5.2	0.06
Serving accuracy	4.8	3.8	4.4	4.0	0.10
Setting accuracy	8.1	3.6	7.6	4.6	0.14
Passing accuracy	8.7	2.7	7.9	3.5	0.30

* Significantly different (p < 0.05) from nonselected group.

Table 2 Descriptive Statistics of Psychological Variables for Selected and Nonselected Players

	Selected (n = 31)		Nonselected (n = 35)		
	Mean	*SD*	**Mean**	*SD*	**p[a]**
Mastery approach	6.29	0.87	5.52	0.97	p < 0.05
Mastery avoidance	4.96	0.83	5.18	0.91	0.059
Performance approach	5.32	0.89	4.94	0.87	0.067
Performance avoidance	4.14	0.85	4.69	0.95	p < 0.05
Perceived sport competence	3.77	0.47	3.13	0.63	p < 0.05
Enjoyment	4.39	0.72	3.98	0.66	p < 0.05
Game intelligence (expert evaluation)[a]	7.36	0.82	6.41	0.97	p < 0.05
Game intelligence (decision making)[b]	15.72	1.55	13.26	1.78	p < 0.05

Note. Data reported are in: [a] arbitrary units on a scale of 1 (low) to 10 (high), [b] right answers out of 20.

[a] p-value based on Mann-Whitney test between selected and nonselected players

Table 3   Discriminant Analysis: Contrasting Selected and Nonselected Volleyball Players

Canonical discriminant function	FC	r[a]
Physical variables		
Vertical jump (5)	0.36	0.38
Skill variables		
Spiking technique (6)	0.27	0.32
Passing technique (4)	0.46	0.47
Psychological variables		
Game intelligence[b] (1)	0.66	0.61
Mastery approach (2)	0.60	0.58
Perceived sport competence (3)	0.53	0.51

Note. FC- standardized discriminant function coefficient. [a]Pooled within-groups correlations between canonical discriminant function and discriminating variables, [b] sum of expert evaluation and laboratory assessment. The inclusion order within the stepwise discriminant model is detailed in paranetheses with each variable name. At each step, the variable that minimizes the overall Wilks's Lambda is entered.

The stepwise discriminant function analysis (Table 3) demonstrated that three psychological variables, two skill variables and vertical jump scores differed significantly between the two groups, Wilks's Lambda =0.516, $p < .000$). The canonical correlation was 0.743 indicating that eight variables accounted for 55.2% of the variance. The model permitted accurate prediction of participant's group 77.1% of the time for nonselected athletes and 87.1% for selected athletes. The standardized discriminant function coefficients show that game intelligence, mastery approach, perceived sport competence and passing technique were the strongest predictors of group membership.

Discussion

The present study examined whether different anthropometric, physical, psychological, and skill test results could discriminate between junior volleyball players of varying ability. It was hypothesized that junior male volleyball players selected to national U-16 and U-18 teams could be discriminated from nonselected players by higher levels of volleyball-specific skills and explosive power. We also expected that selected players would have a higher level of mastery and performance approach goals, game intelligence, perceived sport competence, and more enjoyment of sport participation. The findings only partly support our first hypothesis because only one physical ability (explosive strength) as well as two volleyball-specific skills (spiking and passing technique) discriminate between selected and nonselected junior volleyball players. In line with our second hypothesis, national team players discriminate from their lower-level counterparts by higher game intelligence, mastery approach goals, perceived sport competence and enjoyment of sport participation. These results demonstrate the importance of developing explosive strength of the lower body and spiking and passing technique in junior volleyball players.

In addition, the present results together with those of previous studies underscore the importance of developing game intelligence and fostering a mastery-oriented motivational climate in youth sport settings.

With regard to the first hypothesis of the current study, we found that lower-body explosive power and spiking and passing technique- but not anthropometric measures- were the only variables that contributed significantly to the discriminant analysis. These findings only partly support earlier findings because the majority of talent development studies in team sports so far have been concentrated on physical and physiological characteristics such as body height, adiposity, cardiorespiratory endurance, muscular strength and agility. However, the findings of these studies are controversial. Numerous studies found that youth elite players in soccer (37,45), field hockey (13,34), basketball (25), rugby (36) and volleyball (20) scored better on physical and physiological characteristics when compared with nonelite players. In contrast, other studies have found that anthropometric or physiological variables did not discriminate between successful and unsuccessful talent-identified youth volleyball (20) and field hockey (12) players. During the last decade, numerous authors (12,34,37,46) have stated that the predictive value of the 1-dimensional approach of talent identification (concentration on a combination of anthropometric, physical and physiological measures) has proven to be problematic in the majority of team sports. Consequently, researchers have more often adopted a multidimensional approach in talent identification models, as well as in empirical research conducted on young players in various team sports.

Before discussing the results of the motivational measures, it is interesting to note that the young volleyball players in the current study reported similar levels for all four achievement goals subscales as adolescent Australian footballers (23) and British youth athletes (31) of a similar age. In addition, it was not surprising that youth national team players primarily favored mastery-approach goals and moderate levels of the other three achievement goals. This result is in accordance with the findings of other investigations in sport which have examined approach-avoidance goals. For example, Morris and Kavussanu (31) found that the mastery-approach goal was the only 2×2 goal which significantly predicted enjoyment of sport in British youth athletes. Thus, youth athletes are most satisfied with their sport experience and persisted longer in sport (27) when their goal was to demonstrate task-and self-referenced competence, whereas approach-avoidance goals positively predicted concentration disruption and worry (31).

Despite universal acceptance of psychological factors as determinants of expertise in sport (2), their possible role in the development of expertise is comparatively neglected (22,29). Therefore, there is a relatively limited amount of empirical research conducted on the role of psychological factors in the different stages of talent development in sport (46,47). Ericsson (16), for example, argued that motivation was a prerequisite for sustained engagement in deliberate practice over days, years and even decades. In addition, a recent retrospective study with world-class athletes found that different motivational factors play a crucial role in determining the developmental capacity of an individual (29). In the current study, the role of different motivational factors and game intelligence in conjunction with physical and volleyball-specific measures was examined to discriminate successful young players from their less successful counterparts.

In accordance with our hypothesis, youth national team volleyball players discriminate from lower-level players by higher game intelligence, mastery approach goals, perceived sport competence and enjoyment of sport participation. These results are consonant with predictions stemming from the multiple-goal model (14); findings mainly from educational setting have shown that the approach form of goals relate to positive achievement-related processes and outcomes (15,43). In the limited research that has been done in sport and physical education contexts, mastery-approach goals have been found link positively to the belief that sport competence can be developed, perceptions of mastery climate, mental toughness and enjoyment (6,23,31,33). In addition, perceived competence is considered to be a primary antecedent of goal adoption (14). High perceived competence is posited to orient individuals to the possibility of success and to facilitate the adoption of approach goals. In contrast, low perceived competence is assumed to orient individuals to the possibility of failure and to facilitate the adoption of avoidance goals (14,15). Furthermore, youth sport researchers have reported sport enjoyment as a key predictor of sport commitment (41,48) and team sport participants reported significantly greater enjoyment than individual sport participants (30). Thus, the present results together with those of previous studies demonstrate the importance of fostering a mastery-oriented motivational climate in youth sport settings.

Although important aspects of an athletes' motivation is determined by their own beliefs, cognitions, and values, significant influences can also be exerted by key social agents (21,22). For example, several studies demonstrated the critical role of families and peers in elite athlete involvement and athletic development (8,22,26). Therefore, the wide array of potential motivational influences originating from significant others (coaches, peers, and parents) across a variety of contexts and situations needs to be taken into consideration in talent identification and development research (21,26). However, these potential interpersonal motivational influences were not taken into account in the current investigation.

The present study provides support for including game intelligence measures to the talent identification and development models in ball games. Specifically, we found that selected players demonstrated higher scores in two tests of game intelligence when compared with nonselected players and the sum of these two tests had the strongest discriminative predictor of group membership. Because game intelligence is related to a young player's ability to solve different game-specific problems while taking part in competition, it is important to develop anticipation and decision-making skills an early stage of specialization in sport (ages 12–15). Our results are supported by Falk and colleagues who suggested that in the process of selecting young water-polo players, the greater emphasis should be placed on evaluation of game intelligence (18). In addition, anticipation and decision-making skills are directly related with task and environmental constraints proposed by the Dynamical Systems Theory (35). This multidimensional and dynamical theoretical approach proposed that the matching of intrinsic, task and environmental dynamics may explain expert performance and forms the basis of talent development in sport. Thus, including the measures of game intelligence would also increase the predictive power of tests designed to identify talented male volleyball players.

The findings must be considered within the context of the limitations of the current investigation. First, only a limited number of physical and psychological variables were examined. Recently, McNamara, Button, and Collins (29) stressed the importance of a complex set of psychological skills as critical to talent development in sport (i.e., commitment, imagery, coping skills). Second, the cross-sectional nature of the research provides limited information about the dynamics of talent development. For example, the Dynamical Systems Theory considers developing athletes to be complex neurobiological systems for which the common optimal pathway to top-level performance is not expected. Therefore, this approach is based on the identification of the range of interacting constraints that impinge on the performance potential of individual athletes, rather than evaluating current performance on physical tests (35). Accordingly, this and other multidimensional and dynamical approaches require longitudinal studies. Thirdly, present sample size is small and only male adolescent athletes were studied which make a generalization of the findings limited to other team sports and to female athletes. Future research should determine the extent to which the current findings are applicable to other groups of adolescent athletes. One limitation of our study was a lack of measures of maturity status of young players. Since chronological and biological maturity rarely progress at the same rate, adolescents may be (dis)advantaged on performance tests due to their maturity status (46). Nevertheless, the results provide insights into the selection process in youth volleyball and highlight the interactions among physical abilities, sport-specific skills, game intelligence and motivational variables. Overall, the findings from this study may offer additional information for coaches and practitioners working with youth volleyball players.

In summary, the current study indicates that selected and nonselected male youth volleyball players differ in volleyball-specific skills, explosive power, game intelligence and motivational variables. Young players belonging to the national team demonstrated higher explosive power, execution of passing and spiking skills and game intelligence. In addition, selected players reported higher mastery-approach goals and perceived sport competence and they enjoyed sport participation more than nonselected players. Overall, more attention has to be paid to game intelligence, motivational factors and specific technical skills of young team sport athletes together with the time needed to master these skills.

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