Today's talented youth field hockey players, the stars of tomorrow? A study on talent development in field hockey

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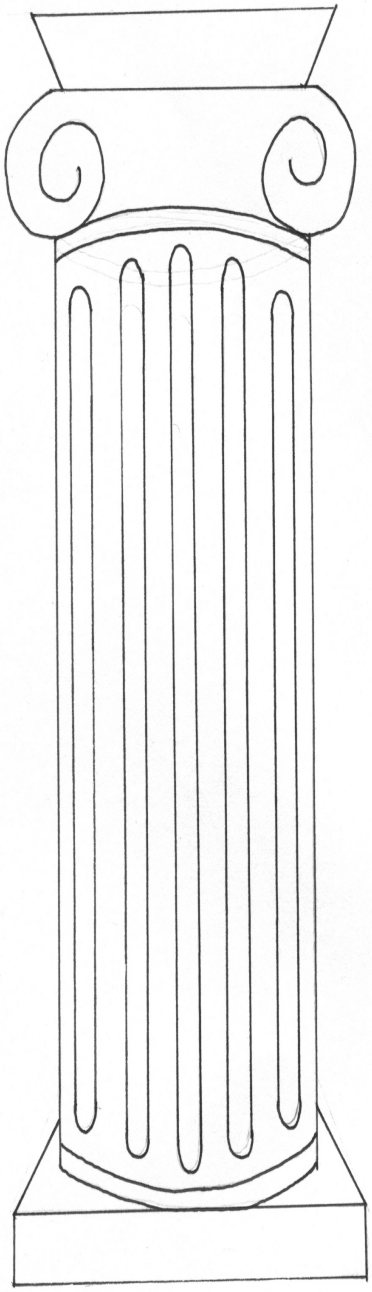
Chapter VII



Development of the Tactical Skills Inventory for Sports

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Abstract

Purpose of this study, in which 19 trainers and 415 competitive youth field hockey and soccer players (age = 15.9 years, *sd* = 1.6; 283 boys and 132 girls) selected by their age, sex, and performance status participated, was to develop a practical, reliable, and valid measure of tactical skills in sports. With trainers, 34 questions were formulated involving tactical skills. Factor analysis yielded the Tactical Skills Inventory for Sports. Scales were labeled Positioning and Deciding, Knowing about Ball Actions, Knowing about Others, and Acting in Changing Situations, covering all aspects of tactical skills regarding declarative versus procedural knowledge, and attack and defense. Internal consistency and test-retest measures for reliability (except Knowing about Ball Actions) were within acceptable limits. Elite players scored better than non-elite players, supporting construct validity. The inventory is suitable for measuring tactical skills in youth field hockey and soccer players in sports practice.

7.1 Introduction

Elite athletes not only need well-developed physiological and technical characteristics, but certain cognitive characteristics too (French and Thomas, 1987; Starkes, 1987; Williams *et al*., 1993; Helsen and Starkes, 1999; Nougier and Rossi, 1999). This certainly applies to players of invasive games, in which players compete at the same field of action as their opponents. Invasive games are time dependent and can be subcategorized into goal-throwing (e.g., basketball), try scoring (e.g., rugby), and goal striking games (e.g., soccer). A characteristic of invasive game players is that they constantly need to adapt to opposition by punctual adaptation to new play configurations and to the circulation of the ball (Gréhaigne and Godbout, 1995). In this type of games, players have to deal with a complex and rapidly changing environment while invading the opposing team's area of the field to score (Almond, 1986; Williams, 2000; Hughes and Bartlett, 2002).

A common way to categorize the cognitive skills needed in sports is the distinction in declarative and procedural knowledge (Anderson, 1982; Thomas and Thomas, 1994; Turner and Martinek, 1999). Both motor skills and tactical skills have elements of declarative knowledge and procedural knowledge (McPherson and Kernodle, 2003). Declarative knowledge includes knowledge of the rules and goals of the game (French and Thomas, 1987; Williams and Davids, 1995), whereas procedural knowledge involves the selection of an appropriate action within the context of the game. In other words, 'knowing what to do' refers to declarative knowledge and 'doing it' refers to procedural knowledge (McPherson, 1994). Bjurwill (1993) stated that, only if a player has a proper understanding of the game, that is, only when he is very good at 'reading the game', can the player be a top player.

So far, many different terms have been used to describe the concept of performing the right action at the right moment. The action and the moment are right when the performance or outcome is successful. For example, Bjurwill (1993) used the terms 'game intelligence' and 'reading the game'. Many other descriptors have been applied, including 'implicit knowledge', 'practical intelligence', 'tricks of the trade', 'tactical knowledge', and 'tactics' (Davids and Myers, 1990; McPherson, 1994; Gréhaigne and Godbout, 1995; Gréhaigne *et al*., 1999). At present the term 'tactical skills' is utilized (McPherson and Kernodle, 2003). Tactical Skills refer to the quality of an individual player to perform the right action at the right moment; it should therefore be distinguished from strategy, which refers to choices discussed in advance with the trainer in order for the team to organize itself (Gréhaigne and Godbout, 1995).

Most studies of tactical skills applied experimental test situations in which, for example, subjects viewed action sequences on a video projection screen (e.g., Starkes and Deakin, 1984; Williams *et al*., 1993; Bard *et al*., 1994; McMorris and Graydon, 1997; Helsen and

Starkes, 1999). Others, especially cognitive psychologists, have used propositional-type analyses of subjects' think-aloud protocols to examine the representation of conceptual knowledge, e.g., declarative, procedural, and to examine how this knowledge guides the solution process during problem-solving or task performance (McPherson, 1994).

Although these settings are useful for fundamental research, they are less suitable for applied purposes. In the field, there is a clear need for information about the tactical skills of individual players, for example, to help trainers guide players toward a higher performance. Information on tactical skills could also prove to be very valuable in leading talented players to the top or in evaluating training effects. Therefore, the goal of this study is to construct an inventory that can be used in sports practice; that is a practical, reliable, and valid measure of tactical skills in sports.

7.2 Methods

To construct the self-reporting inventory, the theoretical elements on tactical skills according to the framework created by McPherson (1994) with one continuum that moves from response selection to response execution and the other continuum that moves from knowledge (knowing what to do) to action (doing it), were discussed with 19 highly qualified trainers of youth national and district selection sports teams in the Netherlands. They were asked to put forward those elements they considered most important for high performance. Elements frequently named as important were overview, anticipation, fast switching from ball possession to no ball possession and vice versa, positioning, man-to-man defense, zone defense, and interception (Elferink-Gemser *et al*., 2004). These elements are specific to match play in invasive games and concern mostly the combination of picking up relevant information from the environment and reacting to that. Questions were formulated and reformulated until consensus was reached on the content of the inventory within the team of experts. Thirty-four items were put in questionnaire form; these were answered on a 6-point scale regarding sports performance with anchors of 1 = very poor and 6 = excellent or of 1 = almost never and 6 = always, while comparing oneself with top players in the same age category (Table 7.1). Factor analysis was applied in Study 1 to examine the structure of relations among the items in the original sample with the purpose of bringing them together into a smaller set of variables or constructs (Nunnally and Bernstein, 1994). After that, the internal consistency of the inventory was examined in Study 2A and test-retest reliability in Study 2B. Starkes (1987) pointed out the importance of cognitive abilities in the development of skill in field hockey, whereas Williams *et al*. (1993) concluded that experienced soccer players' cognitive knowledge permitted more meaningful associations between players'

positions resulting in more efficient retrieval. Based on these studies showing that elite players in field hockey and soccer have better cognitive features than lower-performance players, construct validity was examined by comparing scores of players at different playing levels.

7.3 Study 1: Factor Analysis

Method

Participants

A total of 209 youth players (age = 15.8 years, *sd* = 1.6 years, range = 12.6 - 18.9 years), all participating in competitive field hockey (*n* = 123) or soccer (*n* = 86), gave their informed consent prior to participation. This population consisted of 148 boys and 61 girls. All players were given the same instructions and were taught in the same way. They filled out the original sample of 34 questions individually.

Data analysis

Principal component analysis of the 34 item sample, with four factors fixed, followed by varimax rotation, yielded a structure which accounted for 50% of the response variance. The number of four fixed factors was based on the transition point in the scree plot where successive eigenvalues are plotted against component number (Nunnally and Bernstein, 1994). Items that met the criterion of loading at greater than or equal to 0.55 with a factor were selected to make interpretation of the inventory possible (Kline, 1994; Smith *et al*., 1995).

Results

Twenty-three items met the criterion and are indicated in Table 7.1. Factor 1 consists of Items 1, 2, 4, 5, 6, 7, 8, 9 and 10, and, based on their content, is labeled Positioning and Deciding. Factor 2 consists of Items 16, 17, 18, 19 and 20, and is labeled Knowing about Ball Actions. Factor 3 consists of Items 11, 15, 21, 22 and 23, and is labeled Knowing about Others. Factor 4 has Items 3, 12, 13 and 14, and is labeled Acting in Changing Situations. These four factors make up the four scales in the 23 item Tactical Skills Inventory for Sports.

Table 7.1. Original 34 items and their factor loadings (n = 209).

#	Items	Factor			
		1	2	3	4
	I know which position I should take during matches[x]	0.50	0.10	0.23	0.26
1	Decisions I make during matches about proceeding actions are generally*	0.68	0.09	0.14	0.05
2	I know how to get open during a match*	0.69	0.23	-0.04	0.09
3	My interception of the opponent's ball is*	0.26	-0.04	0.25	0.72
4	My positioning during a match is generally*	0.76	0.10	0.10	0.12
5	My overview (in ball possession or in team's ball possession) is*	0.66	0.34	0.24	-0.08
6	My anticipation (thinking about proceeding actions) is*	0.71	0.14	0.24	0.10
	I know my strong and weak points exactly[x]	0.22	0.33	0.19	0.05
7	I am good at making the right decisions at the right moments*	0.65	0.21	0.25	0.12
8	In the opinion of my trainer, my understanding of the game is*	0.73	0.08	0.16	0.09
9	My getting open and choosing position is*	0.64	0.29	0.07	0.15
10	In the opinion of my trainer, my positioning is*	0.67	0.20	0.13	0.04
11	My judgment of the opponent's play is*	0.32	0.10	0.62	0.15
12	My interception of the ball is*	0.21	0.05	0.41	0.68
	I apply rules of the game smartly to matches[x]	0.29	0.45	0.14	0.20
	During matches I quickly make decisions[x]	0.36	0.49	0.14	0.22
13	If our team loses the ball during a match, I quickly switch to my task as defender*	0.04	0.20	-0.04	0.80
14	I quickly react to changes, as from not possessing the ball to ball possession*	0.29	0.46	-0.12	0.63
	During matches, I look not only at the ball but also look over the field[x]	0.33	0.51	0.07	0.13
15	I know quickly how the opponent is playing*	0.06	0.18	0.57	0.16
16	I know exactly when to pass the ball to a teammate or when not to*	0.27	0.60	0.09	0.01

	I know quickly what to do to win a match[x]	0.06	0.46	0.16	0.18
17	I quickly adapt my play to circumstances, such as rainy or windy weather*†	0.01	0.60	0.11	0.13
	I see the weak points of the opponent quickly[x]	0.06	0.45	0.43	0.03
	I quickly react to correct mistakes of my teammates[x]	0.03	0.43	0.12	0.44
18	If we receive the ball (getting ball possession), I know exactly what to do*	0.21	0.60	0.12	0.15
	While receiving the ball, I do not have to look where my teammates are; I already know[x]	0.33	0.50	0.47	0.03
19	While executing an action in a match, I know exactly what to do subsequently*	0.21	0.63	0.43	0.07
20	If I possess the ball, I know exactly whom I have to pass to*	0.17	0.56	0.43	-0.02
21	Although I do not see my opponents, I know where they are going*	0.25	0.23	0.66	0.12
	If our team loses ball possession, I know exactly what to do[x]	0.07	0.35	0.37	0.50
	If I receive the ball from a teammate, I know in advance where to pass the ball[x]	0.29	0.47	0.48	0.06
22	Without seeing my teammates, I know where they are going*	0.28	0.28	0.60	-0.10
23	If an opponent receives the ball, I know exactly what he is going to do*	0.05	0.12	0.63	0.32

Note: Items were rated on a 6-point scale, using anchors of 1 = very poor and 6 = excellent or of 1 = almost never and 6 = always, while comparing oneself with top players in the same age category. The numbers indicate the item number in the Tactical Skills Inventory for Sports; unnumbered items were not included. Factor 1 = items 1, 2, 4, 5, 6, 7, 8, 9, 10: Positioning and Deciding; Factor 2 = items 16, 17#, 18, 19, 20: Knowing about Ball Actions; Factor 3 = items 11, 15, 21, 22, 23: Knowing about Others; Factor 4 = items 3, 12, 13, 14: Acting in Changing Situations.

[x] Items not meeting the criteria of $a > 0.55$ factor loading.

*Items meeting the criteria of $a > 0.55$ factor loading.

†Item omitted after reliability studies.

7.4 Study 2: Reliability A – Internal Consistency

Method

Participants

A different sample of 206 competitive youth field hockey players (n = 139) and soccer players (n = 67) filled out the Tactical Skills Inventory for Sports (age = 15.9 years, sd = 1.7 years, range = 12.2 - 19.3 years; 135 boys and 71 girls). Again, all players gave their informed consent prior to participation, and procedures were equivalent to those in Study 1.

Data analysis

Raw data were screened for missing values. In case of 20% or more missing values within a scale, a participant was excluded from the analysis. Otherwise, a missing value was replaced by the participant's mean score on the scale involved. Item-total correlations, interitem correlations, Cronbach coefficients alpha for internal consistency, and interscale correlations were used to assess reliability. Concerning item-total correlations, items should correlate more with the scale to which they are assigned than with a different scale. With regard to the interitem correlations, items should correlate positively within their assigned scale. Scales should have a Cronbach coefficient alpha of at least 0.70 (Nunnally, 1978), and interscale correlations should not exceed 0.80 (Carron *et al*., 1985).

Results

None of the participants had 20% missing values or more. Means, standard deviations, and Cronbach coefficients alpha for the inventory are presented in Table 7.2.

Table 7.2. Descriptive statistics and internal consistencies (α) of the four subscales of the Tactical Skills Inventory for Sports (n = 206).

	Scale	Mean	*sd*	α
1	Positioning and Deciding	3.79	0.61	0.89
2	Knowing about Ball Actions	4.11	0.62	0.75
3	Knowing about Others	3.74	0.67	0.74
4	Acting in Changing Situations	4.15	0.69	0.72
	Sum of scales	3.95	0.51	0.91

Internal consistency estimates for the scales ranged from 0.72 to 0.89. Item-total correlations showed that items had higher correlations with their assigned scale than with any other scale, with the exception of Item 11 (which correlated 0.50 with the assigned Scale 3 and 0.51 with Scale 1), Item 12 (which correlated 0.50 with the assigned Scale 4 and 0.54 with Scale 3) and Item 17 (which correlated 0.31 with the assigned Scale 2 and 0.33 with Scale 3). Interitem correlations within each scale were all positive, ranging from 0.17 to 0.75. The interscale correlations varied from 0.37 between Scales 1 and 4 and 0.59 between Scales 1 and 3 (Table 7.3).

Table 7.3. Tactical Skills Inventory for Sports interscale correlations (n = 206).

	Scale 2	**Scale 3**	**Scale 4**
Scale 1	0.52	0.59	0.37
Scale 2		0.56	0.48
Scale 3			0.54
Scale 4			

Note: Scale 1 = Positioning and Deciding; Scale 2 = Knowing about Ball Actions
Scale 3 = Knowing about Others; Scale 4 = Acting in Changing Situations

7.5 Study 2: Reliability B - Test-retest

Method

Participants

From the participants of Study 2A, a sample of 47 competitive youth field hockey players filled out the inventory twice (age = 15.6 years, *sd* = 1.58 years, range = 12.3 - 18.7 years; 18 boys and 29 girls). The second session took place two to four weeks after the first questionnaire completing session, to minimize test-retest effects.

Data analysis

Mean scores and standard deviations for the four scales and the sum of scale scores for the first measurement (t_1) and second measurement (t_2) were calculated. Baumgarter (1989) identified two types of reliability, relative and absolute. Relative reliability is the extent to which individuals maintain their position in a sample with repeated measurements. Absolute reliability is how much repeated measurements vary for individuals. It provides an indication

of the variability in repeated tests for specific individuals, irrespective of the individual's rank in a particular sample (Atkinson and Nevill, 1998; 2001).

The mean difference between the test scores on both days was set as a measure of absolute reliability. If zero lay within the 95% confidence interval of the mean difference, it was concluded that no bias existed between the two measurements. To estimate relative reliability, a one-way analysis of variance was conducted to calculate Intraclass Correlation Coefficients (ICCs) of repeated measures. Ninety-five percent confidence intervals were calculated for all ICC's (Rankin and Stokes, 1998). An ICC above 0.75 was considered to indicate good stability (Lee *et al*., 1989; Streiner and Norman, 1995).

Results

Zero lay within the 95% confidence interval of the mean difference for Scales 1, 3, and 4 and the sum of scales. Scales 1, 3 and 4 and the sum of scales had an ICC varying between 0.76 and 0.89. Only Scale 2 did not meet the criterion, with an ICC of 0.53 (Table 7.4).

Table 7.4. Measures for absolute and relative reliability of the Tactical Skills Inventory for Sports (n = 47).

	t_1 (*sd*)	t_2 (*sd*)	$t_1 - t$ (*sd*)	SE of $t_1 - t_2$	95% CI for $t_1 - t_2$	ICC	95% CI for ICC
Scale 1	3.3 (0.6)	3.4 (0.5)	-0.06 (0.35)	0.05	-0.17 – 0.04	0.88	0.78 – 0.93
Scale 2	3.7 (0.6)	3.4 (0.4)	0.30 (0.60)	0.09	0.13 – 0.48	0.53	0.16 – 0.74
Scale 3	3.3 (0.7)	3.3 (0.6)	0.00 (0.59)	0.09	-0.17 – 0.17	0.76	0.57 – 0.87
Scale 4	3.8 (0.7)	3.7 (0.7)	0.09 (0.54)	0.08	-0.07 – 0.25	0.82	0.67 – 0.90
Sum of scales	3.5 (0.5)	3.5 (0.4)	0.08 (0.31)	0.05	-0.00 – 0.17	0.89	0.80 – 0.94

Note: $t_1 - t_2$ = mean difference between scores from testing times 1 and 2; SE of $t_1 - t_2$ = Standard Error of the mean difference; 95% CI for $t_1 - t_2$ = 95% Confidence Interval for the mean difference; ICC = Intraclass Correlation Coefficient; 95% CI for ICC = 95% Confidence Interval for each Intraclass Correlation Coefficient.

7.6 Study 3: Construct validity

Elite and non-elite youth players were compared on the basis of their scores on the Tactical Skills Inventory for Sports. It was hypothesized that the elite youth group would have higher mean tactical skills scores than the non-elite youth group. Youth players participating in the highest national leagues for their age were considered elite youth players, whereas youth

players at a moderate performance status, i.e., played in a regional competition, were considered non-elite youth players.

Method

Participants

A total of 148 youth field hockey players filled out the inventory. Among them were 76 elite youth field hockey players (age = 15.7 years, *sd* = 1.7 years, range = 12.8 - 18.4 years; 34 boys and 42 girls) from Study 1 and 72 non-elite youth field hockey players (age = 15.3 years, *sd* = 1.7 years, range = 12.3 – 18.7 years; 28 boys and 44 girls) from Study 2. Again, all players gave their informed consent prior to participation, and procedures were equivalent to those in Study 1 and Study 2.

Data analysis

Mean scores and standard deviations were calculated for each scale and the sum of scales. The scores of the elite players were then compared with those of the non-elite players using an analysis of variance.

Results

The lowest mean scores were obtained for Scale 3, Knowing about Others; the highest mean scores for Scale 4, Acting in Changing Situations. The mean Scale 3 score of the elite youth field hockey players was 3.8, and their mean scale score was 4.3 for Scale 4, whereas non-elite youth players showed means of 3.4 for Scale 3 and 3.8 for Scale 4 (Table 7.5). On all scales, elite youth players scored higher than non-elite youth players ($p < 0.01$).

Table 7.5. Scale score statistics for groups playing at different skill levels ($n = 148$).

	Scale	Elite players ($n = 76$)	Non-elite players ($n = 72$)
1	Positioning and Deciding	3.97 (0.56)	3.43 (0.61)
2	Knowing about Ball Actions	4.22 (0.57)	3.77 (0.68)
3	Knowing about Others	3.77 (0.60)	3.41 (0.72)
4	Acting in Changing Situations	4.25 (0.65)	3.82 (0.69)
	Sum of scales	4.05 (0.44)	3.61 (0.55)

Note: Elite and non-elite player groups' mean scores differed on all scales and the sum of scales ($p < 0.01$).

7.7 Discussion

The goal of this study was to construct a practical, reliable, and valid measure of tactical skills in invasive game players. The content of the inventory was selected with the help of a team of expert trainers. Factor analysis yielded four scales which were labeled Positioning and Deciding, Knowing about Ball Actions, Knowing about Others, and Acting in Changing Situations.

Two factors (2 and 3) contain questions more related to declarative knowledge. In these factors, Knowing about Ball Actions and Knowing about Others, knowledge of the game is the central element. The other two factors (1 and 4) contain questions more related to procedural knowledge. In these factors, Positioning and Deciding, and Acting in Changing Situations, selection of the appropriate action is the central element. A way to categorize elements of tactical skills related to the nature of match play in invasive games is by making a distinction between on-the-ball and off-the-ball situations (Oslin *et al*., 1998). Tactics related to scoring or attack can be distinguished from tactics related to preventing scoring or defense (Bjurwill, 1993). According to Mitchell (1996), tactical skills such as maintaining possession of the ball, attacking the goal, and creating space in the attack are similar across invasive games, as are defending space or defending against an attack. Among the four factors, Factors 1 and 2 are more related to the attack, whereas the other two factors (3 and 4) are more related to defense. Questions for Positioning and Deciding and for Knowing about Ball Actions mostly concern situations in which the team possesses the ball. Questions in Knowing about Others and Acting in Changing Situations, on the other hand, mostly concern situations in which the opposing team possesses the ball. By combining both ways of categorizing elements of tactical skills, i.e., declarative versus procedural knowledge and attack versus defense, the four factors in the inventory cover all four of these aspects of tactical skills.

Cronbach coefficients alpha of all four scales were above the criterion value of 0.70, indicating good internal consistency (Nunnally, 1978). In addition, item-total correlations supported the categorization, although three items correlated better with a scale different than their assigned one. However, the small difference between the correlations and the other satisfying psychometric results were the basis for not altering the inventory derived from Study 1. Interscale correlations were moderate, varying from 0.37 to 0.59. This is in line with the assumption that the scales are all part of the same construct. The correlations did not have such high values (< 0.80) that one scale should replace two of them (Carron *et al*., 1985).

Except for Scale 2, Knowing about Ball Actions, values of test-retest reliability led to the conclusion that the scales, as well as the sum of scales, met the criteria for absolute and relative reliability. It was remarkable that the average scores on Scale 2 were lower on t_2 than on t_1, whereas no such decrease was found on the other three scales. When examining the

items of Scale 2, we detected that Item 17 ('I quickly adapt my play to circumstances, such as rainy or windy weather') had a very low ICC compared to the other items (ICC = 0.03). An explanation could be that, between measurements, some players actually had to play a match in rainy or windy weather and found that they were better or worse in adapting to those circumstances than they formerly thought. Reliability coefficients of Scale 2 increase when Item 17 is omitted (ICC = 0.60 instead of 0.53). Besides, the content of this item does not fit well in the scale. Based on these findings, in combination with the results from Study 2A that this item correlated higher with Scale 3 than with its assigned Scale 2, Item 17 should be omitted from the Tactical Skills Inventory for Sports.

Study 3 showed that elite field hockey players scored significantly better on all scales and on the sum of scales than non-elite field hockey players. The above-mentioned findings support the construct validity of the questionnaire. The results are in line with those of other studies showing that skilled players outscore less skilled ones on tactical skills elements (Williams *et al*., 1993; Williams and Davids, 1995; Enns and Richards, 1997).

Whether the inventory is measuring the whole concept of tactical skills cannot completely be ascertained without an accepted reference criterion (inventory). However, this inventory was constructed with help of expert trainers and embedded in theory. This method of gathering items can be considered logical validity, also referred to as face validity, and supports the notion that the inventory is really measuring tactical skills (Thomas and Nelson, 1996). Nevertheless, the results may be influenced by the limitations of the inventory, requiring self-report. Self-reported measures are susceptible to the individual's self-confidence, and, since confidence is associated with elite performance in various sports, this might have affected the results (Mahoney *et al*., 1987; Woodman and Hardy, 2003). Therefore, one could argue that the results of Study 3 for construct validity may have been influenced by enhanced self-confidence of elite players. However, an alternative hypothesis might also be true. The elite players have on average over eight years of active field hockey experience, and they are all part of a talent development program of a field hockey club of national prestige. This means that they have been confronted frequently with all aspects of their performance on the field. Trainers, coaches, peers, and parents give feedback on how fast they are, how well they dribble the ball, and also whether they perform the right action at the right moment. When players are confronted by (significant) others with their tactical skills for many years in a row, they ultimately know how good (or bad) they really are. In other words, regardless of their enhanced confidence, elite players are thought to have a realistic perspective on their tactical skills. It will be interesting to test this hypothesis.

Caution should be taken in generalizing the results to other populations. This sample consisted of competitive youth field hockey and soccer players from the Netherlands.

Therefore Dutch is the original language in which the Tactical Skills Inventory for Sports was constructed. So far, the English version of the inventory has not yet been applied and it can not be assumed straightforwardly that the same results will be obtained. Based on performance indicators, formal games can be classified in three categories: net and wall games, invasive games, and striking and fielding games (Read and Edwards, 1992). Field hockey and soccer are invasive games which fall into the subcategory goal striking games (Hughes and Barlett, 2002). Research could be directed to populations of competitive sports athletes in other categories of formal games and in other countries. Moreover it would be valuable to study the tactical skills from the inventory with other scales than the self-reported inventory.

In conclusion, the internal consistency, test-retest reliability, and construct validity of the Tactical Skills Inventory for Sports were acceptable. With the Tactical Skills Inventory for Sports, which can be used in sports practice, information can be gathered on ‘positioning and deciding’, ‘knowing about ball actions’, ‘knowing about others’, and ‘acting in changing situations’.

References

Almond, L. (1986). Reflecting on theses: a games classification. In *Rethinking games teaching* (edited by R. Thorpe, D. Bunker, and L. Almond), pp. 71-72. Loughborough, England: Loughborough University of Technology.

Anderson, J.R. (1982). Acquisition of cognitive skill. *Psychological Review*, **89**, 369-406.

Atkinson, G. and Nevill, A.M. (1998). Statistical methods for assessing measurement error (reliability) in variables relevant to sports medicine. *Sports Medicine*, **26**, 217-238.

Atkinson, G. and Nevill, A.M. (2001). Selected issues in the design and analysis of sport performance research. *Journal of Sports Sciences*, **19**, 811-827.

Bard, C., Fleury, M., and Goulet, C. (1994). Relationship between perceptual strategies and response adequacy in sport situations. *International Journal of Sport Psychology*, **25**, 266-281.

Baumgarter, T.A. (1989). Norm-referenced measurement reliability. In *Measurement concepts in physical education and exercise science* (edited by M.J. Safrit and T.M. Wood), pp. 45-72. Champaign, IL: Human Kinetics.

Bjurwill, C. (1993). Read and react: the football formula. *Perceptual and Motor Skills*, **76**, 1383 -1386.

Carron, A.V., Widmeyer, W.N., and Brawley, L.R. (1985). The development of an instrument to assess cohesion in sport teams: The group environment questionnaire. *Journal of Sport Psychology*, **7**, 244-266.

Davids, K. and Myers, C. (1990). The role of tacit knowledge in human motor performance. *Journal of Human Movement Studies*, **19**, 273-288.

Elferink-Gemser, M.T., Visscher, C., Lemmink, K.A.P.M., and Mulder, Th. (2004). The relation between multidimensional performance characteristics and level of performance in talented youth field hockey players. *Journal of Sports Sciences*, **22**, 1053-1063.

Enns, J. and Richards, J. (1997). Visual attentional orienting in developing hockey players. *Journal of Experimental Child Psychology*, **64**, 255-275.

French, K.E. and Thomas, J.R. (1987). The relation of knowledge development to children's basketball performance. *Journal of Sport Psychology*, **9**, 15-32.

Gréhaigne, J.F. and Godbout, P. (1995). Tactical knowledge in team sports from a constructivist and cognitivist perspective. *Quest*, **47**, 490-505.

Gréhaigne, J.F., Godbout, P., and Bouthier, D. (1999). The foundations of tactics and strategy in team sports. *Journal of Teaching in Physical Education*, **18**, 159-174.

Helsen, W.F. and Starkes, J.L. (1999). A multidimensional approach to skilled perception and performance in sport. *Applied Cognitive Psychology*, **13**, 1-27.

Hughes, M.D. and Bartlett, M. (2002). The use of performance indicators in performance analysis. *Journal of Sports Sciences*, **20**, 739-754.

Kline, P. (1994). *An easy guide to factor analysis*. London: Routledge.

Lee, J., Koh, D., and Ong, C.N. (1989). Statistical evaluation of agreement between two methods for measuring quantitative variables. *Computers in Biology and Medicine*, **19**, 61-70.

Mahoney, M.J., Gabriel, T.J., and Perkins, T.S. (1987). Psychological skills and exceptional athletic performance. *The Sport Psychologist*, **1**, 181-199.

McMorris, T. and Graydon, J. (1997). The effect of exercise on cognitive performance in soccer specific tests. *Journal of Sports Sciences*, **15**, 459-468.

McPherson, S.L. (1994). The development of sport expertise: mapping the tactical domain. *Quest*, **46**, 223-240.

McPherson, S.L. and Kernodle, M.W. (2003). Tactics, the neglected attribute of expertise. Problem representations and performance skills in tennis. In *Expert performance in sports. Advances in Research on Sport Expertise* (edited by J.L. Starkes and K.A. Ericsson), pp. 137-167. Champaign, IL: Human Kinetics.

Mitchell, S.A. (1996). Tactical approaches to teaching games: improving invasion game performance. *Journal of Physical Education, Recreation and Dance*, **67**, 30-33.

Nougier, V. and Rossi, B. (1999). The development of expertise in the orienting of attention. *International Journal of Sport Psychology*, **30**, 246-260.

Nunnally, J.C. (1978). *Psychometric theory*. New York: McGraw-Hill.
Nunnally, J.C. and Bernstein, I.H. (1994). *Psychometric theory*. New York: McGraw-Hill.
Oslin, J.L., Mitchell, S.A., and Griffin, L.L. (1998). The game performance assessment instrument (GPAI): development and preliminary validation. *Journal of Teaching in Physical Education*, **17**, 231-243.
Rankin, G. and Stokes, M. (1998). Reliability of assessment tools in rehabilitation: an illustration of appropriate statistical analysis. *Clinical Rehabilitation*, **12**, 87-199.
Read, B. and Edwards, P. (1992). *Teaching children to play games*. Leeds: White Line Publishing.
Smith, R.E., Schutz, R.W., Smoll, F.L., and Ptacek, J.T. (1995). Development and validation of a multidimensional measure of sport-specific psychological skills: the athletic coping skills inventory-28. *Journal of Sport & Exercise Psychology*, **17**, 370-398.
Starkes, J.L. (1987). Skill in field hockey: the nature of the cognitive advantage. *Journal of Sport Psychology*, **9**, 146-160.
Starkes, J.L. and Deakin, J. (1984). Perception in sport: a cognitive approach to skilled performance. In *Cognitive sport psychology* (edited by W.F. Straub and J.M. Williams), pp. 115-128. Lansing, NY: Sport Science Associates.
Streiner, D.L. and Norman, G.R. (1995). *Health measurement scales: a practical guide to their development and use*. Oxford: Oxford University Press.
Thomas, J.R. and Nelson, J.K. (1996). *Research methods in physical activity*. Champaign, IL: Human Kinetics.
Thomas, K.T. and Thomas, J.R. (1994). Developing expertise in sport: the relation of knowledge and performance. *International Journal of Sport Psychology*, **25**, 295-312.
Turner, P. and Martinek, J. (1999). An investigation into teaching games for understanding: effects on skill, knowledge, and game play. *Research Quarterly for Exercise and Sport*, **70**, 286-296.
Williams, A. M. (2000). Perceptual skill in soccer: implications for talent identification and development. *Journal of Sports Sciences*, **18**, 737-750.
Williams, M. and Davids, K. (1995). Declarative knowledge in sport: a by-product of experience or a characteristic of expertise. *Journal of Sport and Exercise Psychology*, **17**, 259-275.
Williams, A.M., Davids, K., Burwitz, L., and Williams, J.G. (1993). Cognitive knowledge and soccer performance. *Perceptual and Motor Skills*, **76**, 579-593.
Woodman, T. and Hardy, L. (2003). The relative impact of cognitive anxiety and self-confidence upon sport performance: a meta-analysis. *Journal of Sports Sciences*, **21**, 443-457.