

The Role of Reflection in Sport Expertise

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Reflection is considered a key factor in expert learning and refers to the extent to which individuals are able to appraise what they have learned and to integrate these experiences into future actions, thereby maximizing performance improvements. We assessed the relation between self-reported reflection at baseline and attainment (i.e., international vs. national level) 2.5 years later in 52 elite youth athletes. A Mann-Whitney *U* test showed that those who became senior internationals scored highest on reflection during their junior years compared with those who only attained senior national status. More specifically, athletes who made the transition from junior national to senior international level had higher reflection scores than their peers who did not reach international status and had similar scores to those who were internationals as juniors. These results emphasize the value of reflection in elite youth athletes to attaining senior international status later in development.

In recent decades, increased research attention has been paid to unraveling what it takes for athletes to compete at the highest level, particularly the factors explaining the process of skill acquisition from novice to expert. There is, for example, a long history of interest in the link between practice and attainment (Côté, Baker, & Abernethy, 2007 for a review). Central to this discussion is Ericsson and colleagues' (1993) theory of deliberate practice, which is grounded in the notion that athletes (and other experts) must perform sustained and effortful practice sessions for many years. Elite youth athletes need to progress through different developmental stages in their road to the top with the primary goal of improving current performance levels (Ericsson, Krampe, & Tesch-Römer, 1993). Several studies have emphasized the relationship between the number of training hours of an athlete and the performance level ultimately reached (e.g., Falk, Lidor, Lander, & Lang, 2004; Ford, Ward, Hodges, & Williams, 2009; Helsen, Starkses, & Hodges, 1998; Hodges & Starkses, 1996; Starkses, Deakin, Allard, Hodges, & Hayes, 1996).

Although relevant, with increasing practice and autonomous performance control, athletes who keep progressing need to counteract automaticity and remain cognitively engaged to improve (Ericsson, 2003). Recent research in talent development has underlined the value of cognition by showing that athletes who competed among the best 1.0% in junior competitions (i.e., junior international

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level) discriminated themselves from their peers competing nationally (i.e., the best 2.5%) by their increased use of reflection (Jonker, Elferink-Gemser, & Visscher, 2010). Reflection is defined as an individual's capacity to apply prior experiences to improve subsequent performances in a goal-directed and effective manner (Mezirow, 1991; Peltier, Hay, & Drago, 2006; Zimmerman, 2000). It seems that reflection plays an important role during phases of development, but it remains unclear whether increased use of reflection may play a part in the attainment of senior elite status. Therefore, the purpose of the current study was to relate levels of reflection in elite youth athletes 2.5 years before their age-translated transition to their attainment at senior level and to evaluate the role of reflection in talent development.

Reflection in the context of learning and performance is not a new phenomenon. From an educational perspective, Dewey (1933) reasoned that reflection (i.e., 'the active, persistent and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends'; Dewey, 1933, p. 9) facilitates the problem solving process and improves the effectiveness of learning. More recently, interest in reflection has increased through the work of Zimmerman (1986) and Mezirow (1991) among others.

Zimmerman (1986, 2000) considered reflection as the last phase (self-reflection phase) in his self-regulated learning theory. Self-regulated learners are defined as 'metacognitively, motivationally and behaviorally active participants in their own learning process' (Zimmerman, 1986, p. 308). Reflection is considered to be the part of metacognition that refers to awareness of and knowledge about one's thinking and learning. According to Zimmerman (2000) learners can self-reflect to the result (self-judgment) or to a standard or goal (self-reaction). Differences in these types of reflective thinking are related to learners' sub processes of self-evaluation, causal attributions (as part of self-judgment), self-satisfaction and adaptive inferences (as part of self-reaction). Though Zimmerman's initial work was conducted in an educational setting, his theory has been applied in sports as well (Cleary & Zimmerman, 2002; Kitsantas & Zimmerman, 2002). This means that athletes who want to improve compare self-observed performance against obtained improvement, prior performance, performance of others or contribution to the team performance (i.e., self-evaluation), relate their causes of success and failure to the self-observed performance (i.e., causal attributions), feel satisfied or dissatisfied during reflection by their performance (i.e., self-satisfaction), and adapt their behavior and decisions accordingly to implement new or potentially better strategies and forms of performance regulation to improve in the future (i.e., adaptive inferences; Zimmerman, 2000). As Zimmerman's view of self-regulation is cyclical, these reflective processes take place after each learning effort and have an influence on the subsequent forethought and performance phases of new learning (Zimmerman, 2008). In sports, Cleary and Zimmerman (2001) showed that expert athletes selected more specific goals to reach based on reflective thinking, used more technically oriented strategies and were better able to relate their successes and failures meaningfully by using more strategy attributions.

Within an educational setting, Mezirow (1991) considered critical reflection as an important characteristic of metacognitive reasoning as well. It shapes learners thereby affecting subsequent learning experiences (Mezirow, 1991, 2003). According to Mezirow (1991), reflective people are aware of their kind of reasoning, their way of reasoning and why they need to reason.

In addition, they are conscious about previous learning experiences and are eager to challenge established behavioral patterns and meaning perspectives in their problem solving efforts. They look for new ways to reorient their problem-solving behavior in a more effective way. Through reflection, people in general are able to understand themselves and their learning processes better.

In the current study, we used the initial theories of Zimmerman (1986, 2000) and Mezirow (1991) and considered reflection as the ability of individuals to a) critically value their learning processes by looking back on previous performances which includes Zimmerman's (2000) sub processes of self-evaluation and causal attribution and b) use new information in subsequent learning situations to improve which includes Zimmerman's (2000) subprocesses of adaptive inference. In a practical sense the following two events are examples of the athletes' use of reflection. Soccer player X is selected for the under 19 international youth selection (i.e., junior international level in the year before transition) based on his current capacities. He is tall, strong, and has a good kick, but is less technical and fast. He knows that he has to score more goals if he wants to become selected for the 'real' Dutch soccer team next year. Based on his capacities (i.e., tall, strong, good kick) he decides that his chances to score more goals are biggest when he starts practicing on his free kick. From now on, he arrives early at training to practice and stays after training to refine his kick. At home, he keeps on training his accuracy. Furthermore, he monitors whether this strategy results in attainment of his goal: score more goals during games to become selected for the Dutch soccer team (Toering, 2011, pp. 15). Another example is related to speed-skater Y who has become European champion all-around speed-skating (i.e., best over 4 distances including 500m, 1000m, 1500m and 10.000m). Though, to become an Olympic medalist, which he thinks is the highest achievable, he decides to specialize and solely focus on the 1000 and 1500 m as he assumes to have the most chance at these distances. Therefore, he starts training on speeding-up his opening and the first full round as he is convinced that this will be most beneficial. To develop more speed, he needs to adapt his technique and therefore decides to ask advice from a second coach who is specialized in training sprinters' technique. Several researchers' have cited that expert learners (such as soccer player X and speed skater Y) are more strategic than nonexperts or novices (e.g., Cleary & Zimmerman, 2001; Ertmer & Newby, 1996; Kitsantas & Zimmerman, 2002; Jonker et al., 2010; Toering, Elferink-Gemser, Jordet, & Visscher., 2009) and we consider reflection to help individuals to improve by reflecting on task specific performance characteristics such as mentioned in the examples above. Elite youth athletes striving to reach the top need to improve multiple sport specific performance characteristics (e.g., psychological, technical, tactical) to become good enough for senior international level (Elferink-Gemser, Jordet, Coelho-E-Silva, & Visscher, 2011). In this case, it is assumed that highly reflective elite youth athletes may improve these skills faster and may thereby perform better at a later age as they approach their learning more efficiently by means of reflection. The value of reflective thinking related to performance improvement has been established in human resource development (Van Woerkom, 2004; Van Woerkom & Croon, 2008), and academics (Phan, 2009; Zimmerman, 1986, 1998, 2002) as well.

Elite youth sports is an ideal context to study the use of reflection as athletes are constantly pushing their boundaries to improve in an effort to attain senior elite

status. Toering and colleagues (2009) showed that 12-to 16-year-old elite youth soccer players outscored their subelite peers on reflection. Similarly, Jonker and colleagues (2010) reported that the junior internationals discriminated themselves from their peers competing nationally on the basis of their reported use of reflection, in addition to other self-regulatory skills (e.g., planning, self-efficacy and effort). The authors suggested that the best athletes may have benefitted more from the time spent on training by means of reflection.

Although the trajectory toward the top may differ between sports, most athletes are faced with a relatively small window of opportunity to improve. Moreover, the number of athletes qualified to compete at a given level of competition decreases as competitive level increases (Elferink-Gemser, 2004; Ericsson, 1996) and as a result most athletes are deselected from their talent development programs before they reach senior international status (Côté, Baker, & Abernethy, 2003; Elferink-Gemser, Visscher, Lemmink, & Mulder, 2007). Optimal usage of reflection during the talent years seems beneficial in realizing one's full potential as an athlete (Jonker et al., 2010; Toering et al., 2009).

In the developmental literature, the possibility to use reflection to optimize the learning process seems to run parallel with the years of talent development in most sports (i.e., 12–18 years). From a metacognitive perspective, children start to develop skills such as reflection from an early age (4–6 years; Alexander et al., 1995; McCabe, Veenman & Spaans, 2005). At this young age, metacognitive skills are domain-specific in nature and are thought to increase with age. From approximately 12 years of age, children are expected to be able to use their metacognitive skills with their repertoire developing into a set of domain general skills that can be applied within and between several learning domains (Alexander et al., 1995; Van der Stel & Veenman, 2008; Veenman & Spaans, 2005). Similarly, neurodevelopmental psychology proposes that executive functions, generally defined as psychological processes such as reflection that are involved in the conscious control of thought and action, develop from an early age. Again, children reach adult-level performance on standardized tests of executive functioning at approximately 12 years of age and these capabilities are thought to be domain-general in nature (Zelazo & Müller, 2002).

In sum, although the relation between hours spent on training and ultimate attainment has been shown in prior research (e.g., Ford et al., 2009; Helsen et al., 1998; Hodges & Starkes, 1996; Starkes et al., 1996), more insight is needed regarding what athletes actually derive from their training sessions (e.g., Ericsson, 2003; Jonker et al., 2010; Peltier et al., 2005). The purpose of the current study was to assess the use of reflection of elite youth athletes 2.5 years before their age-related transition to senior competitions (i.e., from junior to senior age) and to relate their levels of reflection to their attained competitive level at senior age (i.e., international or national). To accomplish the purpose of unraveling the specific role of reflection in expertise, and in line with prior research showing relationships between reflective capacity, age, sport-related data and attained senior competitive status, elite youth athletes who made a successful transition to senior international level were matched (by age and training variables) to their counterparts in national competitions when they were junior athletes. We expected that elite youth athletes with the highest levels of reflection were more likely to compete at the international level when they are seniors, thereby emphasizing the value of reflection in reaching expertise.

Method

Participants

In the 2006–2007 and 2007–2008 competitive seasons a representative sample of approximately 1000 elite youth athletes were measured from across The Netherlands. As we wanted to predict attained senior competitive level as early as possible, only elite youth athletes 3 or 2 years before their moment of transition were included. One-hundred and sixty-three athletes (66 male and 97 female) remained who were approximately 2.5 years before their age-related transition to senior competitions in their sport. At that time, all athletes were considered as ‘youth elites’ on the basis of their participation in a talent development program in either baseball, field hockey, gymnastics, handball, judo, speed-skating, soccer, tennis, or volleyball. More specifically, all competed at the highest competitive levels (i.e., national or international) in their respective age group and belonged to the best 2.5% of athletes (Netherlands Olympic Committee*Netherlands Sports Federation [NOC*NSF]). Of these 163 elite youth athletes, 38 athletes (23.31%) reached senior international status in the competitive season 2010–2011 and remained in this study. Athletes are classified as being of international status if they are active in competitions such as World Championships, European Championships, Grand slams, Champions League football or Europe League football, and the Olympics and belong to the best 0.5% of athletes (NOC*NSF).

As previous research showed a relationship between reflective thinking and age, and training variables and attained senior competitive status, the 38 eventual senior internationals were matched with same-age counterparts who did not reach senior international status for the first part of our study. To be included in the matched analyses, athletes from both groups had to have competed in the same sports, be of similar age when reflection was assessed, were similar in age of entry in their sports, years of sport experience and number of training hours per week as their later senior nationals during their junior years. Eventually, 7 male and 19 female later senior internationals were matched with 26 counterparts (11 male and 15 female) who did not reach senior international status. Twelve senior internationals were dropped from our analyses as we were not able to match them with a later senior nationally competing counterpart. Their reflective data were similar to that of the 26 senior internationals who remained in the study; $U = 137.500$; $z = -.587$; $df = 37$; $p = .557$. The mean of the internationals who were dropped from the analyses was 4.23 ($SD = .36$) and mean of the internationals that remained was 4.32 ($SD = .45$). Table 1 shows the general characteristics of the elite youth athletes when they entered the study (i.e., in the 2006–2007 or 2007–2008 seasons) categorized by the attained senior competitive level (i.e., international or national) in 2010–2011.

For the second part of the study, senior internationals and senior nationals were further classified into four competitive level subgroups based on their combined junior competitive level (junior international or junior national) and senior competitive level (senior international or senior national) to control for possible differences in junior competitive level. The first group included athletes who were internationals as junior and retained this status in their senior years (i.e., junior internationals/senior internationals; $n = 14$). The second group was made up of junior internationals that decreased in their competitive level between their junior and senior years (i.e., junior internationals/senior nationals, $n = 5$). The third group

Table 1 Age, Training Related Data (Mean and *SD*), Gender and Academic Level (*n* and %) of the Senior Internationals (*n* = 26) and Senior Nationals (*n* = 26) When They Were Juniors

	Senior internationals		Senior nationals	
	Mean	<i>SD</i>	Mean	<i>SD</i>
Age (yrs)	16.03	1.37	15.77	1.48
Age of entry in their sport (yrs)	6.69	1.93	6.54	1.88
Sport experience (yrs)	9.35	2.43	9.23	2.32
Training (hrs/wk)	13.56	8.72	12.99	8.70
	<i>n</i>	%	<i>n</i>	%
Gender				
Male	7	26.9	11	42.3
Female	19	73.1	15	57.7
Academic level				
Preuniversity	25	96.2	24	92.3
Prevocational	1	3.8	2	7.7

Note. baseball (*n* = 2), handball (*n* = 2), field-hockey (*n* = 2), gymnastics (*n* = 6), judo (*n* = 6), soccer (*n* = 16), speed-skating (*n* = 10), tennis (*n* = 6), volleyball (*n* = 2). * *p* < .05.

included junior nationals that increased in competitive level between junior and senior age (i.e., junior national/senior internationals; *n* = 12) while the final group reflected athletes who were nationals during their junior years and remained at this level as seniors (i.e., junior nationals/senior nationals; *n* = 21). Table 2 shows the general characteristics of the four subgroups.

Procedure

The procedures were in accordance with the standards of the local medical ethics committee of the leading institute. Athletes, the athletes' parents and the schools were informed and gave their verbal consent to participate. In the presence of test leaders, participants completed the reflection subscale of the Self-Regulated Learning—Self-Report Scale (SRL-SRS; Toering, Elferink-Gemser, Jonker, van Heuvelen, & Visscher, 2012) in a classroom setting during their regular school activities in either 2006–2007 or 2007–2008.

The 2010–2011 competitive levels of the athletes (i.e., competing internationally or nationally) were extracted from the NOC*NSF database, from the databases of the sports federations (i.e., Royal Dutch Baseball and Softball Association, Royal Dutch Handball Association; Royal Dutch Hockey Federation, Royal Dutch Gymnastics Federation, Dutch Judo Association, Royal Dutch Skating Federation, Dutch Volleyball Federation; Royal Dutch Tennis Federation; Royal Dutch Football Association) or from the Association of Tennis Professionals (ATP) and Women's Tennis Association (WTA) tennis rankings. On the basis of their competitive level in the season 2010–2011, all internationals were matched with athletes competing nationally on the following variables: age, age of entry in their sports, years of

Table 2 Age, Training Related Data (Mean and SD), Sport Competing in, Gender and Academic Level (n and %)
of the Four Combined Competitive Level Subgroups When They Were Juniors

	Junior international/ Senior international (n = 14)			Junior international/ Senior national (n = 5)			Junior national/ Senior international (n = 12)			Junior national/ Senior national (n = 21)		
	Mean	SD	%	Mean	SD	%	Mean	SD	%	Mean	SD	%
Age (yrs)	15.79	1.48		16.80	1.64		16.33	1.23		15.52	1.36	
Age of entry in their sport (yrs)	6.57	2.21		7.00	3.16		6.83	1.64		6.43	1.54	
Sport experience (yrs)	9.21	2.55		9.80	3.90		9.50	2.39		9.10	1.89	
Training (hrs/wk)	16.60*	10.78		10.40	4.63		10.01*	3.19		13.61	9.40	
Sport competing in	n		%	n		%	n		%	n		%
Baseball	1		7.1	1		20.0	0		0.0	0		0.0
Handball	0		0.0	0		0.0	1		8.3	1		4.8
Field-hockey	1		7.1	0		0.0	0		0.0	1		4.8
Gymnastics	3		21.4	0		0.0	0		0.0	3		14.3
Judo	3		21.4	1		20.0	0		0.0	2		9.4
Soccer	3		21.4	3		60.0	5		41.7	5		23.8
Speed-skating	1		7.1	0		0.0	4		33.4	5		23.8
Tennis	2		14.5	0		0.0	1		8.3	3		14.3
Volleyball	0		0.0	0		0.0	1		8.3	1		4.8
Gender												
Male	4		28.6	2		40.0	3		25.0	9		42.9
Female	10		71.4	3		60.0	9		75.0	12		57.1
Academic level												
Preuniversity	13		92.9	5		100.0	12		100.0	19		90.5
Prevocational	1		7.1	0		0.0	0		0.0	2		9.5

Note. * $p < .05$.

sport experience, and number of training hours per week. This means that the senior internationals competed in the same sports as the senior nationals, were of approximately the same age (i.e., they differed maximally 1 year in age which is consistent with the Dutch competition structure), were about the same age when they entered their sport (i.e., they differed maximally 3 years), had similar years of experience in their sports (i.e., they differed maximally 3 years), and had similar training hours per week (i.e., they differed maximally 3 hr per week) when the athletes filled out the questionnaire as juniors in the 2006–2007 or 2007–2008 seasons.

Although all athletes were part of a talent development program as juniors, and were matched on training related characteristics, it may still be the case that the athletes already differed in their competitive level (i.e., junior international or junior national level). To control for this phenomenon we also extracted the competitive level of the athletes in the seasons 2006–2007 and 2007–2008 from the NOC*NSF and Sports Federations' databases. This information was used for the second part of our study.

Instrument

As noted above, the SRL-SRS was used (Toering et al., 2012), which measures participants' personal details (e.g., date of birth) and their sport-related data (e.g., sport(s) involved, age of entry, number of years of experience in their sport, and number of training hours per week) as well as their self-reported use of self-regulatory skills. The SRL-SRS has found to be a reliable and valid (content and construct) instrument measuring self-regulation in general learning contexts and was based on Zimmerman's (1986) work (i.e., content validity; Toering et al., in press). For the purpose of the current study the reflection subscale of the SRL-SRS was used. This is a 5-item Likert-type scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) measuring the extent to which respondents are able to appraise what they have learned and to adapt their past knowledge and experiences to improve themselves. Table 3 shows the items of the questionnaire as well as the considered observed correspondence in content with Zimmerman's sub processes of self-reflection.

Toering and colleagues (2012) assessed the reliability and construct validity by two confirmatory factor analyses (CFA) with different samples between 12 and 17 years of age. The first CFA showed that an adjusted six-factor model was an acceptable fit to the data with factor loadings for the 5 reflection items ranging from .62 to .72. The CFA of the second sample reproduced these results and supported the validity of the SRL-SRS. The temporal and absolute test-retest reliability was examined using a subpopulation of the first sample ($n = 290$) that filled out the questionnaire twice with a four-to-six week time interval. The ICC for reflection was .84 which supports the relative temporal stability of this scale. In addition, the mean difference between both measurements was not significant, meaning that the absolute temporal stability was sufficient as well. Furthermore, the Cronbach's alpha was $\alpha = .78$ (Toering et al., 2012) which determined a sufficient internal consistency. Similarly, the Cronbach's alpha in the current study was $\alpha = .86$.

Analyses

Data were analyzed using SPSS 17.0. Mean scores and standard deviations on reflection for the senior internationals and the senior nationals were calculated. An Mann-Whitney U test was performed to examine whether the scores for reflection

Table 3 The Reflection Subscale of the SRL-SRS (Toering et al., in Press)

Item	Zimmerman's subprocess of	Mean scores of the subgroups per item			
		Senior internationals	Senior nationals	Difference in mean	p
1	I reappraise my experiences so I can learn from them.	4.15 (.54)	3.85 (.37)	.30	.063
2	I try to think about my strengths and weaknesses.	4.31 (.74)	4.19 (.49)	.12	.537
3	I think about my actions to see whether I can improve them.	4.54 (.51)	4.15 (.46)	.39	.033
4	To understand new ideas, I think about my past experiences.	4.27 (.67)	3.92 (.69)	.35	.134
5	I try to think about how I can do things better next time.	4.35 (.56)	4.12 (.33)	.23	.115

Note. Subscale was originally based on the *Reflection* subscale of the *Reflective Learning Continuum* by Peltier and colleagues (2006). Questions were scored on a 5-point Likert-type scale ranging from *strongly disagree* to *strongly agree*.

differed between the senior internationals and the senior nationals as measured when they were all junior athletes. According to Mann and Whitney (1947) a nonparametric test is better to use with unequal or small sample sizes. Reflection served as the dependent variable with senior international or senior national level as between subjects factor. Using a Mann-Whitney *U* test enabled us to match the senior internationals with their nationally competing counterparts on important influential factors (i.e., the matching variables noted earlier) with sufficient power (i.e., power = .80). This would not have been possible using logistic regression.

To determine whether senior athletes already differed in their competitive level (international or national) as juniors, which may also relate to their levels of reflection (Jonker et al., 2010), we examined the four groups (i.e., group 1: junior international/senior international, group 2: junior international/senior national, group 3: junior national/senior international, group 4: junior national/senior national; see Figure 1 for a summary of groups and overview of analyses) using

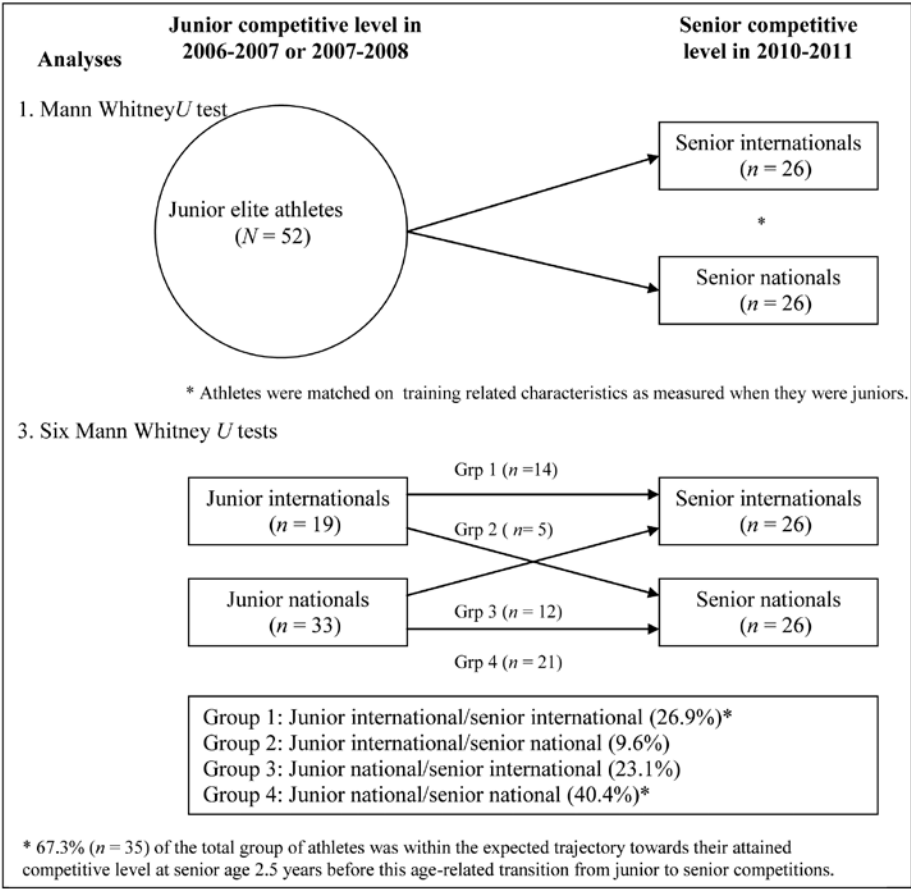


Figure 1 — Overview of analyses for the first and second part of the study and summary of groups according to combined junior and senior international or national competitive levels.

six Mann-Whitney *U* tests to assess possible differences on reflection between the four subgroups. In these analyses, reflection served as the dependent variable with the four subgroups as independent variables.

Mann Whitney *U* tests were executed as follow-up analysis to assess possible differences between subgroups on specific items of the reflection scale. An alpha level of .05 was adopted for all tests and the Bonferroni correction was applied. Effect sizes (*d*) were calculated to interpret the scores. Effect sizes around 0.20 are considered small, around 0.50 moderate and around 0.80 large (Cohen, 1988).

Results

First Part: Difference Between Senior Internationals and Senior Nationals

The results of the Mann-Whitney *U* test showed that when measured as juniors, the senior internationals (mean = 4.32, *SD* = .45) had significantly higher scores on reflection than their senior nationally competing peers (mean = 4.05, *SD* = .28), $U = 220.000$; $z = -2.189$; $df = 51$; $p = .029$; the senior internationals had an average rank of 31.04, while the senior nationals had an average rank of 21.96. This effect was accompanied by a fairly large effect size, $d = .72$. Table 3 revealed that the later senior internationals outscored their later nationally competing peers particularly on 'thinking about actions to improve' (item 3); $U = 238.500$; $z = -2.138$; $df = 51$; $p = .033$; $d = .80$. No significant results were found on the other items, but a moderate-to-large effect size was observed for 'reappraising experiences to learn' (item 1), and moderate effect sizes for 'to understand new ideas, I think about experiences' (item 4) and 'thinking about how I can do things better next time' (item 5). A small effect sizes was found for 'thinking about strengths and weaknesses' (item 2; Table 3).

Second Part: Differences Between the Four Competitive Level Subgroups

Table 4 shows the mean scores (and standard deviations) on reflection and the item scores for the four combined junior and senior international and national subgroups.

The Mann-Whitney *U* tests showed that the junior national/senior international subgroup (group 3) differed significantly from the junior national/senior national subgroup (group 4) on reflection, $U = 57.500$; $z = -2.615$; $df = 32$; $p = .009$ with the junior national/senior internationals reporting higher reflection than their junior national/senior national counterparts (average ranks of 22.71 and 13.74 respectively). The corresponding effect size was large, $d = 1.01$. No significant differences were found between the other subgroups ($p > .05$) and the effect sizes ranged from small between groups with similarity in the attained senior competitive levels (i.e., group 1 vs. group 3; $d = -.31$, and group 2 vs. group 4; $d = .12$) to moderate and large when comparing between the other subgroups (see Table 4).

Mann-Whitney *U* tests on the specific items showed no significant effects between the four subgroups ($p > .05$). Corresponding effect sizes are displayed in Table 4 and ranged from small to large. The athletes who increased or decreased between their junior and senior competitive level were randomly distributed over the sports included in the current study.

Table 4 Means and Standard Deviations on the Total Scale of Reflection (Mean and SD) and Per Item (Mean and SD for the Four Subgroups Based on the Combined Junior and Senior Competitive Levels of the Athletes

Combined junior and senior competitive level subgroup								
Junior international/ senior international (JISI; <i>n</i> = 14)			Junior international/ senior national (JISN; <i>n</i> = 5)		Junior national/ senior international (JNSI; <i>n</i> = 12)		Junior national/ senior national (JNSN; <i>n</i> = 21)	
Item	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	4.14 ^a	0.36	3.80 ^a	0.44	4.17 ^a	0.72	3.86 ^b	0.36
2	4.14 ^a	0.86	4.20 ^a	0.45	4.50 ^a	0.52	4.19 ^a	0.51
3	4.50 ^a	0.52	4.20 ^a	0.45	4.58 ^a	0.52	4.14 ^b	0.48
4	4.14 ^a	0.66	3.80 ^a	0.84	4.42 ^a	0.67	3.95 ^b	0.67
5	4.36 ^a	0.50	4.40 ^a	0.55	4.33 ^a	0.65	4.05 ^b	0.22
Total	4.26 ^a	0.47	4.08 ^a	0.39	4.40 ^a	0.43	4.04 ^b	0.26
Range (min—max)	3.60	5.00	3.60	4.60	3.60	5.00	3.40	4.40

Note. Corresponding effect sizes between:

- JISI and JISN were small for items 2 and 5 ($d = -.09$ and $d = -.08$), moderate for items 3 and 4 ($d = .62$ and $d = .45$), large for item 1 ($d = .85$), and moderate ($d = .42$) for the total score on reflection.

- JISI and JNSI were small for items 1, 3 and 5 ($d = -.05$, $d = -.15$, and $d = .05$), moderate for items 2 and 4 ($d = .51$ and $d = .42$), and small ($d = -.31$) for the total score on reflection.

- JISI and JNSN were small for items 2 and 4 ($d = -.07$ and $d = .29$), large for items 1, 3 and 5 ($d = .78$, $d = .72$, and $d = .80$), and moderate ($d = .56$) for the total score on reflection.

- JNSI and JISN were small for item 5 ($d = -.12$), moderate for items 1 and 2 ($d = .62$ and $d = .62$), large for items 3 and 4 ($d = .78$ and $d = .82$), and large ($d = .78$) for the total score on reflection.

- JNSI and JNSN were moderate for items 1, 2, and 5 ($d = .54$, $d = .60$ and $d = .58$), large for item 3 and 4 ($d = .88$ and $d = .70$), and large ($d = 1.01$) for the total score on reflection.

- JISN and JNSN were small for item 1, 2, 3, and 4 ($d = -.15$, $d = .02$, $d = .13$, and $d = -.20$), large for item 5 ($d = .84$), and small ($d = .12$) for the total score on reflection.

^{ab} Within each row, means having the same letter in their superscripts are not significantly different from each other at the .05 level.

Discussion

Our analyses used data with a future time component to assess whether elite youth athletes with the highest self-reported levels of reflection were more likely to attain senior international status. Knowledge about the role of reflection in sport expertise can give coaches and athletes increased understanding about how elite youth athletes learn and how their learning process can be optimized during talent development, ultimately leading to superior performance. Results of the first part of our study, where junior internationals and junior nationals were matched on a range of critical variables, supported our hypothesis that junior athletes who attained senior international status displayed more frequent use of reflection during their years as juniors. This suggests that the senior internationals may have derived more from their practice sessions even though both groups had similar hours spent on practice (Cleary & Zimmerman, 2001; Ericsson, 1998; Ertmer & Newby, 1996; Jonker et al., 2010; Peltier et al., 2006; Toering et al., 2009) and as a consequence were better able to improve in the restricted time period toward the transition to senior competitions.

When we relate the content of the items on which the later senior internationals differed most from their later nationally competing peers (i.e., ‘thinking about actions to improve’ and ‘reappraising experiences to learn’; items 1 and 3 as shown by the effect sizes in Table 3) to Zimmerman’s sub processes of reflection, it seems that the later senior internationals use more information from past experiences (Zimmerman’s sub process of self-evaluation), but also seem willing to adjust their past strategies to improve next time (Zimmerman’s sub process of adaptive inferences). As these items possess a kind of openness to new ideas and willingness to modify, we consider those aspects in line with Mezirow’s (1991) point of view as well.

In the second part of our study, we attempted to gain more knowledge about the relationship between reflection and attainment of senior status by subdividing the athletes into four combined junior and senior competitive levels. In this new analysis, junior competitive level was taken into account, as athletes may have differed in junior competitive level, but moreover this analysis may reveal possible changes in junior and senior competitive levels related to athletes’ use of reflection. This analysis displayed that the twelve (23.1%) junior nationals/senior internationals (i.e., those who increased in competitive level from junior to senior age) had similar or even slightly higher scores on reflection than their peers who were already junior internationals and remained internationals at the senior level (i.e., 4.40 vs. 4.26 respectively; Table 4). In addition, their mean scores were significantly higher than their junior national peers who did not make it to senior international level. The mean scores on reflection of the five (9.6%) junior internationals/senior nationals (i.e., those athletes who decreased in competitive level from junior to senior age) was similar to the scores of the athletes who were nationals during their junior years and remained nationals at senior age (i.e., 4.08 vs. 4.04 respectively, Table 4).

Above mentioned findings are interesting as they show that almost 35% of the junior athletes were not in the athletic track leading to their attained senior competitive level (Figure 1) and relations with their use of reflection were found. Namely that most of the athletes who scored high on reflection were still able to increase in their competitive level between their junior and senior years, while those who

were junior nationals and stayed nationals at senior age had significantly lower reflective mean scores (Table 4). Furthermore, the lowest score of the latter group (Table 4) refers to *neutral* which means that athletes do not always agree to reflect or do not know whether they reflect, while the lowest score of the junior nationals/senior internationals refers to *agree*. The highest score of the junior nationals/senior nationals refers to *agree*, while the highest score of the junior nationals/senior internationals refers to *strongly agree*. This indicates that those junior nationals who became senior internationals at least always agree to use reflection. We suggest that coaches and youth scouts should be aware of this phenomenon. They need to facilitate their athletes who are allowed to compete in international competitions at junior age with the best opportunities to make progression (Elferink-Gemser et al., 2011), but also their nationally competing peers should have access to the best opportunities to improve and must receive high-quality attention from coaches. Since, this study points out that 23.1% of the later senior internationals are still competing nationally 2.5 years before the transition to senior competitions (Figure 1). Based on the results of the current study, we recommend trainers and coaches to monitor their athletes' levels of reflection as making use of these skills toward the moment of transition may be related to making a successful transition from junior to senior age.

More practically these differences in reflective scores showed that the junior nationals/senior internationals improved their competitive level enough to be able to compete at senior international levels of competition and reported the frequent use of reflective skills suggesting that the senior internationals may have improved their sport specific skills as a consequence of their optimal usage of reflection. Although no significant effects were observed, closer examination of the differences in their item scores (Table 4), indicates they may have benefited most from their increased use of 'thinking about actions to improve' and 'to understand new ideas, I think about experiences' (items 3 and 4) as is shown by large and moderate-to-large effect sizes. These aspects are in line with Zimmerman's sub processes of self-evaluation and adaptive inferences. For the junior internationals/senior nationals the opposite may be true since they had lower scores on reflection than their international junior peers who made it to the senior international level. When looking to differences in item scores, the junior internationals/senior nationals scored relatively low on 'thinking about actions to improve' and 'to understand new ideas, I think about experiences' (items 3 and 4) compared with the athletes who attained senior international status (Table 4). It should, however, be acknowledged that this last group consisted of five athletes only.

When relating items of our questionnaire to Zimmerman's (2000) sub processes of reflection, we have to acknowledge that our instrument does not include the sub process of self-satisfaction. To recapitulate, self-satisfaction refers to learners' feelings of satisfaction or dissatisfaction against one's performance (Zimmerman, 2000) and has, thereby an influence on learners' subsequent effort and approach to learning. It may therefore, well be the case that the senior internationals differ from the senior nationals on self-evaluation and adaptive inferences due to an increased satisfaction and confidence of the senior internationals in their own capabilities. Bandura (1991) showed that learners with increased feelings of self-satisfaction are more likely to adapt their behavior to improve in future tasks. Furthermore, he emphasized that the more task-specific character of self-satisfaction as people

are generally more familiar with making judgments on task-specific forms of performance. Although our results are still considered valuable as they shed light on the predictive value of reflection for those who are going to make it to the top, we recommend for future studies to use more qualitative measurements including Zimmerman's subprocess of self-satisfaction.

An other weak point is related to the use of a general self-report questionnaire. Using self-report is not without discussion. There is, for example, ongoing debate regarding whether people are able to report their thoughts and cognitions appropriately (Eccles, *in press*; Nisbett & Wilson, 1977). Besides that, we have to acknowledge that what we know from our results is that the later senior internationals say to reflect more frequently, but what remains unclear is where the senior internationals have exactly reflected on and why they chose for that subsequent action or strategy to improve in a range of different possibilities. How and if this was reflected in behavior remains unknown as well. Nevertheless, a recent study of Toering and colleagues (2011) showed positive and significant correlations between the self-report instrument used in the current study and behavioral observations for reflection as part of self-regulation as reported by expert coaches in elite youth soccer (Toering, Elferink-Gemser, Jordet, Jorna, Pepping, & Visscher, 2011). Still, it would be valuable for future research to develop instruments that can assess athletes' use of reflection more qualitatively.

In addition, our results were based on elite youth athletes' scores on reflection at solely one moment during development (*i.e.*, 2.5 years before transition). For future studies, we recommend to use longitudinal data as this may reveal the value of reflection during several phases of development of expertise. Furthermore, analyses were performed with relatively small sample sizes. Although, the power of our main analyses are considered sufficient (see above), and which is underlined by the moderate-to-large and large effect sizes, some other analyses may lack power. A high power avoids making a type 1 error which in this case would mean that we assume that senior internationals outscore their senior national peers on reflection while in fact they do not. This should be acknowledged when interpreting our results. Furthermore, one might argue that the two sets of analyses in the current study are somewhat redundant as the athletes could have been matched on junior competitive level within the first analysis as well. Besides, the fact that this would leave us with even smaller sample sizes, the results of the second analysis further contributes to the value of reflection during development of expertise as it reveals not only numbers of athletes that still changed in competitive levels between junior and senior years, but it also emphasizes its relation with their self-reported use of reflection. We therefore consider the execution of both analyses as a strength of our study.

Other strengths of our study relate to the future time component of our research design since most research with young athletes has been conducted retrospectively (*e.g.*, Helsen et al., 1998; Hodge & Starkes, 1996; Starkes et al., 1996). In our study, we were able to track athletes of the highest competitive levels in their sports across their stages of development. This reveals better information about this critical period than examining the recalled perspectives of athletes who have reached elite status (Coté, 1999; Holt & Dunn, 2004), which may be subject to a range of recall biases. In addition, even though discussion exists regarding whether reflection should be measured as domain-specific or domain-general, we think that in this age category measurement of domain-general reflection is a strength. Not only can the results of the current study be compared with those of experts in other

domains, Wylleman and colleagues (2004) noted that athletes aged 10-to-22 years are faced with important transitions on athletic, psychological, academic, and/or individual levels (Wylleman, Alfermann, & Lavallee, 2004). In line with Mezirow's (1991) point of view on reflection, we assume that in order for athletes to improve they need to balance these shifts and use all relevant information in their lives to understand themselves and their learning process.

An additional strength of the current analysis is that it assessed the levels of reflection of younger athletes who are still in high school, an age group rarely considered in skill acquisition and talent development research. Thus, results of the current study contribute to existing literature in that specifically reflection as aspect of self-regulation has predictive value for those who attained the highest competitive status in sport. Research with athletes at these extremely high levels of competition is valuable in itself, but we were also able to track them during development. We did not know during research who was going to make it and who was not. To our knowledge, most research has emphasized the value of reflection solely during development without relating it to the attainment of success at senior age, or assessed it retrospectively which is more susceptible to recall biases (Côté, 1999; Holt & Dunn, 2004). Though measured with a self-report questionnaire, which has its limitations as well (see above), this study was one of the first able to access athletes during development, namely 2.5 years before transition. Although, the relationships between Zimmerman's (2000) subprocesses of reflection should be further assessed in future research, the current study sheds light on the importance of specific sub processes of reflection in the attainment of senior international status.

Although this study emphasizes the value of reflection, it is also in line with the main idea of the deliberate practice theory (i.e., that expert performance is closely related to the accumulated numbers of hours of training; Côté et al., 2007; Ericsson et al., 1993). All senior internationals competed in their sport of expertise for more than 10 years before their transition to senior competitions, started at an early age and spent large numbers of hours of training in their sport per week (Table 1 and Table 2). In addition to Ericsson's (2003) proposition that cognitive involvement is necessary to attain higher levels of performance, the current study shows the value of reflection in reaching senior international level. In addition to research showing the value of the accumulated numbers of training hours of athletes (e.g., Falk et al., 2004; Ford et al., 2009; Helsen et al., 1998), our results emphasize that reaching senior international status is more multifaceted than merely accumulating hours of deliberate training (Baker, Côté, & Abernethy, 2003; Ericsson, 1998). Athletes who reached senior international status displayed higher scores on reflection as juniors and, perhaps more interestingly, athletes who increased in competitive level from junior national to senior international reported using reflection even more frequently. It seems that maximizing one's potential by means of reflection may ultimately determine attainment at the senior level (i.e., international vs. national level).

Our results have several implications for athletes, trainers and coaches. In general, identifying athletes with high and low levels of reflection as juniors may be informative since these levels of reflection seem to predict attainments as seniors. More importantly, coaches and trainers should be aware that athletes at lower levels of junior competition are still able to make the transition to higher levels as seniors. Athletes competing nationally as juniors who displayed high levels of reflection were still able to reach senior international status. Furthermore, when working with athletes who are physically 'gifted' but with low levels of reflection,

coaches and trainers should be conscious of the role of reflection in the attainment of senior international level. Furthermore, and as mentioned in the introduction, most elite youth athletes are deselected from their talent development programs in their journey to the top. Our results suggest that some of these athletes fail to reach senior international status due to an insufficient use of their reflective skills.

More practically, in case of soccer player X and speed-skater Y, we assume that they would never have obtained success when they kept on training simply like they did, or when they were not aware of their own abilities and disabilities on which they based their strategies to improve. Previous research in educational settings has suggested that the development and use of reflection can be taught (Cleary, Nelson, & Platten, 2008; Masui & De Corte, 2005) and coaches and trainers may wish to put this into practice. This means that trainers and coaches should approach their athletes individually to set personal goals of attainment based on athletes' willingness to invest, personal strengths and weaknesses, the competitive level of competitors, and assess different possibilities to improve as an outcome of shared reflective thinking. Furthermore, trainers and coaches should be aware of their own capabilities related to their athletes' goals and should be willing to ask advice from other specialists to improve their athletes' performance. This means that training methods must become more personally and athlete-centered, in which the athlete takes control over learning and is involved processes of goal-setting and planning. Further research is needed to develop a reflective intervention from a talent developmental perspective in youth sports. From this point of view, helping athletes to develop their reflective skills may help them exert more control over their learning process and benefit more from their training sessions.

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