The importance of reflection and evaluation processes in daily training sessions for progression toward elite level swimming performance

Post, Aylin K.; Koning, Ruud H.; Visscher, Chris; Elferink-Gemser, Marije T.

Published in:
Psychology of sport and exercise

DOI:
10.1016/j.psychsport.2022.102219

Publication date:
2022

Psychology of Sport & Exercise 61 (2022) 102219

Contents lists available at ScienceDirect

Psychology of Sport & Exercise

journal homepage: www.elsevier.com/locate/psychsport

The importance of reflection and evaluation processes in daily training sessions for progression toward elite level swimming performance

Aylin K. Post [a,*], Ruud H. Koning [b], Chris Visscher [a], Marije T. Elferink-Gemser [a]

[a] Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, Sector F A, Deusinglaan 1, 9713 AV, Groningen, the Netherlands
[b] Department of Economics, Econometrics & Finance, Faculty of Economics and Business, University of Groningen, Duisenberg Building, Nettelbosje 2, 9747 AE, Groningen, the Netherlands

ARTICLE INFO

Keywords:
Youth athletes
Talent development
Acquisition of expertise
Self-regulated learning
Reflection and evaluation
Competitive swimming

ABSTRACT

Self-regulated learning (SRL) involves self-directed metacognitive subprocesses and motivational beliefs that facilitate more effective and efficient learning. We investigated whether youth swimmers who are on track to becoming elite swimmers apply SRL subprocesses more frequently in their daily training sessions compared with swimmers who are not on this track. Insights into swimmers' use of training-centered SRL could advance understanding about underlying individual characteristics that contribute to optimal engagement in daily training and, consequently, progression toward elite level swimming performance. We collected data on training-centered SRL subprocesses (evaluation, planning, reflection, speaking up, effort and self-efficacy) and performance data for 157 youth swimmers aged 12–21 years (73 males and 84 females). The results of a multivariate analysis of covariance revealed significantly higher scores for reflection processes during training for high-performing swimmers but lower scores for effort compared with lower-performing swimmers ($p < 0.05$). A closer examination of the high-performing group showed that those demonstrating greater improvement during a season scored significantly higher for evaluation processes after training compared with those evidencing less improvement during a season ($p < 0.05$). Significant between-group differences in SRL subprocesses remained after adjusting for differences in weekly training hours. Youth swimmers on track to becoming elite swimmers are characterized by more frequent use of reflection processes during training and evaluation processes after training, which suggests that these swimmers' learning and training processes are more effective and efficient. Ultimately, this could contribute to a higher quality of daily training, which may result in greater improvements during a season, higher performance levels, and a greater chance of reaching the level of elite swimming performance.

Youth swimmers who aspire to become elite swimmers must demonstrate outstanding progress (Allen et al., 2014; Post et al., 2020a, 2020b). To reach such expertise, the importance of an extensive period of training is widely acknowledged and usually starts during adolescence or even before (Howe et al., 1998; Starkes 2000). However, not only do aspiring swimmers need to invest in extensive training in terms of quantity (e.g., ~12,000 h of training, Koninklijke Nederlandse Zwembond [KNZB], 2021), it is also essential that they get the most out of their training sessions in terms of quality (Ericsson et al., 1993; Young et al., 2021). With respect to the latter, self-regulated learning (SRL) is considered as an important variable on athletes' capacity to improve (Elferink-Gemser et al., 2015; McCardle et al., 2019; Tedesqui & Young, 2015). Consequently, SRL is an intriguing concept in the study of underlying individual characteristics that contribute to progression toward elite level swimming performance.

SRL indicates the extent to which individuals are metacognitively, motivationally and behaviorally proactive in their own learning processes (Zimmerman 1986, 2006). Conceptually, it refers to an individual's engagement in a set of psychological subprocesses and beliefs that (1) makes them think about their own thinking (meta-cognitive processes like evaluation and reflection) and (2) motivates them to engage in meta-cognitive and behavior control (e.g. through effort and self-efficacy; Zimmerman, 2011). Zimmerman's (2000) social-cognitive SRL model, which is the most commonly used model in the SRL

* Corresponding author. Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, Sector F A, Deusinglaan 1, 9713, AV Groningen, the Netherlands.
E-mail address: a.k.post@umcg.nl (A.K. Post).

https://doi.org/10.1016/j.psychsport.2022.102219
Received 17 August 2021; Received in revised form 21 March 2022; Accepted 11 May 2022
Available online 18 May 2022

literature, posits that these subprocesses and beliefs fall into three structurally interrelated and cyclically sustained phases: the forethought phase (before learning), the performance phase (during learning) and the self-reflection phase (after learning). Feedback from prior performances (the self-reflection phase) is applied during the forethought phase to make adjustments for current and future efforts (the performance phase), thus completing a self-regulatory cycle (Ertmer & Newby, 1996; Zimmerman, 2000).

It has been posited that engagement in SRL subprocesses and beliefs increase learners' awareness and control of the functional relationships between their patterns of thought and action, and outcomes in the real-world (Zimmerman, 1986). Learners who set clear goals, formulate a plan to practice, monitor the strategy's implementation, and evaluate practice outcomes to adjust subsequent behavior or goals, gain clarity on what they want to achieve, what they have to do to achieve their self-designated goals, what they should actually do during practice, and the effectiveness of their thoughts, strategies, and actions. Consequently, they acquire a better understanding of what can be learned from past performances in order to improve current and future performances. Thus, SRL is thought to help individuals to learn more effectively and efficiently (Jonker, Elferink-Gemser, & Visscher, 2010; Zimmerman, 1986, 2006), which is major source of motivation for continued self-regulation and investment of effort in the learning process (Bandura, 1997; Zimmerman & Paulsen, 1995).

Effective and efficient acquisition of knowledge and skills is highly desirable in competitive, globalized sports, such as competitive swimming. Given the restricted number of daily training hours (work-rest ratio), the limited time available to make it to the top (with advancing age) and the ongoing increase of the international performance standards, it is important for aspiring swimmers to gain maximal benefits from training and competition. Engagement in SRL may enable ambitious swimmers to optimize their developmental process. As such, effective SRL may be an indirect but crucial factor for acquiring sport expertise (McCardle et al., 2019; Zimmerman, 2006).

The association between SRL and the attainment of sport expertise is supported by several studies that investigated differences in SRL among skill-based groups. For example, Cleary and Zimmerman (2001) found that expert youth basketball players set more specific goals, selected more technique-oriented strategies, were more strategic, and displayed higher levels of self-efficacy than non-experts and novices. Jonker et al. (2010a, 2010b) and Toering et al. (2009) highlighted the importance of reflection skills in relation to performance levels. Both studies found that advanced youth athletes outscored their lower-level peers in the area of reflection. Moreover scores for reflection were higher for athletes who made the transition from junior national to senior international level (Jonker et al., 2012) and distinguished junior international athletes from junior national athletes (Jonker et al., 2010a; Toering et al., 2012a, 2012b). Bartulovic et al. (2017), who studied senior athletes, showed that elite status was most strongly associated with engagement in overall SRL and self-monitoring. In sum, these studies unanimously suggest that expert athletes engage more frequently and in more sophisticated SRL subprocesses than less proficient or novice athletes.

However, it is noteworthy that the SRL concept has been studied and measured in various ways within the SRL literature (see review McCardle et al., 2019). For example, Cleary and Zimmerman (2001) assessed meta-cognitive processes of SRL using a microanalytic approach (an examiner asked a set of questions during practice and participants responded orally). Their questions about SRL, which solely related to free throws in basketball (domain-specific), were focused on one task of short duration (microscopic-level) within a training session and were about specific instances (event) with a temporally defined beginning and end. By contrast, Toering et al. (2009, 2012a) and Jonker et al. (2010a, 2010b,2012) measured six SRL subprocesses (planning, monitoring, evaluation, reflection, self-efficacy and effort) using the Self-Regulation of Learning Self-Report Scale (SRL-SRS)

questionnaire (Toering et al., 2012b), which also included motivational aspects of SRL. In these studies, questions about SRL were related to the overall learning context (domain-general) and focused on broader, longer-term regulation across multiple learning sessions (macroscopic-level). Moreover, they assessed the frequency of engagement in SRL subprocesses as a relative enduring, aptitude-based characteristic. Inspired by this line of research, Toering et al. (2013) and Bartulovic et al. (2017) developed sport-specific SRL questionnaires, initializing the recent trend in SRL research in which SRL is proposed to be a more sport-specific skill rather than a domain-general disposition (Reverberi et al., 2021). Moreover, they argued that SRL measures should focus on everyday sports practice sessions in order to provide meaningful results that could contribute to a better understanding of sport-related performance development.

Accordingly, we suggest that besides the more training-centered and sport-specific focus in SRL, an additional shift in research is needed. Whereas most SRL studies in sport have focused on the relationship between SRL and athletes' performance levels, there has been little attention to how SRL relates to performance progression (Elferink-Gemser et al., 2015). Establishing a link between SRL and performance progression could be a crucial step towards advancing understanding of the development of sport expertise. For example, previous studies on competitive swimming have shown that youth swimmers who are on track to becoming elite swimmers (i.e., top 50 swimmers worldwide) are characterized by higher performance levels (Post et al., 2020a) and progression within a season (Post et al., 2020b). However, the underlying individual characteristics that contribute to the actual progression of an individual from one performance level to another remain unclear. Therefore, a question that arises is whether differences in training-centered SRL are associated with differences in performance levels and progression in competitive swimming. By investigating individuals' training-centered SRL in relation to their performance levels and progression, we may acquire a better understanding of underlying individual characteristics that contribute to optimal engagement in daily training sessions and consequently to progression toward elite level swimming performance. Therefore, knowledge about training-centered SRL in competitive swimming may be of value for enhancing the effectiveness and efficiency of talent development programs.

The present study was aimed at extending the body of SRL research in relation to the performance levels and progression of youth swimmers, using a sport-specific, aptitude-based questionnaire (Toering et al., 2013) focusing on daily training sessions. We sought to answer the question of whether youth swimmers who are on track to reach the elite level apply SRL more frequently in their daily training sessions compared to swimmers who are not on this track. Consequently, we investigated training-centered SRL in advanced competitive swimmers who differed in (a) their performance levels and (b) their performance progression within a season. Despite the theoretical and practical implications, there is a lack of studies combining training-centered SRL with these performance measures.

Our investigation comprised two parts. First, we examined differences between high-performing and lower-performing swimmers relating to their use of training-centered SRL (part one). Second, focusing specifically on high-performing swimmers, we examined differences in the use of training-centered SRL by swimmers whose progress was advanced and those whose progress was less advanced (part two). We hypothesized that (a) high-performing swimmers obtained higher scores for training-centered SRL than lower-performing swimmers (part one) and (b) swimmers whose performance progress was advanced obtained higher scores for training-centered SRL than those whose progress was less advanced (part two).

1. Material and methods

Ethical approval

All participants were informed of the study's procedures prior to their participation and provided their written informed consent to participate. Informed consent was also obtained from parents of participants who were below 16 years old. All procedures used in the study complied with the Helsinki Declaration and were approved by the research ethics committee of the University Medical Center Groningen, University of Groningen, The Netherlands (202000488).

1.1. Data collection

A total of 157 Dutch competitive swimmers (73 males and 84 females) aged 12–21 years were included in the present study. All swimmers had participated in the National Dutch Junior Championships ("Nederlandse Junioren & Jeugd Kampioenschappen"; n = 125) and/or were selected for talent development programs (n = 33) organized by the KNZB. We collected data on the use of training-centered SRL and swim performances of these swimmers during the 2018/2019 swim season (see Figure 1). The season, which was officially launched on September 1, 2018 and ended August 31, 2019 (Fédération Internationale de Natation [FINA], 2021), comprised a short course season (September–December in the 25 m pool) and a long course season (January–August in the 50 m pool).

Cross-sectional data on training-centered SRL were collected using an online survey instrument (Qualtrics, Provo, UT) one month before the start of the long course swim season (December 2018). Longitudinal data on long course swim performances for all strokes and distances (swim events) were obtained from Swimrankings (2021) during the long course swim season (January 2019–August 2019). Swimmers were divided into age groups according to their age on December 31, 2018 (KNZB, 2021). Therefore, all ages in the present study refer to the age categories in which swimmers participated during the 2018/2019 swim season and not to the swimmers' calendar ages.

Swimmers were included in the present study if they (1) were 12 years or older, (2) had completed the questionnaire in December 2018, and, if (3) information on swim performances for the 2018/2019 swim season was available.

1.2. Survey measures

The online questionnaire comprised three sections: general items, sport-specific items and SRL-related items.

General items. In the first section of the questionnaire, swimmers provided their personal details (e.g., date of birth and sex).

Sport-specific items. In the second section, swimmers responded to sport-specific items on their training sessions (e.g., the number of weekly training sessions, the number of hours of weekly swimming training, and their sport history).

SRL-related items. In the third section, six SRL subprocesses were assessed using various existing questionnaires (Toering et al., 2012b, 2013). We included items on processes of evaluation (6 items), planning (5 items), reflection (9 items) and speaking up – which can be considered as a SRL strategy (6 items), to measure the meta-cognitive aspect of SRL. Our instrument for measuring meta-cognitive SRL was based on the football-specific SRL questionnaire developed by Toering et al (2013). Respondents rated items using a 5-point Likert scale (1 = *never*, 2 = *seldom*, 3 = *sometimes*, 4 = *often*, 5 = *always*). Examples of items were as follows. Evaluation: "After each practice session, I think back and evaluate whether I did the right things to reach my practice goal." Planning: "Before each practice session, I plan my actions relative to the goal I want to attain during the practice session." Reflection: "During each practice session, I try to identify my strengths and think about ways to improve these even more." Speaking up: "If the coach changes an exercise and I don't understand the change, I ask the coach to explain."

The football-specific self-regulated learning questionnaire was developed as a self-report instrument to measure SRL used in daily football practice. Small adjustments were made to use the questionnaire in competitive swimming. Football-related terms (i.e. "football player" and "football skills) were replaced with swimming-related terms ("i.e. "swimmer" and "swimming skills"). Two planning items were removed because they did not apply to competitive swimming (e.g., "After each practice session, I stay to work on specific skills.") For the same reason, coaching-related items in the football-specific SRL questionnaire were not included in the present study.

Items on processes of self-efficacy (10 items) and effort (9 items) were included to measure the motivational aspect of self-regulation. The instrument for measuring motivational SRL processes was derived from the SRL-SRS questionnaire developed by Toering et al. (2012a, 2012b) and responses were scored using a 4-point Likert scale (1 = *almost never*, 2 = *sometimes*, 3 = *often*, 4 = *almost always*). Examples of items are as follows. Effort: "I put forth my best effort when performing tasks." Self-efficacy: "I am confident that I can deal efficiently with unexpected events."

Following Toering et al. (2013) we assigned five of the six SRL subprocesses to one of the three sequential phases of daily practice: before practice, during practice, or after practice. Planning aspects pertained to the time before training; aspects relating to speaking up, reflection and effort pertained to the time during training; and evaluation aspects pertained to the time after training. Self-efficacy was not confined to a particular training phase. Appendix A lists all SRL items in our questionnaire. Cronbach's α coefficients were calculated to determine the internal consistency of the measurements of the six SRL subprocesses. Measurements of all SRL subprocesses met the criterion value of $\alpha > 0.70$ (α between 0.75 and 0.89; Nunnally, 1978). The inter-scale correlations were calculated with Spearman correlations and did not exceed a value of 0.80 (r_s between 0.21 and 0.75; see Appendix B; Carron et al., 1985).

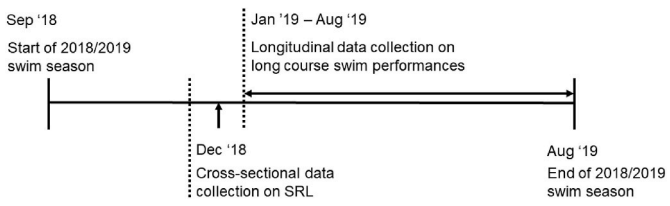

Figure 1. Schematic timeline of the data collection procedure
Note. The vertical arrow indicates the moment of cross-sectional data collection on training-centered SRL. The horizontal arrow indicates the time period in which longitudinal data collection of long course swim performances took place.

1.3. Performance measures

We collected longitudinal data on individual swimmers' performances for multiple swim events, which necessitated the use of a method for comparing swim performances between swim events to define the best swim performance of the 2018/2019 swim season. The method that we used was introduced by Stoter et al. (2019) in the context of speed skating and has also been applied in competitive swimming (Post et al., 2020a; 2020b). Following this method, we linked swim performances to the prevailing world record (WR) during the 2018/2019 swim season, known as relative Swim Time (rST). The rST denotes the absolute swim time as a percentage of the world record. In this study, rST was used to define swim performance (see equation 1).

$$\text{relative swim time (rST)} = \left(\frac{\text{swim time}}{\text{world record}}\right) * 100\% \quad \text{(eq. 1)}$$

Referring to the rST, we determined the best swim event of the

season for each swimmer. The best seasonal swim event was defined as the swim event with the lowest rST, reflecting the swim performance closest to the prevailing WR. Only the longitudinal data on the best seasonal swim event was selected for further analyses.

1.4. Defining performance level groups (part one)

In part one of the present study, swimmers were divided into two groups according to their performance levels: a high-level performance group or a lower-level performance group. We defined groups according to performance trajectories of international elite swimmers, representing the top 50 swimmers worldwide (FINA, 2021). Following Post et al. (2020a), we used the slowest seasonal best swim performance by age category, sex and swim event of these international elite swimmers as performance benchmark (maximum season's best rST per age category, sex and swim event). Swimmers whose seasonal best performances (season's best rST) fell within the performance benchmark were defined as high-level performers (n = 92). Conversely, those swimmers whose swim performances were not fast enough were defined as lower-level performers (n = 65; see Figure 2).

1.5. Defining performance progression groups (part two)

Part two of the present study included solely swimmers of the high-level performance group of part one with at least two recorded swim performances in their seasonal best swim event during the 2018/2019 swim season. Therefore, out of the total sample of 157 swimmers, 89 swimmers (49 males and 40 females) aged 12–20 years were included for further analysis (see Figure 2). These 89 swimmers were divided into an advanced progression group and a less advanced progression group, according to their progression level within a season.

Applying the method of Post et al. (2020b), we calculated the within-season performance progression of these swimmers during the period between the first swim performance of the season (first rST) and the season's best rST (see equation 2).

Again, we defined groups according to performance trajectories of international elite swimmers, representing the top 50 swimmers worldwide (FINA, 2021). The mean performance progression within a season of these international elite swimmers aged 12–21 years (by sex and swim event) was used as a progression benchmark for categorizing swimmers as advanced progressors or less advanced progressors (Post et al., 2020b). Swimmers who progressed as much as or more than the progression benchmark were defined as advanced progressors (n = 23), whereas swimmers whose progress did not reach the progression benchmark were defined as less advanced progressors (n = 66, see Figure 2). Youth swimmers in the advanced progression group (12 males and 11 females) were considered to be on track to becoming elite swimmers (i.e., belonging to the top 50 swimmers worldwide).

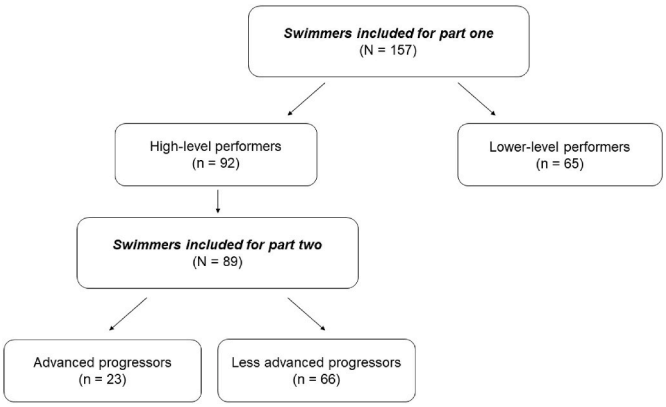

Figure 2. Schematic representation of the study sample

$$\text{performance progression within the season} = -\left(\frac{\text{current season's best rST} - \text{first rST}}{\text{first rST} - 100}\right)*100\% \quad \text{(eq. 2)}$$

1.6. Statistics

All data were analyzed using R (R Core Team, 2019). Descriptive statistics (mean scores and SDs) were calculated for the six self-regulation processes for (a) high-level performers and lower-level performers (part one) and (b) advanced and less advanced progressors (part two). To interpret the scores, effect sizes (Cohen's d values) were calculated. An effect size of approximately 0.20 was considered small, while effect sizes of 0.50 and 0.80 were considered moderate and large, respectively (Cohen, 1988).

Referring to the previous literature (see Jonker et al., 2011) and our own data, we conducted a preliminary multivariate analysis of variance (MANOVA), which showed that the engagement in SRL subprocesses was significantly related to weekly training hours but not to age and sex. Therefore, weekly training hours were included as covariates in the analyses conducted for both studies.

We included a multivariate analysis of covariance (MANCOVA) to examine differences in the application of SRL processes between (a) high-level and lower-level performers (part one) and (b) advanced and less-advanced progressors (part two). Pillai's trace was used as a test statistic. The six SRL processes were the dependent variables, performance level group (part one) or performance progression group (part two) was the independent variable, and weekly training hours was the covariate. When appropriate, a univariate analysis of covariance (ANCOVA) was separately performed on each of the dependent variables, with performance level group (part one) or performance progression group (part 2) as the independent variable. For the MANCOVA, $p < 0.05$ (two-tailed) was set as the significance level. For the ANCOVA, $p < 0.05$ (one-tailed) was set as the significance level.

A sensitivity power analysis using G* Power (Faul et al., 2007, 2009) confirmed that our statistical tests were sufficiently sensitive to detect significant differences with an effect size of 0.45 (study purpose 1) and of 0.60 (study purpose 2) (alpha = 0.05, power = 0.80). Statistical tests for measuring invariance were not performed given the nature of our dataset (relatively few observations for many items).

2. Results

Table 1 shows the descriptive characteristics according to performance level and progression (92 high-level performers; 65 lower-level performers; 23 high progressors, 66 lower progressors). Tables 2 and 3 show the mean scores and standard deviations for the six SRL subprocesses for performance level and progression groups and the corresponding effect sizes.

2.1. SRL subprocesses and performance level (part one)

The MANCOVA analysis revealed significant differences for performance level groups ($F_{(6,149)} = 2.659$; $p < 0.05$). The ANCOVA showed that high-level performers significantly outscored lower-level performers on reflection ($F_{(1,154)} = 3.067$; $p < 0.05$, $d = 0.28$). Moreover, the scores for effort of high-level and lower-level performers differed significantly, with the former having lower scores than the latter ($F_{(1,154)} = 3.354$; $p < 0.05$, $d = 0.29$). No significant differences between the two performance level groups were observed for evaluation ($F_{(1,154)} = 0.382$), planning ($F_{(1,154)} = 1.041$), speaking up ($F_{(1,154)} = 2.001$), and self-efficacy ($F_{(1,154)} = 0.583$), (all $p > 0.05$ with small effect sizes). Covariate weekly training hours were significant, indicating that swimmers who expended more weekly training hours reported higher scores for SRL subprocesses ($F_{(6,149)} = 3.018$; $p < 0.01$).

Table 1
Characteristics of swimmers according to performance level and progression (N = 157).

	Performance level groups (N = 157)				Performance progression groups (N = 89)			
	Lower-level performers (n = 65)		High-level performers (n = 92)		Less advanced progressors (n = 66)		Advanced progressors (n = 23)	
Characteristic	M	SD	M	SD	M	SD	M	SD
Age (years)	15.0	1.9	15.1	2.0	14.9	1.6	16.0 *	2.0
Swim training (hours per week)	9.8	3.8	11.2 *	4.4	10.8	4.4	12.7 *	3.9
Season's best rST (%)	123.4	8.2	117.3 *	7.6	118.7	7.5	112.8 *	6.1
Performance progression (%)	–	–	–		16.3	7.0	37.8 *	9.0

Note. Means (M) and standard deviation (SD) values for age, swim training hours per week and performance measures according to performance level and performance progression.
*p < 0.05 (one-tailed)

Table 2
Descriptive statistics for all self-regulated learning (SRL) subprocesses applied by swimmers according to performance level (N = 157).

	Lower-level performers (n = 65)		High-level performers (n = 92)		Effect sizes
SRL subprocess	M	SD	M	SD	*d*
Evaluation •	3.27	0.81	3.33	0.71	0.07
Planning •	3.26	0.97	3.39	0.91	0.15
Reflection •	3.42	0.79	3.61 *	0.60	0.28
Speaking up •	3.80	0.64	3.93	0.48	0.24
Effort ◆	3.55	0.33	3.44 *	0.41	0.29
Self-efficacy ◆	3.19	0.46	3.24	0.41	0.13

Note: Means (M) and standard deviation (SD) values for all self-regulated learning (SRL) subprocesses according to performance level.
• meta-cognitive subprocesses were measured using a 5-point Likert scale (range 1–5)
◆ motivational subprocesses were measured using a 4-point Likert scale (range 1–4)
*p < 0.05 (one-tailed)

Table 3
Descriptive statistics for all self-regulated learning (SRL) subprocesses for high-level performers according to performance progression within a season (N = 89).

	Less advanced progressors (n = 66)		Advanced progressors (n = 23)		Effect sizes
SRL subprocess	M	SD	M	SD	*d*
Evaluation •	3.26	0.79	3.58 *	0.31	0.47
Planning •	3.46	0.96	3.25	0.75	0.23
Reflection •	3.61	0.64	3.68	0.42	0.11
Speaking up •	3.92	0.52	3.96	0.36	0.09
Effort ◆	3.47	0.43	3.35	0.35	0.29
Self-efficacy ◆	3.22	0.42	3.28	0.39	0.16

Note. Means (M) and standard deviation (SD) values for all self-regulated learning (SRL) subprocesses according to performance progression.
• meta-cognitive subprocesses were measured using a 5-point Likert scale (range 1–5)
◆ motivational subprocesses were measured using a 4-point Likert scale (range 1–4)
*p < 0.05 (one-tailed)

2.2. SRL subprocesses and performance progression (part two)

The results of the MANCOVA analysis revealed significant differences for performance progression groups ($F_{(6,80)} = 3.451$; $p < 0.01$). The ANCOVA analysis showed that the scores of advanced progressors were significantly higher than those of less advanced progressors for evaluation ($F_{(1,85} = 3.611$; $p < 0.05$, $d = 0.47$). No significant differences between the two performance progression groups were observed for reflection ($F_{(1,85} = 0.219$), planning ($F_{(1,85} = 1.031$), speaking up ($F_{(1,85} = 0.167$), effort ($F_{(1,85} = 0.246$), and self-efficacy ($F_{(1,85} = 0.495$) (all $p > 0.05$ with small effect sizes). Covariate weekly training hours were not significant ($F_{(6,80)} = 1.040$; $p > 0.05$).

3. Discussion

We investigated training-centered SRL subprocesses in relation to performance levels and performance progression within a season of youth swimmers aged 12–21 years. After controlling for differences in weekly training hours, we found that swimmers in the high-level performance group scored significantly higher on reflection during training but significantly lower on effort than swimmers in the lower-level performance group (part one). Furthermore, a closer examination of the high-level performance group showed that those demonstrating greater improvement during the season significantly used evaluation processes after training more frequently compared with those evidencing less improvement during the season (part two). To the best of our knowledge, the present study is the first to investigate this combination of performance variables and SRL measures, providing new insights into the role of training-centered SRL in the development of swim expertise.

Our study provides an answer to the key question of whether youth swimmers who are on track to reach the elite level use SRL subprocesses more frequently during their daily training sessions than do those who are not on this track. An important matter while addressing this question is the way performance groups are defined, given that a different classification of performance groups may lead to different outcomes (Swann et al., 2015). It is noteworthy that we defined performance groups according to performance trajectories of international elite swimmers (i.e., the top 50 swimmers worldwide). Therefore, swimmers in the advanced progression group were youth swimmers who were considered to be on track of becoming elite swimmers (i.e., their performances and progression were at the benchmark levels). In other words, these swimmers are considered to have the potential to make it to the top 50 swimmers worldwide. When studying such talented swimmers, traditional null hypothesis testing may be limited due to small sample sizes, which are characteristic for elite sport (Skorski & Hecksteden, 2021). This could lead to insufficient power to detect significant differences with small effect sizes. Consequently, a small change in a variable may be interpreted as having no effect. However, small changes may be practically meaningful, especially in this research field (Gabbett et al., 2017). Therefore, in the interpretation of our results, effect sizes are of particular relevance as they convey the magnitude of the effect (Nuzzo, 2014). Another key point in our analyses is that we corrected for differences in weekly training hours, so that between-group differences in SRL subprocesses referred to differences in the individual characteristics of swimmers rather than to the consequences of more hours in training. Considering our methodological choices and statistical outcomes, we argue that youth swimmers who are on track to becoming elite swimmers are characterized by more frequent use of reflection processes during training (small to medium effect sizes) and evaluation processes after training (small to medium effect sizes).

In line with previous studies of Jonker et al. (2010a, 2010b, 2012) and Toering et al. (2009, 2012a, 2012b), our findings support the notion that reflection processes contribute to more efficient learning and, consequently, to the attainment of higher performance levels. Here, reflection refers to the ability to learn by looking back critically on

previous performances and to use new information in subsequent learning situations for self-improvement (Jonker et al., 2012). Our findings not only showed that swimmers in the high-level performance group significantly engaged more frequently in reflection processes during training compared with those in the lower-level performance group, but they also showed that these swimmers scored significantly lower (but still relatively high) for willingness to invest effort. In other words, high-performing swimmers seem to get more out of their training even though they put in relatively less work compared with swimmers who perform at a lower level. A possible explanation could be that high-performing swimmers who frequently engage in reflection during their training sessions carefully assess which tasks to expend effort in rather than expending effort in all situations. As a result, they may train more efficiently (Jonker et al., 2011). The ability to distinguish between what is important (main issues) and what is less important (side issues) is essential for achieving further progress toward goal attainment. Nevertheless, it is important to note that scores for effort were relatively high for all swimmers in our study. This finding, which is in line with findings of other studies (e.g., Jonker et al., 2010a; Toering et al., 2009), accords with the idea that youth athletes who aspire to make it to the top must be willing to expend maximal efforts (Ericsson et al., 1993). However, our findings highlight the importance of directing those efforts towards relevant tasks that contribute to performance development (Stam et al., 2020). Put differently, effort is evidently important but it is not enough. Moreover, our findings showed that high-performing swimmers tended to score higher on evaluation, planning, self-efficacy (negligible effect sizes), and speaking up (small to medium effect sizes), although these results were not statistically significant. Therefore, supported by our results, we argue that the engagement in training-centered SRL, and especially the frequent use of reflection during training sessions, is a fundamental characteristic of swimmers who are on track to becoming elite swimmers.

In addition to reflection, another notable SRL subprocess that seems to be typical for swimmers who are on track to reach the elite level is evaluation. We found that among high-performing swimmers, those who demonstrated more improvement within a season used evaluation processes after training more frequently compared with those who showed less improvement. Here, it is important to note that all high-performing swimmers demonstrated similar performance levels at the start of the season, but differed in their performance progression during the season. Consequently, their performance levels varied at the end of the season. Though advanced progressors tended to score higher for reflection, self-efficacy, and speaking-up (negligible effect sizes) and lower for planning and effort compared with less advanced progressors, evaluation was the only SRL subprocess that reached significance. Therefore, performance progression within a season seems to be related especially to evaluation after training, which is striking. According to Zimmerman (2000), evaluation is a subprocess of reflective thinking that is related to the result (self-judgement) rather than to a standard or goal (self-reaction). In particular, evaluation refers to the ability to assess both the learning process and the result achieved after task execution (Jonker, Elferink-Gemser, Toering, et al., 2010). The assessment of training outcomes in light of attainment goals may be a crucial starting point for further improvement. Swimmers who evaluate their training outcomes more frequently after training may, as a consequence, be better able to correct for weaknesses in their training program, and make appropriate adjustments in their training behavior or goals, thereby, achieving greater improvements during a season. In essence, evaluation processes may contribute to more effective learning.

A striking finding is that the meta-cognitive processes related to differences in the swimmers' performance levels and progression occurred during the same phase of the SRL cycle, namely the self-reflection phase. However, reflection and evaluation processes relating to daily training sessions, as measured in the present study, were assigned to different moments in time (before, during, and after training). These observations highlight two key points, namely the prominent role of the self-reflection phase in the SRL cycle relating to performance development and the dimension-transcending nature of SRL. Hence, we are well aware that swimmers may also use the same SRL subprocesses during other phases of the learning, training, or developmental processes (e.g., reflective processes after training and evaluative processes during training) that we did not measure. In light of our assessment of the swimmers' engagement in SRL before, during, and after training, we concluded that those swimmers who are on track to reach the elite level not only engage more frequently in SRL subprocesses during training (reflected, for example, in higher reflection scores) but also post-training (reflected, for example, in higher evaluation scores). Therefore, we suggest that the capacity to derive more from training may extend beyond the actual training time spent in the pool.

The present study sheds light on a unique and specific aspect of the SRL concept in relation to sports. However, it is important to realize that SRL is a dynamic, multidimensional construct, which can be viewed, measured, and applied across different dimensions (see the review of McCardle et al., 2019). Consequently, our findings relate to how we approached SRL: as a domain-specific aptitude (i.e., the consistency of SRL processes in competitive swimming) applied during daily training sessions (temporal framing). This means that specific SRL subprocesses are measured during specific phases of the training process (e.g., reflection processes are measured during a training session, whereas evaluation processes are measured after a training session). We believe that when used in combination with the included performance variables, and when corrections are made for differences in weekly training hours, the theoretical and practical relevance of our SRL approach is apparent, advancing understanding of progression toward elite level swimming performance.

From a theoretical perspective, the finding that training-centered SRL is not only related to performance level but also to progression within a season, provides an important link between the SRL framework and athletes' development of expertise. Whereas previous studies mainly promoted the idea that self-regulating athletes are able to derive more from training and likely to reach higher performance levels, our findings add to the body of literature, suggesting that performance progression within a season is an important link in understanding this relation. We found that high-performing swimmers who demonstrate greater improvements during a season (i.e., are on track to becoming elite swimmers) are characterized by more frequent use of reflection and evaluation processes in their daily training sessions. These individual characteristics are considered to contribute to more effective and efficient learning (and training), which may explain why these swimmers improve more during a season and, consequently, reach higher performance levels. Therefore, the present study contributes not only to a deeper understanding of the individual characteristics relating to advancement toward swimming expertise but it also sheds light on the potential underlying mechanisms that may partly explain why higher scores for SRL subprocesses are ultimately related to higher performance levels. This finding is strengthened by the finding that between-group differences in reflection and evaluation processes remained significant after controlling for differences in weekly training hours. Therefore, we suggest that swimmers who are on track to attain the elite level are able to get more out of their training in terms of quality and ultimately to benefit more from this ability by practicing for more hours in a week (see Table 1). These conclusions are in alignment with the theory of deliberate practice (DP; Baker et al., 2003; Deakin & Cobley, 2003; Ericsson et al., 1993)

Pursuing this line of reasoning, we suggest that future studies should examine the causal relationships among training-centered SRL, the quantity and quality of DP, and the development of sport expertise (McCardle et al., 2019). However, a number of issues need to be addressed beforehand. First, there is considerable inconsistency in the measurement of SRL subprocesses using subscales in self-reported questionnaires. For example, we used items describing the self-monitoring processes that were applied by Bartulovic et al. (2017)

to measure reflection processes during training. Moreover, we used a 4-point and 5-point Likert scale to measure SRL subprocesses, whereas Bartulovic et al. (2017) applied a 7-point Likert scale. Such refined scale is recommended for future studies, as it could increase the power of statistical tests and, thus, the sensitivity to detect significant differences, also with small effect sizes (Wasserstein & Lazar, 2016). The inconsistency in the measurement of SRL subprocesses makes it difficult to compare findings between studies. However, this issue is not new in the literature on elite sports (see Swann et al., 2015) and psychology (see Dohme et al., 2017) and a similar approach (e.g., a systematic review) could help to create more consistency and common ground in the measurement of SRL subprocesses.

Second, there is a further need to develop reliable and valid methods for mapping the quantity and quality of DP (Baker et al., 2020). To establish causal relationships between SRL, DP and performance development, variables such as weekly training hours should be further specified in terms of DP. Moreover, given that SRL is considered as a factor that contributes to the quality of DP, it would be interesting not only to examine the quantity of training-centered SRL subprocesses (as in the present study) but also their quality. For example, reflection and evaluation processes could be analyzed in relation to goal-setting and goal-evaluation standards. Finally, the present study was the first to introduce both performance level and performance progression measures in SRL. However, we were unable to include longitudinal data on SRL because of COVID-19 restrictions. Rather than cross-sectional research, longitudinal studies extend beyond a single moment in time and measure within-person change. This can enhance our understanding of how phenomena unfold over time and is a prerequisite to draw causal inferences (Stenling et al., 2017). Given the significant developmental changes that occur in maturing swimmers, the inclusion of longitudinal data would have been highly relevant for advancing the understanding of how age and developmental status could impact on the engagement and value of SRL in sport. Therefore, when studying the development of sport expertise, we call for the inclusion of longitudinal data on all key parameters (SRL, DP, and performance measures) in future studies. Such longitudinal studies could further examine whether SRL is an underlying individual characteristic with predictive value for future elite swimming performances.

3.1. Practical implications

Given time constraints that affect the trajectory for reaching elite status, it is essential to get the most out of each training, especially in a competitive, globalized sport like competitive swimming. Therefore, effective and efficient learning (and training) is fundamental for swimmers who aspire to make it to the top. Consequently, it could be valuable to monitor and develop SRL subprocesses, especially those relating to reflection and evaluation, during daily training sessions. The more frequent use of these SRL subprocesses are shown to be characteristic for swimmers who improved more during a season and reached higher performance levels. Therefore, coaches could encourage swimmers to reflect more frequently on their strengths and weaknesses during training sessions and to assess their training outcomes in relation to the attainment of their goals after training. Moreover, coaches could help swimmers to focus and expend effort on the main tasks that matter most rather than on side tasks that are less important. Finally, coaches and swimmers should be aware that effective and efficient learning is an ongoing process, which does not necessarily stop after the training session ends.

4. Conclusion

The results of this study have shown that swimmers who are on track to becoming elite swimmers are characterized by higher scores on reflection and evaluation processes entailed in daily training sessions. The more frequent use of SRL subprocesses during and after training among swimmers who are on track to reach the elite level suggests that they learn and train in a more efficient and effective way. Moreover, our findings suggest that, compared with their peers, these swimmers may benefit more from training because they are more actively involved in their learning process both in and out of the water. Ultimately, this proactive involvement could contribute to a higher quality of daily training, which may result in greater improvements during a season, higher performance levels, and a greater chance of reaching the level of elite swimming performance.

Author statement

A. K. P: investigation, data curation, formal analysis, and drafting the original manuscript; R. H. K: data curation, formal analysis; C. V.: conceptualization, supervision, writing, review, and editing; M.T. E-G: conceptualization, supervision, writing, review, and editing.

Funding

We did not receive any funding for the writing of this article.

Declaration of interests

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

Acknowledgements

We would like to thank Swimrankings for making swimming results publicly available, thereby enabling us to conduct this study. We would also like to thank the Koninklijke Nederlandse Zwembond and Inno-SportLab de Tongelreep for their support.

Appendix A

Items for each self-regulated learning (SRL) subprocess

SRL subprocess	Items
Evaluation	Each practice session I think back and evaluate whether I did the right things to become a better swimmer. After each practice session I think back at situations I've been through during practice and use this information to practice specific situations either alone or together with others. Each practice session I keep track of my performance during practice, so that I can see which swim skills I must improve (for example, technique, tactics). After each practice session I think back and evaluate whether I did the right things to reach my practice goal. After each practice session I think about what I did right and wrong during the session.

(*continued on next page*)

(*continued*)

SRL subprocess	Items
	After each practice session I think back at specific practice situations and what I did right and wrong.
Planning	I have a clear goal for each practice session. Before each practice session I plan which skills I want to work on during the session. Each practice session I use information from TV/internet/live swim matches to become a better swimmer. Before each practice session I plan my actions relative to the goal I want to attain during the practice session. Each practice session I use information from books, magazines, and interviews about elite swimmers to develop myself as a swimmer.
Reflection	Each practice session I think about both my strengths and weaknesses and of ways that I can improve them. During each practice session I check whether I make progress in my swimming skills. I know my strengths and weaknesses and at each practice session I plan how I can improve them. During each practice session I keep track of my swim performance relative to my practice goal (so that I know where I stand). Each practice session I try to identify my strengths and think about ways to improve these even more. Each practice session I work on my strengths and weaknesses because I believe in my potential as a swimmer. Each practice session I focus on my practice goal. During each practice session I check what I still have to do to reach my practice goal. Each practice session I try to identify my weaknesses and think about how to improve these.
Speaking up	If I don't understand the coach's explanation, I ask the coach about it. During practice I ask for help if I need help to improve my swim performance/swim skills. Each practice session I ask the coach what I can do to become a better swimmer. Each practice session I discuss with my coach which aspects of my swim performance need improvement. If the coach changes an exercise and I don't understand the change, I ask the coach to explain. During practice I speak up if I don't understand something or if I don't agree with teammates or the coach.
Effort	I keep working even on difficult tasks. I put forth my best effort when performing tasks. I concentrate fully when I do a task. I don't give up even if the task is hard. I work hard on a task even if it is not important. I work as hard as possible on all tasks. I work hard to do well even if I don't like a task. If I'm not really good at a task I can compensate for this by working hard. I am willing to do extra work on tasks in order to learn more.
Self-efficacy	I know how to handle unforeseen situations, because I can well think of strategies to cope with things that are new to me. I am confident that I could deal efficiently with unexpected events. If I am in a bind, I can usally think of something to do. I remain calm when facing difficulties, because I know may ways to cope with difficulties. I always manage to solve difficult problems if I try hard enough. It is easy for me to concentrate on my goals and to accomplish them. I can solve most problems if I invest in the necessary effort. When I am confronted with a problem, I usually find several solutions. No matter what comes my way, I'm usually able to handle it. If I persist on a task, I'll eventually succeed.

Note. Evaluation[a]: the ability to assess both the learning process and the result achieved after task execution. Planning[a]: awareness of the demands of a task before its execution. Reflection[a]: the extent to which respondents are able to appraise what they have learned and to adapt their past knowledge and experiences to improve themselves. Speaking up[b]: taking initiative in searching feedback. Effort[a]: willingness to attain the task goal. Self-efficacy[a]: judgement of one's capability to organize and execute the required action.

[a] Jonker, Elferink-Gemser, Toering, et al. (2010), [b] Toering et al. (2013)

Appendix B

Cronbach's α and Spearman correlations for self-regulated learning (SRL) subprocesses.

Scale	Chronbach's α	*1*	*2*	*3*	*4*	*5*	*6*
Evaluation	0.84	–	0.67	0.75	0.39	0.44	0.30
Planning	0.75		–	0.67	0.32	0.45	0.30
Reflection	0.89			–	0.38	0.50	0.29
Speaking up	0.75				–	0.21	0.26
Effort	0.82					–	0.45
Self-efficacy	0.84						–

Note. All Spearman correlations are significant ($p < 0.01$).

References

Allen, S. V., Vandenbogaerde, T. J., & Hopkins, W. G. (2014). Career performance trajectories of Olympic swimmers: Benchmarks for talent development. *European Journal of Sport Science, 14*(7), 643–651. https://doi.org/10.1080/17461391.2014.893020

Baker, J., Côté, J., & Abernethy, B. (2003). Learning from the experts: Practice activities of expert decision makers in sport. *Research Quarterly for Exercise & Sport, 74*(3), 342–347. https://doi.org/10.1080/02701367.2003.10609101

Baker, J., & Young B., Tedesqui, R., & McCardle, L. (2020). Handbook of Sport Psychology. In G. Tenenbaum & R.C. Eklund, R.C (Eds.). New perspectives on deliberate practice and the development of sport expertise (4th ed., pp. 556-577). John Wiley & Sons.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* W H Freeman/Times Books/ Henry Holt & Co.

Bartulovic, D., Young, B. W., & Baker, J. (2017). Self-regulated learning predicts skill group differences in developing athletes. *Psychology of Sport and Exercise, 31*, 61–69. https://doi.org/10.1016/j.psychsport.2017.04.006

Carron, A. V., Widmeyer, W. N., & Brawley, L. R. (1985). The development of an instrument to assess cohesion in sport teams: The group environment questionnaire. *Journal of Sport & Exercise Psychology, 7*(3), 244–266. https://doi.org/10.1123/jsp.7.3.244

Cleary, T. J., & Zimmerman, B. J. (2001). Self-regulation differences during athletic practice by experts, Non-Experts, and Novices. *Journal of Applied Sport Psychology, 13*(2), 185–206. https://doi.org/10.1080/104132001753149883

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Deakin, J. M., & Cobley, S. (2003). An examination of the practice environments in figure skating and volleyball: A search for deliberate practice. In J. Starkes, & K. A. Ericsson (Eds.), *Expert performance in sports: Advances in research on sport expertise* (pp. 115–135). Human Kinetics.

Dohme, L.-C., Backhouse, S., Piggott, D., & Morgan, G. (2017). Categorising and defining popular psychological terms used within the youth athlete talent development literature: A systematic review. *International Review of Sport and Exercise Psychology, 10*(1), 134–163. https://doi.org/10.1080/1750984X.2016.1185451

Elferink-Gemser, M. T., De Roos, I., Torenbeek, M., Fokkema, T., Jonker, L., & Visscher, C. (2015). The importance of psychological constructs for training volume and performance improvement. A structural equation model for youth speed skaters. *International Journal of Sport Psychology, 46*(6), 726–744. https://doi.org/10.7352/IJSP.2015.46.726

Ericsson, K. A., Krampe, R. T., & Tesch-Römer, C. (1993). The role of deliberate Practice in the acquisition of expert performance. *Psychological Review, 100*(3), 363–406. https://doi.org/10.1037/0033-295x.100.3.363

Ertmer, P. A., & Newby, T. J. (1996). The expert learner: Strategic, self-regulated, and reflective. *Instructional Science, 24*(1), 1–24. https://doi.org/10.1007/BF00156001

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149–1160.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Fédération Internationale de Natation (FINA). (2021, March 17). Swimming rankings. https://www.fina.org/swimming/rankings.

Gabbett, T. J., Nassis, G. P., Oetter, E., Pretorius, J., Johnston, N., Medina, D., Rodas, G., Myslinski, T., Howells, D., Beard, A., & Ryan, A. (2017). The athlete monitoring cycle: A practical guide to interpreting and applying training monitoring data. *British Journal of Sports Medicine, 51*(20), 1451–1452. https://doi.org/10.1136/bjsports-2016-097298

Howe, M. J. A., Davidson, J. W., & Sloboda, J. A. (1998). Innate talents: Reality or myth? *Behavioral and Brain Sciences, 21*(3), 399–442. https://doi.org/10.1017/S0140525X9800123X

Jonker, L. (2011). *Self-regulation in sport and education: Important for sport expertise and academic achievement for elite youth athletes*. [Doctoral dissertation, University of Groningen. https://research.rug.nl/en/publications/self-regulation-in-sport-and-education-important-for-sport-expert.

Jonker, L., Elferink-Gemser, M. T., de Roos, I. M., & Visscher, C. (2012). The role of reflection in sport expertise. *The Sport Psychologist, 26*(2), 224–242.

Jonker, L., Elferink-Gemser, M. T., Toering, T. T., Lyons, J., & Visscher, C. (2010). Academic performance and self-regulatory skills in elite youth soccer players. *Journal of Sports Sciences, 28*(14), 1605–1614. https://doi.org/10.1080/02640414.2010.516270

Jonker, L., Elferink-Gemser, M. T., & Visscher, C. (2010). Differences in self-regulatory skills among talented athletes: The significance of competitive level and type of sport. *Journal of Sports Sciences, 28*(8), 901–908. https://doi.org/10.1080/02640411003797157

Koninklijke Nederlandse Zwembond (KNZB). (2021). Topsport en talentontwikkeling. June 14) https://www.knzb.nl/vereniging_wedstrijdsport/wedstrijdsport/zwemmen/topsport/.

McCardle, L., Young, B. W., & Baker, J. (2019). Self-regulated learning and expertise development in sport: Current status, challenges, and future opportunities. *International Review of Sport and Exercise Psychology, 12*(1), 112–138. https://doi.org/10.1080/1750984X.2017.1381141

Nunnally, J. C. (1978). An overview of psychological measurement. In B. B. Wolman (Ed.), *Clinical diagnosis of mental disorders* (pp. 97–146). Springer. https://doi.org/10.1007/978-1-4684-2490-4_4.

Nuzzo, R. (2014). Scientific method: Statistical errors. *Nature, 506*, 150–152. https://doi.org/10.1038/506150a

Post, A. K., Koning, R. H., Stoter, I. K., Visscher, C., & Elferink-Gemser, M. T. (2020b). Interim Performance Progression (IPP) during consecutive season best performances of talented swimmers. *Frontiers in sports and active living, 2*, Article 579008. https://doi.org/10.3389/fspor.2020.579008

Post, A. K., Koning, R. H., Visscher, C., & Elferink-Gemser, M. T. (2020a). Multigenerational performance development of male and female top-elite swimmers-A global study of the 100 m freestyle event. *Scandinavian Journal of Medicine & Science in Sports, 30*(3), 564–571. https://doi.org/10.1111/sms.13599

R Core Team. (2019). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. URL Version 3.6.0. https://www.R-project.org.

Reverberi, E., Gozzoli, C., D'Angelo, C., Lanz, M., & Sorgente, A. (2021). The self-regulation of learning - self-report scale for sport practice: Validation of an Italian version for football. *Frontiers in Psychology, 12*, Article 604852. https://doi.org/10.3389/fpsyg.2021.604852

Skorski, S., & Hecksteden, A. (2021). Coping with the "small sample - small relevant effects" dilemma in elite sport research. *International Journal of Sports Physiology and Performance, 16*(11), 1559–1560. https://doi.org/10.1123/ijspp.2021-0467

Stam, F., Kouzinou, S., Visscher, C., & Elferink-Gemser, M. T. (2020). The value of metacognitive skills and intrinsic motivation for current and future sport performance level in talented youth athletes. *Psychology, 11*(2), 326–339. https://doi.org/10.4236/psych.2020.112021

Starkes, J. (2000). The road to expertise: Is practice the only determinant? *International Journal of Sport Psychology, 31*(4), 431–451.

Stenling, A., Ivarsson, A., & Lindwall, M. (2017). The only constant is change: Analysing and understanding change in sport and exercise psychology research. *International Review of Sport and Exercise Psychology, 10*(1), 230–251. https://doi.org/10.1080/1750984X.2016.1216150

Stoter, I. K., Koning, R. H., Visscher, C., & Elferink-Gemser, M. T. (2019). Creating performance benchmarks for the future elites in speed skating. *Journal of Sports Sciences, 37*(15), 1770–1777. https://doi.org/10.1080/02640414.2019.1593306

Swann, C., Moran, A., & Piggott, D. (2015). Defining elite athletes: Issues in the study of expert performance in sport psychology. *Psychology of Sport and Exercise, 16*, 3–14. https://doi:10.1016/j.psychsport.2014.07.004.

Swimrankings. March 17). *Ranglijsten* https://www.swimrankings.net/index.php?page=rankingDetail&club=NED, (2021).

Tedesqui, R. A., & Young, B. W. (2015). Perspectives on active and inhibitive self-regulation relating to the deliberate practice activities of sport experts. *Talent Development and Excellence, 7*(1), 29–39.

Toering, T., Elferink-Gemser, M. T., Jordet, G., Pepping, G.-J., & Visscher, C. (2012a). Self-regulation of learning and performance level of elite youth soccer players. *International Journal of Sport Psychology, 43*(4), 312–325.

Toering, T. T., Elferink-Gemser, M. T., Jordet, G., & Visscher, C. (2009). Self-regulation and performance level of elite and non-elite youth soccer players. *Journal of Sports Sciences, 27*(14), 1509–1517. https://doi.org/10.1080/02640410903369919

Toering, T., Gemser, M., Jonker, L., van Heuvelen, M., & Visscher, C. (2012b). Measuring self-regulation in a learning context: Reliability and validity of the self-regulation of learning self-report scale (SRL-SRS). *International Journal of Sport and Exercise Psychology, 10*(1), 24–38. https://doi.org/10.1080/1612197X.2012.645132

Toering, T., Jordet, G., & Ripegutu, A. (2013). Effective learning among elite football players: The development of a football-specific self-regulated learning questionnaire. *Journal of Sports Sciences, 31*(13), 1412–1420. https://doi.org/10.1080/02640414.2013.792949

Wasserstein, R. L., & Lazar, N. A. (2016). The ASA statement on p-values: Context, process and Purpose. *The American Statistician, 70*(2), 128–133. https://doi.org/10.1080/00031305.2016.1154108

Young, B. W., Eccles, D. W., Williams, A. M., & Baker, J. (2021). K. Anders Ericsson, deliberate practice, and sport: Contributions, collaborations, and controversies. *Journal of Expertise, 4*(2).

Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology, 11*(4), 307–313. https://doi.org/10.1016/0361-476X(86)90027-5

Zimmerman, B. J. (2000). Attaining self-regulation: A social cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press. https://doi.org/10.1016/B978-012109890-2/50031-7.

Zimmerman, B. J. (2006). Development and adaptation of expertise: The role of self-regulatory processes and beliefs. In K. A. Ericsson, N. Charness, P. J. Feltovich, & R. R. Hoffman (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 705–722). Cambridge University Press. https://doi.org/10.1017/CBO9780511816796.039.

Zimmerman, B. J. (2011). Motivational sources and outcomes of self-regulated learning and performance. In B. J. Zimmerman, & D. H. Schunk (Eds.), *Handbook of self-regulation of learning and performance* (pp. 49–64). Routledge/Taylor & Francis Group.

Zimmerman, B. J., & Paulsen, A. S. (1995). Self-monitoring during collegiate studying: An invaluable tool for academic self-regulation. *New Directions for Teaching and Learning, 1995*(63), 13–27. https://doi.org/10.1002/tl.37219956305