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The Temporal Ordering of Motivation and Self-Control: A Cross-Lagged Effects Model

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Abstract

Mechanisms leading to cognitive energy depletion in performance settings, such as high-level sports, highlight likely associations between individuals' self-control capacity and their motivation. Investigating the temporal ordering of these concepts combining the self-determination theory and psychosocial self-control theories, we hypothesized that athletes' self-control capacity would be more influenced by their motivation than vice versa, and that autonomous and controlled types of motivation would predict self-control capacity positively and negatively, respectively. High-level winter sport athletes from [name masked for review] elite sport colleges ($N = 321$; 16–20 years) consented to participate. Using Bayesian structural equation modeling and three-wave analyses, findings revealed credible self-control → motivation → self-control cross-lagged effects. Athletes' trait self-control especially initiated the temporal ordering of the least controlled types of motivation (i.e., intrinsic, integrated, and amotivation). Findings indicate that practicing self-control competencies and promoting athletes' autonomous types of motivation are important components in the development toward the elite level. These components will help athletes maintain their persistent goal striving by increasing the value and inherent satisfaction of the development process, avoiding the debilitating effects of self-control depletion and exhaustion.

Keywords: motivation regulations, self-control, youth athlete, cross-lagged model, Bayesian structural equation modeling

Introduction

In [name masked for review], athletes often attend elite sport colleges facilitating the combination of education and elite sport development. These colleges are located in different parts of the country, and many athletes live far away from home with limited family support. As such, youth athletes' ability to regulate behaviors and control thoughts, emotions, attention, and cognitive impulses is important in order to successfully reach long-term goals (Baumeister & Vohs, 2016; Englert, 2016, 2017). This self-control strength will likely help athletes in their strenuous physical and mental exercises, as it makes them persistent and focused in the face of adversity and better at volitionally controlling their emotions and attention as they enter important competitions (Englert, 2017). In addition, athletes' types of motivation stem from a variety of sources, ranging from intrinsic and autonomously motivated behaviors inspired by genuine interest and inherent satisfaction to amotivation and nonintentional behaviors performed without athletes' control (Jordalen, Lemyre, & Durand-Bush, 2019; Ryan & Deci, 2000). This multidimensional motivation profile prompts youth athletes' sport endeavors as they intrinsically enjoy hours of activity in their sport, while they simultaneously head toward increasing their capacity beating their own personal best as well as other opponents. These various types of motivation have been found to associate with more or less successful outcomes. The more autonomous types of motivation do energize self-regulatory behaviors, thus have been associated with energy maintenance and importantly lower levels of depletion (Jordalen, Lemyre, Solstad, & Ivarsson, 2018; Ryan & Deci, 2008). In addition, shifts in the quality of motivation across a competitive season have been found to reliably predict burnout susceptibility among elite athletes (Lemyre, Treasure, & Roberts, 2006). As such, a better understanding of the psychology behind youth athletes' behaviors and actions requires an investigation of the interrelated processes of human motivation and cognition (Baumeister, 2016). In this article, we investigated the temporal ordering of motivation and self-control—key concepts that facilitate athletes' development throughout a competitive season.

Many youth athletes enjoy their engagement in sport activities while simultaneously competing at high levels adapting their actions to facilitate development and perhaps, one day, become world champions. They may not only differ in quantity of motivation (i.e., total amount of motivation; Gould, 1996), but also in quality of motivation (i.e., type of motivation; Lemyre, Roberts, & Stray-Gundersen, 2007). Within self-determination theory (SDT; Ryan & Deci, 2000), human motivation is considered along a continuum composed of three types of autonomous motivation regulation (i.e., intrinsic, integrated, and identified), two types of controlled motivation regulation (i.e., introjected and external) and one type of nonregulated motivation (i.e., amotivation). Autonomously motivated athletes are driven by genuine interest that is fueled by intrinsically felt rewards, and their activities are experienced as meaningful (Ryan & Deci, 2000). Conversely, more controlled types of motivation differ in degree of self-determination, and athletes are fueled by the value and utility of workouts or are solely guided by their coaches. They may experience disinterest and no personal causation. As such, actions motivated by autonomous or controlled reasons will lead to qualitatively different experiences and performances, as motives typically guide direction, intensity, and persistence of youth athletes' development (Cerasoli, Nicklin, & Ford, 2014). For example, athletes motivated by autonomous reasons will experience less inhibition and control, leading to increased psychological energy and prolonged engagement (Ryan & Deci, 2008). Thus, it seems that autonomous reasoning is key to healthy youth sport development (Ryan & Deci, 2000), even though athletes are likely driven by various types of motivation at once (Chantal, Guay, Dobreva-Martinova, & Vallerand, 1996). A pure autonomous motivation profile may not exist in sport (Gillet, Vallerand, & Rosnet, 2009), and research needs to go beyond the unique framework of motivation theories and emphasize cognitive psychological aspects of youth athletes' sport performance to better understand what drives these athletes in a competitive context over time.

Self-control, the effortful subset of self-regulation, empowers cognitive competencies and directs attention away from tempting stimuli (e.g., stay up late with friends resulting in excessive fatigue negatively affecting their subsequent training) that interfere with youth athletes' planned actions and long-term goals (e.g., training for finishing a long-distance race; Baumeister, Vohs, & Tice, 2007). This volitional ability is crucial in athletes' everyday life, as they are confronted with challenging situations in training and competitions (e.g., maintain focus and concentration in high-pressure contexts; Englert, 2017). The strength model (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister et al., 2007) has conceptually informed the majority of research on self-control. This model is based on the notion that both state and trait self-control depends on limited resources, and becomes temporary impaired when used sequentially. This leaves the individual in a state labelled ego-depletion, where further acts of self-control are prone to failure (Baumeister et al., 2007).

Investigating self-control strength, studies have used a common research design where participants perform two separate, independent tasks, both requiring self-control (e.g., individuals who regulated their emotions to an upsetting movie experienced reduced physical stamina; Baumeister & Vohs, 2016; see Muraven, Tice, & Baumeister, 1998). Typically, individuals spend effort on the first task, thus less remains for the second task and performance suffers. Depletion inhibits inhibition, and individuals' top-down control is impaired allowing more bottom-up automatic responses without restraint or inhibition (i.e., this increases a range of impulsive, disinhibited behaviors, and individuals are not aware of their conscious attitudes). However, trait measures as opposed to state measures of self-control are more stable across situations and over time, and are rather individually determined (Anusic & Schimmack, 2016; de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). As athletes' state self-control is more susceptible to situational influences, it is assumed that high trait self-control is preferable as this makes athletes better at controlling impulses regardless of context and situation (e.g., whether in training or competitions, high vs. low pressure situations; de Ridder et al., 2012; Englert, 2017; Tangney, Baumeister, & Boone, 2004). High trait self-control, as opposed to state self-control, may also reduce the risk of experiencing a state of ego-depletion, even though both trait and state self-control are prone to depletion just as a muscle gets tired from exertion (Baumeister et al., 2007; de Ridder et al., 2012). Within the self-control literature, much attention has been given to the processes leading to depletion patterns and whether they actually cause depletion (Hagger & Chatzisarantis, 2016; Lee, Chatzisarantis, & Hagger, 2016; Tuk, Zhang, & Sweldens, 2015). For example, when depleted participants went through a brief period of mindfulness meditation or were provided incentives or choice, this helped sustain their self-control performance (Friese, Messner, & Schaffner, 2012; Moller, Deci, & Ryan, 2006; Muraven & Slessareva, 2003).

Analyzing arguments in defense or against the ego-depletion effect, Friese, Loschelder, Gieseler, Frankenbach, & Inzlicht (2019) concluded that "…despite several hundred published studies, the available evidence is inconclusive" (p. 107). Attempting to explain alternative mechanisms behind self-control performance and gaining a more precise account of depletion processes, a revision of the strength model resulted in the process model of depletion (Inzlicht & Schmeichel, 2012). The process model proposes that shifts in individuals' motivation, attention, and emotions, as well as an imbalance in internal and external motives, are associated with regulatory failures (Inzlicht, Schmeichel, & Macrae, 2014). Motivational shifts are explained in an evolutionary psychology perspective—they serve an adaptive function of redirecting behavior toward activities with increasing inherent utility. 'Have-to tasks' are motivated by a sense of duty or obligation and need energy to be sustained (cf. more controlled types of motivation), whereas 'want-to tasks' are motivated by interest and enjoyment and are more easily maintained (cf. more autonomous types of motivation; Inzlicht et al., 2014; Ryan & Deci, 2000). In this sense, motivation moderates depletion, and it seems that individuals' motivation highly affects their self-control capacity and vice versa. According to the process model of depletion, shifts in motivation are caused by acts of self-control, and individuals subsequently prefer activities that are enjoyable and gratifying (i.e., autonomously motivated behaviors) over activities that require effort (i.e., controlled motivated behaviors). Thus, individuals' self-control performance is impaired as a function of changed motivation in subsequent acts of self-control.

One explanation of self-control as a potential determinant of motivation quality is that individuals high in trait self-control may be more likely to possess higher autonomous reasons for their actions, as they find more interest and/or meaning in what they are doing even though they are navigating through both conflicting and sometimes tedious tasks (Converse, Juarez, & Hennecke, 2019; Holding, Hope, Verner-Filion, & Koestner, 2019). Converse and colleagues (2019) examined associations between trait self-control and autonomous and controlled motivation in a series of studies, and they favored the interpretation that self-control especially affects autonomous motivation. In the SDT literature, it is outlined that self-control may influence goal internalization processes, as "the types of behaviors and values that can be assimilated to the self increase with growing cognitive and ego capacities" (Deci and Ryan, 2000, p. 63). Furthermore, it is reasoned that self-control and autonomous motivation have mutual links to ease of goal pursuit and task construal (Holding et al., 2019). Longitudinally, trait self-control positively and negatively predicts autonomous and controlled motivation beyond other possible determinants of motivation quality, respectively (e.g., the Big Five personality traits; Holding et al., 2019). However, these recent studies did not provide direct causal evidence for one specific temporal ordering between these concepts, as they did not examine all possible causal associations (e.g., autonomous motivation on trait self-control; Jose, 2016).

In the SDT model of vitality, Ryan and Deci (2008) suggest that more autonomously driven self-control is less depleting as compared to when individuals are driven by more external forces, draining energy. Autonomously motivated acts of self-control are experienced as harmonious and efficient, requires less inhibition, and is related to reduced temptations (e.g., see Milyavskaya, Inzlicht, Hope, & Koestner, 2015). More externally controlled acts of self-control are often associated with pressure and tension requiring greater resources by the individual. As a result, individuals will possess maintained vitality and less depletion, or contrary, significantly lower levels of vitality and higher risk of depletion, respectively. Summarized, motivational explanations of ego depletion suggest on the one hand, that youth athletes' self-control performance is impaired as a function of changed motivation in subsequent acts of self-control (Inzlicht et al., 2014); and on the other hand, that self-control behaviors are associated with external motivational forces draining athletes' psychological energy (Ryan & Deci, 2008). As such, these motivational explanations of self-control depletion suggest that cognition and youth athletes' self-control direct motivation and vice versa, respectively.

Conceptually, it seems that the type rather than total amount of motivation reflected in self-control efforts is important. Though, the method of evaluating the various types of motivation has been debated, concerned to testing motivation regulations individually, using aggregates like autonomous and controlled motivation, or calculating a motivational index (e.g., the RAI/SDI; Chemolli & Gagne, 2014). Calculating an index, this score may mask important results and the unique contribution of each individual regulation, thus results are less reliable (Chemolli & Gagne, 2014). Widely used, aggregates have also been described as oversimplifications that do not account for the nuanced perspective of each motivation regulation (Cerasoli et al., 2014). Finally, testing motivation regulations individually allows the different regulations yield different outcomes (Chemolli & Gagne, 2014). Autonomous versus controlling motivational incentives are likely associated with self-control behaviors and reduced or increased ego-depletion, respectively. In this interaction with autonomous motivation, acts of self-control will lead to positive sport participation outcomes, such as increased well-being, whereas acts of controlled motivation will induce self-control depletion and even more severe experiences such as athlete burnout (Briki, 2016; Cresswell & Eklund, 2005; Jordalen et al., 2018; Muraven, 2008; Ryan & Deci, 2008). However, the individual contribution of each motivation regulation and the ordering of motivation and self-control constructs is unclear (e.g., Converse et al., 2019), and have not been studied explicitly in youth winter sport participants previously. Guided by the SDT and self-control literature theoretical frameworks (Baumeister et al., 1998; Baumeister et al., 2007; Inzlicht & Schmeichel, 2012; Ryan & Deci, 2000, 2008), we hypothesized that youth athletes' self-control capacity will be more influenced by the type of motivation that inspires behavior than vice versa. We suggest that autonomous and controlled types of motivation positively and negatively predict trait self-control, respectively. The motivational regulations were evaluated individually in six different models, as this method allowed testing independent effects of each motivation regulation and the complexities of motivation associated with self-control competencies. As such, the current study investigates the reciprocal associations of various types of motivation and trait self-control over time.

Methods

Participants

A total of 321 youth winter sport athletes (173 males, 98 females; aged 16 to 20 years, *M* = 17.98, *SD* = 0.89) attending elite sport colleges in [name masked for review] consented to participate. Athletes competed in cross-country skiing (*n* = 122), biathlon (*n* = 64), ski jumping (*n* = 15), alpine skiing (*n* = 63), and Nordic combined (*n* = 7). Competitive experiences (CE) ranged from 1–16 years (*M* = 7.86 years, *SD* = 2.93), and athletes competed at international (*n* = 54), national (*n* = 193), or regional levels (*n* = 24). Descriptive information was collected at time point 1 (T1). Athletes who only participated at time point 2 (T2) and/or 3 (T3) did not report descriptive statistics (T1 *n* = 271; T2 *n* = 201; and T3 *n* = 197).

Measures

Motivation. A [name masked for review] version [reference masked for review] of the Sport Motivation Scale II (SMS-II; Pelletier, Rocchi, Vallerand, Deci, & Ryan, 2013) measured athletes' motivational regulations, and response options ranged from 1 (*does not correspond at all*) to 7 (c*orresponds completely*). Latent variable modeling was used to evaluate scale reliability (ρ; see Table 1 in Supplemental online material; Raykov, 2009). This method offers scale reliability point estimates and identifies potentially weak components of a scale, inspecting loading, variance estimates, and standard errors. Each motivation regulation included three items, and participants reported the extent to which the listed reasons for practicing their sport corresponded with their own personal reasons. The assessed regulations were intrinsic (e.g., "because it is very interesting to learn how I can improve"), integrated (e.g., "because participating in sport is an integral part of my life"), identified (e.g., "because I have chosen this sport as a way to develop myself"), introjected (e.g., "because I feel better about myself when I do"), external (e.g., "because people around me reward me when I do"), and amotivated (e.g., "it is not clear to me anymore; I don't really think my place is in sport").

Self-control. A [name masked for review] version (Toering & Jordet, 2015) of the Brief Self-Control Scale (BSCS; Tangney et al., 2004) assessed athletes' dispositional self-control abilities (13 items, e.g., "I am good at resisting temptations"). Items 6 and 8 were deleted due to low factor loadings (< .20; Kline, 2011). Response options ranged from 1 (*not* *at all*) to 5 (*very much*). Items 2, 3, 4, 5, 7, 9, 10, 12, and 13 were reverse scored (Tangney et al., 2004).

Procedures

Subsequent to approval by the [name masked for review], sports directors and coaches at elite sport colleges in [name masked for review] were contacted. Athletes were invited to partake if sports directors approved participation. The first author gave written and verbal presentations of the study, and visited colleges every fifth week for data collection, three times in total. That is, the author spent one week times three traveling to the various colleges within the country (week 4, 9, and 14), thus all athletes answered questionnaires during the same time point in their competitive season. Athletes who agreed to participate provided written informed consent prior to data collection. Answering questionnaires, athletes indicated the extent to which questions represented their thoughts or actions during practice sessions the last five weeks. The data collection was completed within the last two months of the competitive season, corresponding to a key time point where athletes competed in national and international competitions while also preparing for subsequent college exams scheduled in the off-season period. As such, athletes were challenged to demonstrate excellent competencies at different arenas simultaneously, and the resulting combination of social, psychological, and physiological demands when living far from home represented a great context to test athletes' quality of motivation and self-control competencies (Martinent, Decret, Guillet-Descas, & Isoard-Gautheur, 2014). It is especially interesting to investigate the temporal ordering of motivation and self-control in this high-pressure context, to explore possible explanations of youth athletes' ego depletion experiences and even more severe consequences such as athlete burnout. SurveyXact 8.0 (QuickQuest) was used to collect data.

Analyses

First, descriptive statistical analyses were performed with JASP 0.8.0.0 (Table 1). Second, variables composition, model fit, and reliability were examined in M*plus* 7.4 (see

Table 1 in Supplemental online material; Muthén & Muthén, 1998-2016; Raykov, 2009). Additionally, approximate measurement invariance (AMI) was tested between time points to ensure that respondents attribute the same meaning to, and understand, items at each data collection time point (van de Schoot, Lugtig, & Hox, 2012). Third, six Bayesian Structural Equation Modeling (BSEM; Muthén & Asparouhov, 2012) cross-lagged panel model analyses were performed, each analysis including self-control and one motivation regulation represented as latent variables. In these six analyses three time points were included (T1, T2, and T3; *Figure* I). As peoples' motivation seems to be driven by both internal and external motives (Ryan & Deci, 2000), and self-control in exercise contexts seems to be changeable (Hagger, Wood, Stiff, & Chatzisarantis, 2010a), examination of stability and temporal causality within these concepts is relevant.

BSEM is based on Bayes' Theorem, and information (priors) from previous studies will, together with current data, generate the posterior distribution (Muthén & Asparouhov, 2012). This approach will, in comparison with more traditional maximum likelihood (ML) estimation, improve convergence issues, aid in model identification, and is especially helpful when researchers deal with small sample sizes (Depaoli & van de Schoot, 2015). Parameter specifications of exact zeros were replaced with approximate zeros by weakly informative priors (Muthén & Asparouhov, 2012), which influence posterior distributions to a lesser extent but contain useful information to model identification processes (Depaoli & van de Schoot, 2015). That is, priors allowed low cross-loadings and variances within and between each latent variable at different time points, and their distributional form was defined as Normal (0, 0.005) or Inverse Wishart (0, 32). Sensitivity analyses were performed and investigated (i.e., varying residual correlation and cross-loading variance priors; De Bondt & Van Petegem, 2015), and are available upon request.

In model identification, we implemented two Markov Chain Monte Carlo (MCMC) simulation procedures with the Gibbs sampler method (Depaoli & van de Schoot, 2015). Here, the distribution of one set of parameters is used to make random draws of other parameter values, and missing values (current study item-level missing data < 36.8%) are treated as values to be estimated. In this study, some athletes were away due to competition travelling or practices scheduled at the time of data collection (see Table 2 for response rate). Hence, no implicit factors affect missing data, and this procedure seems justifiable as analyses indicated data missing completely at random (Little MCAR test, $p = .443$; Enders, 2011). Convergence of the MCMC chains was based on the potential scale reduction (PSR) factor (i.e., PSR factor close to 1; Muthén & Asparouhov, 2012), and convergence cut-off values were specified at 0.01 to reduce bias caused by precision (van de Schoot et al., 2014; van de Schoot et al., 2013). Resulting model fit was based on the Bayesian posterior predictive *P* (PP*P*) and the 95% confidence interval (CI; van de Schoot et al., 2014). A PP*P* close to .50 and a symmetric 95% CI centering on zero indicate excellent fit, although PP*P* > .01 is still acceptable (Muthén & Asparouhov, 2012; van de Schoot et al., 2014). To reduce autocorrelation between the MCMC draws, every 10th iteration was used (De Bondt & Van Petegem, 2015), resulting in 200 000 (50 000 burn-in) iterations. Trace plots were visually inspected for chain convergence (Depaoli & van de Schoot, 2015).

Testing cross-lagged panel models longitudinally, researchers should ensure measurement invariance (MI; Little, 2013). This implies that constructs are equivalent over time, and respondents attribute the same meaning to the latent factor(s) and equality in the levels of underlying items at different time points (van de Schoot et al., 2012). However, AMI used in this study allows for some wiggle room for factor loading and intercept variance differences between time points, as the precision of priors may vary (van de Schoot et al., 2013). As such, this is an interesting alternative compared to the unrealistic assumption of exact zeros in more strict MI testing (van de Schoot et al., 2013). In AMI, zero mean, small variance priors (0.05, 0.01, and 0.005) for differences between estimates of the same parameters (factor loadings and intercepts) at T1–T3 were evaluated (Muthén & Asparouhov, 2012, 2013, January 11). The lowest deviance information criterion (DIC) indicated the best-fitting model (Asparouhov, Muthén, & Morin, 2015). Then, Muthén and Asparouhov's (2013, January 11) two-step approach testing AMI for factor loadings and intercepts simultaneously was performed, freeing eventually non-invariant parameters in the second step.

Autoregressive paths (e.g., T1 → T2 intrinsic motivation) and stability over time (e.g., T1 → T2 vs. T2 → T3 intrinsic motivation) were investigated in the cross-lagged panel models, as well as the temporal causality and cross-lagged paths (e.g., T1 intrinsic motivation → T2 self-control, vs. T1 self-control → T2 intrinsic motivation; Little, 2013). The cross-lagged and autoregressive paths are both predictors onto another variable, and are reciprocally controlled for when leading to the same construct (Little, 2013). That is, autoregressive effects are uniquely controlled for when estimating cross-lagged paths and vice versa. Hence, the goal of investigating constructs in cross-lagged panel models is to find a reduced, more parsimonious and theoretically meaningful set of structural paths that explains associations within data (Little, 2013). Interpreting structural paths, 95% credibility intervals not covering zero were considered credible (Muthén & Asparouhov, 2012; van de Schoot et al., 2014).

A simulation analysis, using the Monte Carlo framework, was conducted to evaluate the power and precision of the structural paths within the specified model (for more information about simulation analysis, see Muthén & Muthén, 2002). The coverage rates for the structural paths were above 93.8%, and the power (β) for the parameters ranged between .93 and .1.00.

Results

Descriptive statistics and correlations for motivation and self-control are presented in Table 1. Generally, self-control is positively and negatively correlated with autonomous and controlled types of motivation, respectively, and motivation regulations adjacent on the SDT continuum are positively related. Reliability analyses (Rho (ρ); Raykov, 2009) indicated acceptable reliability, except some motivation regulations (see Table 1 Supplemental online material). Testing AMI between time points, time point difference variances of .05, .01 and .005 were examined. DIC values indicated that variances of .005 resulted in the best model reflecting the lowest DIC, and all factor loadings and intercepts were invariant (Table 2–7 in Supplemental online material). As such, parameters were constrained to be approximately equal (see Table 3 for approximate MI model fit).

Results from the BSEM cross-lagged panel models are presented in Table 4. Strong effects were found for all autoregressive paths ($0.449 \geq \beta \leq 0.742$; e.g., T1→ T2 self-control, $\beta = 0.631$, 95% CI = [0.517, .0.724]). Cross-lagged paths were weaker when controlling for autoregressive paths ($-0.003 \geq \beta \leq 0.278$; e.g., intrinsic motivation T2→ self-control T3, $\beta = 0.278$, 95% CI = [0.120, 0.436]). Further, the stability over time within the various constructs displayed some instability. Motivation regulations showed higher T2 → T3 compared to T1 → T2 autoregressive paths, whereas the self-control construct reflected more complex patterns, as T2 → T3 compared to T1 → T2 paths both increased and decreased. However, we focused on self-control and motivation cross-lagged paths and temporal causality in this article, and these results are presented next.

In the cross-lagged panel models, we investigated the hypothesized associations that individuals' self-control capacity will be more influenced by the type of motivation than vice versa, and that autonomous and controlled types of motivation positively and negatively predict trait self-control, respectively. In these three time point models, self-control credibly predicted intrinsic motivation ($\beta = 0.182$, 95% CI = [0.028, 0.336]), integrated regulation ($\beta =$

0.211, 95% CI = [0.071, 0.347]), and amotivation (β = −0.146, 95% CI = [−0.271, −0.016]) in the T1 → T2 cross-paths, and integrated regulation (β = 0.150, 95% CI = [0.009, 0.290]) in the T2 → T3 cross-paths. Self-control was credibly predicted by intrinsic motivation (β = 0.278, 95% CI = [0.120, 0.436]), integrated regulation (β = 0.239, 95% CI = [0.081, 0.389]), and amotivation (β = −0.252, 95% CI = [−0.398, −0.097]) in the T2 → T3 cross-paths. Analyses revealed noncredible and weak cross-paths between self-control and identified, introjected, and external regulations.

Discussion

Anchored in the frameworks of the SDT (Ryan & Deci, 2000) and theories of self-control (Baumeister et al., 1998; Inzlicht & Schmeichel, 2012; Ryan & Deci, 2008), we investigated the temporal ordering of motivation regulations and dispositional self-control in young, high-level winter sport athletes. Recent empirical evidence states that athletes are not always capable of dealing with the self-control demands they are constantly confronted with (Englert, 2017). Evidence also suggests that various types of motivation play a crucial role in the optimal functioning of self-control competencies among athletes (Jordalen et al., 2016; Jordalen et al., 2018). Self-control capacity has been conceptualized as limited by psychological and physiological resources, and sequential acts of self-control without adequate recovery will result in temporary shifts in motivation and depletion patterns followed by self-control failure (Baumeister et al., 2007; Inzlicht & Schmeichel, 2012). However, models explaining self-control depletion and self-control failure do not agree about the temporal ordering of these concepts.

While no previous studies have examined the temporal ordering of motivation and self-control in the sport context, it is possible to infer from earlier findings that autonomous motivation positively directs acts of self-control in other domains (e.g., Muraven, Gagné, & Rosman, 2008). For example, autonomous types of motivation may protect athletes against temptations and thereby boost their self-control capacity, as they may experience fewer obstacles and tempting in-the-moment desires in the face of their goal pursuits (Milyavskaya et al. 2015). This direction of effects has previously been supported in exercise contexts when investigating the association between motivation and well-being mediated by trait self-control (Briki, 2016). In this study, Briki (2016) found that autonomous and controlled types of motivation positively and negatively predicted well-being via self-control competencies among regular exercisers. Conceptually consistent, previous study findings suggest that motivation directs acts of self-control (Baumeister, 2016; Ryan & Deci, 2008).

In the current study, the temporal ordering of high-level athletes' motivation and self-control looked different than what was anticipated. Athletes' initial self-control was a stronger predictor of motivation, than vice versa, in the three-wave cross-lagged models. As such, current study findings support Inzlicht and Schmeichel's (2012) process model of self-control, as well as recent findings (see e.g., Converse et al., 2019; Holding et al., 2019), that self-control initially directs changes in motivation subsequently affecting acts of self-control. The process model questions whether individuals actually are depleted and suggests that there is a shift in motivation, attention, and emotion that causes self-control decreased performance (Inzlicht & Schmeichel, 2012). For example, an initial act of self-control leaves athletes less motivated to deliberately control their actions (e.g., persistently engage in alternative training when not fully recovered from injury) and more motivated to execute personally rewarding and enjoyable tasks (e.g., go for a favorite workout even though not fully recovered). This motivational shift leading to reduced motivation for have-to tasks and the increased motivation for want-to tasks corresponds to the shifts in types of motivation where the more externally motivated performances are difficult to maintain over time (Ryan & Deci, 2000). This may exemplify how self-control and high-level athletes' strong work-ethic override other tempting desires in their development of exceptional competencies.

High levels of trait self-control may help athletes move along the self-determination continuum and gain more autonomous reasons for goal striving (Holding et al., 2019). For example, athletes who autonomously control their efforts and persist in the face of adversity may experience their activities as more meaningful and interesting, leading to increased pleasure and fun within the activity (i.e., internalization of motivation; Ryan & Deci, 2000). Moreover, the fact that athletes' self-control competencies initiated the causal paths between self-control and motivation reflect that athletes in the competitive nature of elite sport possess strong self-control and willpower competencies (Hoffer & Giddings, 2016). These mental characteristics have been found to help athletes stay focused on the task at hand and guide their performance toward goal achievements (Boes, Harung, Travis, & Pensgaard, 2014). However, these findings may reflect the relative stability of trait self-control over time (Tangney et al., 2004), underlined in strong autoregressive effects (Adachi & Willoughby, 2015), and a requirement to assess these associations longitudinally for example during competitive as well as off season periods (Anusic & Schimmack, 2016; Jordalen et al., 2018).

Investigating how trait self-control predicted changes in motivation quality across the academic year, self-control positively and negatively predicted undergraduate students autonomous and controlled motivation above other personality traits (Holding et al., 2019). In their study, Holding, Hope, Verner-Filion, & Koestner (2019) confirmed strong autoregressive effects of motivation, but did not investigate autoregressive effects of self-control. Accordingly, current study findings offer important information as autoregressive effects is controlled for investigating cross-lagged paths (Adachi & Willoughby, 2015). Athletes in the current study participated in different sports, but competed in national and international competitions within the same period of time. The first measurement time point was organized prior to these competitions, and one could speculate whether athletes' self-control was especially important predicting their motivation already at this point. Elite athletes have previously been found to yield multidimensional motivation profiles including a combination of autonomous and more controlled types of motivation (Gillet, Berjot, Vallerand, Amoura, & Rosnet, 2012). Thus, an important consideration is whether athletes' motivation was fluctuating throughout the season (Lemyre et al., 2006). Based on the strong autoregressive effects of motivation underlining stability over change, findings contradict this suggestion and showcase the power of self-control predicting motivation over time (Adachi & Willoughby, 2015; Holding et al., 2019).

Interestingly, trait self-control was specifically associated with motivation regulations (i.e., intrinsic, integrated, and amotivation) that are not characterized by volitional processes (Ryan & Deci, 2000). Rather, these types of motivation reflect natural motivational desires to act or a total lack of motivation to act, and refer to doing something because it is interesting, fun, and meaningful, or conversely represent a lack of intentionality and sense of personal causation. However, these motivation regulations were further associated with athletes' trait self-control at the end of the season, reflecting how autonomous types of motivation may energize acts of self-control, whereas controlled forms of motivation will rather deplete these cognitive resources (Briki, 2016; Holding et al., 2019; Jordalen et al., 2018; Muraven, 2008; Ryan & Deci, 2008). At the later stages of the season, athletes likely shifted their competitive sport focus and deliberately focused on their academic efforts as college exams are typically scheduled during this period. In this transition period, they are especially challenged by educational as well as psychological and physiological demands related to the student-athlete life, and would typically benefit from the interaction of autonomous motivation and self-control competencies (e.g., thought control; Martinent & Decret, 2015). This may help athletes continue their process of goal pursuit, as the combination of self-control and more autonomous types of motivation results in decreased impulsive attraction to goal-disruptive temptations and individuals' perceptions of obstacles (Milyavskaya et al., 2015). In addition, the direction of associations in the current study appears to be influenced by athletes' type of motivation. In accordance with previous research findings (e.g., Briki, 2016; Holding et al., 2019; Muraven, 2008), associations between self-control and more autonomous types of motivation were positive, and conversely, athletes' amotivation negatively associated with trait self-control. This type of motivation is characterized by a lack of control (Ryan & Deci, 2000), and hence athletes' levels of T2 amotivation are negatively associated with end of season self-control. This association has been found maladaptive, as it likely leads to exhaustion and eventually burnout experiences (Jordalen et al., 2018).

Current study findings suggest that self-control initiate the causal paths between athletes' various types of motivation and self-control competencies. These associations were conceptually consistent, as self-control was positively and negatively associated with autonomous and controlled types of motivation, respectively. Additionally, findings suggest a need to examine these concepts longitudinally, during competitive season and off-season periods to better identify complex and interrelated psychological patterns.

Limitations

The current study makes a unique contribution to the literature concerning the temporal ordering of self-control and motivation in youth sport athletes. However, findings should be interpreted based on potential limitations. Although it is hard to assess their influence, factors such as the use of self-reported data and the first author's presence when visiting colleges at every data collection time point are likely to have influenced athletes' perception (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Furthermore, possible limitations related to questionnaires, design, and type of analyses should be emphasized. For example, some motivation regulations' reliability scores were low and two BSCS items were deleted due to low factor loadings. The translation of items needs to be further investigated as this may cause unseen linguistic or cultural gaps (Benítez, Padilla, Hidalgo Montesinos, &

Sireci, 2016). However, validity analyses were performed with the M*plus* robust maximum likelihood (MLR) estimator, and even though this estimator is robust for non-normal conditions and missing data (Enders, 2010), main analyses were performed with BSEM where priors allowed for some wiggle room for differences between parameters (van de Schoot et al., 2013). This method, where exact zero constraints (e.g., for cross-loadings) are replaced with approximate zero constraints, is an attractive and more realistic approach. The content validity of the SMS-II has been criticized as well (e.g., see Langan et al., 2016), and the wording of items may not necessarily apply to elite sport settings (e.g., asking athletes if they were engaged because they enjoyed learning more about their sport). In addition, self-control reverse scored items may cause method bias (Marsh, Scalas, & Nagengast, 2010; Podsakoff et al., 2003), and various compositions of this construct have previously been investigated (Jordalen, Lemyre, & Durand-Bush, 2016; Jordalen et al., 2018; Maloney, Grawitch, & Barber, 2012; Toering & Jordet, 2015). Finally, the current study's 10-week data collection period may not be sufficient for some interaction effects to emerge (e.g., Martinent & Decret, 2015; Stenling, Ivarsson, & Lindwall, 2017). This data collection period may not reflect longitudinal associations between motivation and self-control.

Future Directions

Recently, it has been emphasized that there is a need to go beyond laboratory research settings when measuring self-control and cognitive competencies, as the validity of tasks used to manipulate or measure self-control capacity is generally unknown (Baumeister & Vohs, 2016; Carter, Kofler, Forster, & McCullough, 2015). These competencies should be studied longitudinally in real life settings, for example in youth sport competitive and off-season periods (Holding et al., 2019; Stenling et al., 2017). Former research has advocated intervention strategies to improve self-control (see e.g., Jordalen et al., 2018; Milyavskaya & Inzlicht, 2017). These strategies could either act on autonomous or controlled self-control motives (Ryan & Deci, 2000, 2008). For example, individuals may internalize the reason for engaging in acts of self-control, thus experience self-control behaviors as personally meaningful and interesting (jf., autonomous motive); or individuals are able to resist immediate temptations in favor of a distal goal in order to receive an extra bonus (jf., more controlled motive, delay of gratification; Mischel, 2014). The former motive is, according to SDT, preferable, as it helps individuals maintain behaviors over time without the necessity of separable consequences (Deci & Ryan, 2000). This, in line with current study findings as well as former research (e.g., Converse et al., 2019: Holding et al., 2019; Jordalen et al., 2016, 2018), suggests that autonomous self-control motives enhances self-control performance over time. For example, athletes can increase the value of engaging in acts of self-control by discussing important self-control processes (e.g., behavioral and emotional responses, self-management, enhanced focus, as well as thought and impulse control) with their coach and significant others (Dubuc-Charbonneau & Durand-Bush, 2015).

Based on limitations of the current study questionnaires, some future directions should be endorsed. For example, it is important to evaluate the potential consequences of deleting two BSCS items and why these items displayed low factor loadings. The various compositions of this questionnaire previously investigated (e.g., Jordalen et al., 2016; Jordalen et al., 2018; Maloney et al., 2012; Tangney et al., 2004; Toering & Jordet, 2015), as well as current study analyses, suggest that a thorough investigation of self-control items is needed. Do current BSCS items reflect athletes' actual self-control, or do these items solely measure participants illusive self-control; is this a unidimensional construct as originally suggested (see Tangney et al., 2004), or a two-factor scale more recently investigated (Toering & Jordet, 2015); and do the BSCS items actually measure trait self-control, or do they inadequately measure stability over time (Fullerton, Lane, Nevill, and Devonport, 2018)? Future research should additionally evaluate the [name masked for review] version of the

SMS-II, and consider validation of a new motivation regulations questionnaire for high-level youth athletes. Finally, it is important that sport psychology research apply longitudinal designs and methods to evaluate causal processes in athletes' everyday life (Preacher, 2015; Stenling et al., 2017), and account for threats of method bias using self-report measures (e.g., social desirability; Grossbard, Cumming, Standage, Smith, & Smoll, 2007; Podsakoff et al., 2003). For example, answering sport motivation questionnaires, youth athletes most likely report favorable scores consistent with their long-term agenda to achieve elite level status.

Conclusion

Our study's findings highlight interrelated associations between youth athletes' dispositional self-control and various types of motivation. Investigating the temporal ordering of these concepts throughout athletes' competitive winter sport season, findings challenge the established fact that inherent motivation initially and exclusively moves athletes to act. This belief disregards that psychological and cognitive competencies may energize and enable drives to be fulfilled. Our results suggest a multifaceted relationship between athletes' motivation and trait self-control, and suggest that self-control capacity initially enables motivation desires to evolve. In a three-wave cross-lagged panel model, intrinsic regulation, integrated regulation, and amotivation were predicted at time point two by athletes' self-control at the beginning of the competitive season. These motivation regulations further predicted trait self-control at the end of the season, and findings reflect that athletes' self-control capacity is associated with types of motivation not specifically characterized by volitional processes. Noteworthy, the more autonomous and controlled forms of motivation were positively and negatively associated with trait self-control, respectively, likely important for the maintenance of self-control performance.

These findings have important applied implications for high-level youth athletes. As these athletes are constantly challenged with self-control demands in their strenuous everyday combining education and elite sport development with family and social activities, an emphasis on supporting the types of motivation that are positively associated with athletes' volitional resources is important. Autonomous types of motivation protect athletes against tempting self-control dilemmas, as they experience an increased awareness of the value, meaning, and inherent satisfaction of their own developmental processes. This suggests that athletes' with high-levels of trait self-control may better internalize external types of motivation and maintain their persistent goal striving. They avoid the debilitating effects of self-control depletion and exhaustion, experiencing increased feelings of well-being and other positive health outcomes. Finally, current study findings showed that motivation and self-control are stable constructs over a 10-week period of time. It is important to outline an extended time frame when coaches and significant others intend to facilitate positive changes in these mental dispositions. As such, research exploring the forces directing competitive athletes' behaviors and performances needs to further integrate ideas from multiple lines of research and theory, and explore motivational and cognitive issues simultaneously.

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Table 1. Descriptive Statistics and Correlations of Study Variables at Time Point 1, 2, and 3

	M (*SD*)	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
1. InT1	6.11 (0.71)	-	.63*	.59*	.66*	.44*	.44*	.54*	.40*	.45*	.20*	.11	.10	.07	-.07	.01	-.25*	-.39*	-.28*	.25*	.32*	.24*
2. InT2	6.07 (0.82)		-	.69*	.49*	.74*	.55*	.35*	.64*	.58*	.09	.23*	.19	-.02	.01	.07	-.44*	-.48*	-.56*	.34*	.26*	.36*
3. InT3	5.90 (0.88)			-	.39*	.51*	.75*	.26*	.42*	.65*	.10	.13	.32*	-.04	-.10	.01	-.34*	-.53*	-.51*	.20	.31*	.33*
4. IeT1	5.80 (0.81)				-	.65*	.53*	.49*	.45*	.43*	.45*	.35*	.31*	.17	.06	.11	.17	-.24*	-.12	.26*	.27*	.17
5. IeT2	5.79 (0.90)					-	.68*	.33*	.61*	.52*	.27*	.44*	.39*	.07	.12	.16	-.33*	-.37*	-.38*	.37*	.27*	.31*
6. IeT3	5.66 (0.93)						-	.22	.35*	.58*	.14	.20	.46*	-.05	-.10	.03	-.27*	-.45*	-.44*	.26*	.26*	.35*
7. IdT1	5.54 (0.96)							-	.60*	.43*	.36*	.22	.26*	.21*	.10	.20	-.06	-.14	-.14	.13	.26*	.13
8. IdT2	5.57 (1.04)								-	.62*	.22	.34*	.26*	.16	.19	.16	-.17	-26*	-.35*	.22	.29*	.26*
9. IdT3	5.52 (0.99)									-	.14	.21	.33*	.04	-.01	.10	-.21	-.41*	-.29*	.16	.30*	.17
10. IrT1	4.45 (1.26)										-	.67*	.57*	.44*	.30*	.32*	.19*	.12	.22	-.10	-.02	-.15
11. IrT2	4.37 (1.30)											-	.67*	.36*	.48*	.39*	.04	.01	.11	-.07	-.03	-.10
12. IrT3	4.46 (1.22)												-	.31*	.27*	.41*	.05	-.01	-.01	.03	.01	.01
13. ExT1	2.76 (1.17)													-	.67*	.61*	.29*	.16	.25*	-.23*	-.19	-.19
14. ExT2	2.73 (1.24)														-	.61*	.22	.26*	.26*	-.30*	-.32*	-.28*
15. ExT3	2.86 (1.17)															-	.14	.20	.28*	-.11	-.19	-.22
16. AT1	2.36 (1.44)																-	.75*	.64*	-.30*	-.32*	-.36*
17. AT2	2.43 (1.55)																	-	.81*	-.38*	-.45*	-.54*
18. AT3	2.61 (1.59)																		-	-.29*	-.36*	-.56*
19. SCT1	3.56 (0.53)																			-	.76*	.64*
20. SCT2	3.57 (0.54)																				-	.72
21. SCT3	3.44 (0.52)																					-

Note: In = Intrinsic regulation; Ie = Integrated regulation; Id = Identified regulation; Ir =Introjected regulation; Ex = External regulation; A = Amotivation regulation; SC = Self-control; T1, T2, and T3 = time point 1, 2, and 3.

* = BF > 10.

Table 2. Overall Response Rate

Time point	Total (*n*)	Limited response rate (*n*)
T1	271	
T2	201	17
T3	197	20
T1, T2	184	
T1, T2, T3	136	
T2, T3		13
T1, T3		17
Sum	321	

Note. T1, T2, and T3 = time point one, two, and three; Limited response rate = athletes who only participated at one or two time points; Sum = all athletes enrolled in the study (i.e., new athletes enrolled at T1, T2, and T3, as well as T2 and T3).

Table 3. Approximate MI Model Fit for the Three Time Point Models

Model	#fp	λ prior (μ, σ2)	ν prior (μ, σ2)	PP*P*	2.5% PP limit	97.5% PP limit	DIC
1, Step 1	785	0.05	0.05	0.468	−105.038	125.416	24173.362
	785	0.01	0.01	0.490	−109.306	114.096	24161.410
	785	0.005	0.005	0.504	−113.570	113.134	24154.002
2, Step 1	785	0.05	0.05	0.510	−116.999	138.414	24346.728
	785	0.01	0.01	0.532	−118.225	134.054	24334.237
	785	0.005	0.005	0.537	−117.666	134.229	24326.324
3, Step 1	785	0.05	0.05	0.316	−87.323	146.343	24197.218
	785	0.01	0.01	0.332	−91.724	145.464	24184.188
	785	0.005	0.005	0.341	−93.047	147.852	24179.177
4, Step 1	785	0.05	0.05	0.282	−80.283	160.897	24383.048
	785	0.01	0.01	0.290	−87.769	159.203	24371.392
	785	0.005	0.005	0.296	−87.600	159.075	24365.056
5, Step 1	785	0.05	0.05	0.498	−121.697	132.471	24279.686
	785	0.01	0.01	0.506	−124.903	123.466	24261.677
	785	0.005	0.005	0.518	−127.241	119.482	24253.079
6, Step 1	785	0.05	0.05	0.420	−107.741	139.817	23618.120
	785	0.01	0.01	0.442	−115.779	134.142	23607.077
	785	0.005	0.005	0.460	−120.078	133.579	23599.967

Note. Model 1 = intrinsic regulation – self-control, Model 2 = integrated regulation – self-control, Model 3 = identified regulation – self-control, Model 4 = introjected regulation – self-control, Model 5 = external regulation – self-control, Model 6 = amotivation – self-control; #fp = number of free parameters, PP*P* = posterior predictive *P*, DIC = deviance information criterion.

Items are standardised.

[a] Factor loading and intercept difference variances = 0.005 indicated the best model fit according to the PP*P* and DIC. Analyses with difference variances = 0.01 and = 0.05 were estimated, and are available upon request.

Table 4. Cross-Lagged Three Time Point Models

Model	T1Mot → T2Mot (95% CI)	T2Mot → T3Mot (95% CI)	T1SC → T2SC (95% CI)	T2SC → T3SC (95% CI)	T1Mot → T2SC (95% CI)	T2Mot → T3SC (95% CI)	T1SC → T2Mot (95% CI)	T2SC → T3Mot (95% CI)
1	0.449	0.636	0.626	0.564	0.056	0.278	0.182	0.120
	(.280, .584)	(.497, .741)	(.503, .717)	(.387, .689)	(−.067, .181)	(.120, .436)	(.028, .336)	(.017, .258)
2	0.502	0.653	0.625	0.577	0.024	0.239	0.211	0.150
	(.348, .627)	(.508, .759)	(.488, .718)	(.417, .696)	(−.113, .165)	(.081, .389)	(.071, .347)	(.009, .290)
3	0.511	0.538	0.632	0.674	0.105	−0.003	0.092	0.128
	(.365, .624)	(.369, .667)	(.504, .720)	(.495, .777)	(−.046, .263)	(−.166, .169)	(−.046, .233)	(−.028, .296)
4	0.584	0.629	0.627	0.680	−0.114	−0.083	−0.042	0.006
	(.448, .690)	(.480, .736)	(.497, .711)	(.555, .765)	(−.253, .026)	(−.219, .057)	(−.177, .096)	(−.143, .147)
5	0.537	0.591	0.618	0.643	−0.075	−0.084	−0.137	0.021
	(.371, .664)	(.405, .723)	(.505, .713)	(.505, .750)	(−.211, .064)	(−.228, .055)	(−.283, .008)	(−.136, .177)
6	0.572	0.742	0.631	0.551	−0.069	−0.252	−0.146	−0.021
	(.432, .676)	(.618, .835)	(.517, .724)	(.397, .678)	(−.205, .066)	(−.398, −.097)	(−.271, −.016)	(−.158, .119)

Note. Model 1 = Intrinsic regulation – Self-control; Model 2 = Integrated regulation – Self-control; Model 3 = Identified regulation – Self-control; Model 4 = Introjected regulation – Self-control; Model 5 = External regulation – Self-control; Model 6 = Amotivation – Self-control; CI = credibility intervals.

95% CI not covering zero are considered credible (Muthén & Asparouhov, 2012; van de Schoot et al., 2014).