The Need for Self-Control in Achievement Tests:

Changes in Students' State Self-Control Capacity and Effort Investment

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Abstract

In the present research, we investigated the relation between changes in students' state self-control capacity and their motivational test-taking effort over the course of an achievement test. Thereby, we considered trait self-control as a major predictor of achievement-related behavior as a covariate. *N* = 1,840 apprentices repeatedly rated their state self-control capacity and the test-taking effort they invested while working on a 140-minute achievement test in mathematics and science. Using growth curve analyses, our results revealed correlated decreases in state self-control capacity and the test-taking effort invested over the course of the test. Furthermore, we found that trait self-control helped to keep state self-control capacity and test-taking effort at a higher level over the course of the test. Our results support the assumption of the process model of self-control that waning self-control capacity is reflected in reduced motivational effort. Furthermore, our findings provide evidence that self-control might play a crucial role in students' test-taking behavior in large-scale assessment studies. By modeling changes in state self-control capacity and effort investment while considering trait self-control, we provide an alternative approach for investigating self-control-dependent processes and the underlying mechanisms of self-control in achievement situations.

Keywords: self-control capacity, ego depletion, test-taking effort, self-regulation, achievement testing, motivation

1. Introduction

In large-scale assessment studies, students have to demonstrate their performance in a variety of domains over the course of achievement tests. Therefore, they have to invest mental effort to solve the test items (Ackerman & Kanfer, 2009) and self-control to focus their attention on the items' content while inhibiting any test-irrelevant thoughts or emotions (cf. e.g., Bertrams, Baumeister, Englert, & Furley, 2015; Bertrams, Baumeister, & Englert, 2016). Research suggests that any process requiring active self-control leads to a short-term depletion of a finite mental capacity (i.e., state self-control capacity), which goes hand in hand with a decline in self-control performance (Baumeister, Vohs, & Tice, 2007). In connection with recent discussions about the robustness and even the existence of such experimentally induced self-control depletion effects (Hagger et al., 2016), researchers have suggested investigating the motivational aspects of self-controlled behavior in ecologically valid settings as a way of exploring the underlying mechanisms of self-control (cf. e.g., Inzlicht & Berkman, 2015; Inzlicht & Schmeichel 2017).

A prominent model from social psychological research, the process model of self-control (Inzlicht & Schmeichel, 2012; Inzlicht, Schmeichel, & Macrae, 2014), assumes that the depletion of the self-control capacity is reflected in individuals' reduced motivational effort when working on cognitive tasks that require self-control in order for them to persist in a goal-directed manner. If this assumption is true, students' state self-control capacity and test-taking effort should decrease simultaneously when they work on achievement tests in which they have to focus their attention and thoughts on the items' content over longer periods of time.

The aim of the present study was to investigate the interplay between changes in students' state self-control capacity and their test-taking effort over the course of an achievement test while also considering trait self-control, which is known to be a major predictor of achievement-related behavior (e.g., De Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012; Lindner, Nagy, & Retelsdorf, 2015). Using latent growth curve modeling, our study is one of the first to investigate the interrelations between students' trait and state self-control as well as their effort investment during an achievement test. Our study contributes to educational research by exploring students' test-taking behavior in large-scale assessment studies and to social psychological research by gaining further insights into the underlying mechanisms of self-control in achievement situations. Furthermore, we follow the long-standing calls for a deeper investigation of self-control-dependent processes in ecologically valid settings (e.g., Inzlicht & Berkman, 2015; Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014) by modeling progressive changes in students' state self-control capacity and effort investment over the course of an achievement test.

1.1. Self-control and effort investment in achievement situations

The exertion of self-control and the investment of test-taking effort, which represents the intensity aspect of motivation when working on a task (cf. Gendolla & Richter, 2010), are known to be key components of achievement-related behavior, enabling students to persist with achievement tests while inhibiting test-irrelevant impulses (e.g., Baumert & Demmrich, 2001; Bertrams, Englert, Dickhäuser, & Baumeister, 2013; Kurzban et al., 2013; Lindner et al., 2015; Schmeichel, Vohs, & Baumeister, 2003; Tangney, Baumeister, & Boone, 2004). More precisely, test-taking effort and self-control are needed in order to initiate activities that reduce the discrepancy between the current state (i.e., processing the first test item) and the desired state (i.e., having solved all the test items) when working on a task (Carver & Scheier, 1982).

Various studies have provided evidence showing that the exertion of self-control briefly undermines the mental capacity that participants need in order to focus their attention, to access working memory operations and to regulate their thoughts and emotions in a goal-directed manner over longer periods of time (for an overview, see, e.g., Hagger, Wood, Stiff, & Chatzisarantis, 2010). As a consequence, individuals with reduced state self-control capacity show diminished cognitive and behavioral operations; these operations are necessary, for example, when taking achievement tests in school or in large-scale assessment settings. In their overview, Clarkson, Otto, Hassey and Hirt (2016) state that low self-control capacity is reflected in perceived levels of mental fatigue, which also seem to increase when people work on long achievement tests (cf. Ackerman & Kanfer, 2009). Such test-related mental fatigue effects may also explain individuals' decreased test-taking effort, which seems to be related to the decreased probability of solving test items over the course of testing (Weirich, Hecht, Penk, Roppelt, & Böhme, 2017).

In educational research, various studies have provided evidence showing that the level of students' state self-control capacity is related to achievement-related outcome variables. For example, Bertrams et al. (2013) found that anxious students were distracted by worrying thoughts during an arithmetic test more often when their state self-control capacity was reduced. Latest research provides support for the assumption of Inzlicht and Berkman (2015) that self-control wanes over the course of time. In the study of Lindner, Nagy, Ramos Arhuis and Retelsdorf (2017), students with low state self-control capacity showed progressive performance declines over the course of a computer-based mathematical problem-solving test. These results raise the question of how the underlying psychological mechanisms of self-control can explain students' test-taking behavior in achievement situations.

One prominent framework that takes the relations between self-control capacity, motivational effort investment, and achievement-related behavior into account is the process model of self-control (Inzlicht & Schmeichel, 2012; Inzlicht, et al., 2014). The model assumes that the exertion of self-control, which is needed in order to focus attention on tasks while inhibiting any distracting stimuli, becomes more and more aversive over time. Thus, the maintenance of high self-control for too few rewards is assumed to lead to a disengagement from self-control requiring tasks, while attentional shifts toward reward-related stimuli and the motivation to engage in enjoyable tasks increase. In other words, the model suggests that a reduction in state self-control capacity is reflected in decreased effort investment on tasks requiring self-control.

First support for this assumption from the field of educational research was provided by Price and Yates (2010). After an experimental manipulation of students' state self-control capacity, students were given the option of selecting the difficulty levels of each test item in a subsequent computer-based mathematics test. The authors found that students with low state self-control capacity chose to work on easier test items throughout the test compared to students with high state self-control capacity. This result indicates that students with low state self-control capacity might invest less test-taking effort and fewer mental capacities by choosing easier test items when working on achievement tests. In another study, Pohl, Erdfelder and Hilbig (2013) also found that people with low state self-control capacity more often used simple heuristics to reduce the mental effort they had to invest when working on recognition tasks. Whereas these studies focused on individuals' reduced effort investment as a consequence of their low self-control capacity, Baumeister (2014) claims that there is still no evidence that self-control depletion is related to a decline in motivational effort.

The present study is one of the first to investigate the interplay between simultaneous changes in students' state self-control capacity and their effort investment over the course of time by using an ecologically valid achievement-test situation. Moreover, since Ackerman and Kanfer (2009) found that students' test-taking effort was positively related to their subjective level of mental fatigue—a concept similar to the level of state self-control capacity (cf. Hagger et al., 2016)—we hypothesize that state self-control capacity and effort investment decrease simultaneously over test-taking time. Furthermore, we investigated the question of whether trait self-control, as one of the major predictors of achievement-related behavior (Duckworth & Seligman, 2005), might prevent the postulated decrease in state self-control capacity and effort investment.

1.2. Trait self-control and achievement-related behavior

Despite individuals' situational fluctuations in self-controlled behavior, self-control is considered to be a personality trait that remains relatively stable across situations and time (Gillebaart & De Ridder, 2015). High levels of trait self-control enable people to override, inhibit, or modify their impulses, thoughts, emotions, and behavior and to bring them into line with standards and personally endorsed overarching goals (Baumeister et al., 2007; Inzlicht et al., 2014). Research provides evidence that trait self-control is a major predictor of students' achievement-related learning behavior (e.g., Zimmerman & Kitsantas, 2014) at school (e.g., Bertrams & Dickhäuser, 2009), in university (e.g., Tangney, Baumeister, & Boone, 2004) and in vocational education and training programs (Lindner et al., 2015). Furthermore, it has been shown that trait self-control also predicts students' grade point average and performance in achievement tests (Duckworth & Seligman, 2005, 2006). Whereas various studies have focused on the relations between dispositional aspects of self-control and outcome variables, to date, little is known about the relations between students' trait and state self-control when they are required to invest effort in order to work on domain-specific items in standardized achievement tests.

In general, individuals with high trait self-control are assumed to use more effortless strategies (Gillebaart & De Ridder, 2015) to inhibit distractions and to focus their attention and thoughts in a goal-directed manner. Therefore, they might show more engagement in time-consuming, controlled information processing when working on achievement tests. Trait self-control is also assumed to be positively related to persistence in self-controlled behavior (Schmeichel & Zell, 2007) and has been described as an effort investment trait (Duckworth, Eichstaedt, & Ungar, 2015). Lindner et al. (2017) found that trait self-control was positively related to the amount of effort and time-on-task that students invested in order to solve items over the course of an achievement test in mathematics. Therefore, we assume trait self-control to be positively related to students' invested test-taking effort.

Up until today, the interrelations between trait self-control and state self-control capacity are poorly understood (Gillebaart & De Ridder, 2015). Whereas Muraven, Collins, Shiffman and Paty (2005) found that individuals with high trait self-control were less affected by situational self-control demands and it was hypothesized that they had a larger pool of the mental capacities needed for the exertion of self-control, Stillman, Tice, Fincham and Lambert (2009) found that trait self-control did not have any effect on the relation between state self-control capacity and performance. More recent studies (Imhoff, Schmidt, & Gerstenberg, 2014; Lindner et al., 2017) even found that high trait self-control might be negatively related to individuals' state self-control capacity. If this is the case, it could be expected that trait self-control induces detrimental rather than protective effects on changes in state self-control capacity over time. By considering trait and state self-control together, the present study makes it possible to investigate their interplay and their relation to the test-taking effort invested by students over the course of an achievement test.

1.3. Present Research

The aims of the present study were twofold: First, we wanted to gain deeper insights into the interplay between state self-control capacity and effort investment during an achievement test. Therefore, we investigated the assumptions from the process model of self-control (Inzlicht & Schmeichel, 2012) about the evolvement of state self-control capacity and its relation to the effort invested when working on a test. More precisely, the process model postulates that decreased state self-control capacity is reflected in the effort invested when working on self-control intensive tasks. Focusing on this model, we expected to find correlated decreases in the students' state self-control capacity and in their test-taking effort over the course of an achievement test. Since Clarkson, Hirt, Jia and Alexander (2010) provided evidence that the perceived level of individuals' invested state self-control capacity is predictive of their subsequent self-controlled behavior, Inzlicht and Schmeichel (2012) suggested that using self-report measures to map processes that lead to decreased state self-control capacity might be a viable option in self-control research. We followed their suggestion in our investigation and used self-report measures to repeatedly assess state self-control capacity and test-taking effort over the course of a 140-minute achievement test.

Second, we investigated the role that trait self-control plays in the levels of and changes in students' state self-control capacity and their test-taking effort. Thus, students with high levels of trait self-control were expected to keep their effort at a consistently higher level during the testing session than students with lower levels of trait self-control. Furthermore, we investigated the effect of trait self-control on the changes in students' state self-control capacity over the course of the test in an exploratory manner, since previous findings do not make straightforward expectations possible (Gillebaart & De Ridder, 2015).

2. Method

2.1. Participants

The sample we investigated stemmed from the project "Mathematics and science competencies in vocational education and training" and comprised N = 1,840 apprentices (technicians, clerks, and lab assistants) in their first year of vocational training and education (23% female; M_{age} = 18.94 years, SD_{age} = 2.40) in three German federal states. This sample size was considered sufficient for detecting small to medium effects in the bivariate latent growth curve models (e.g., Hertzog, Lindenberger, Ghisletta, & Oertzen, 2006). The data were collected by the Data Processing and Research Center (DPC) in Hamburg, which is part of the International Association for the Evaluation of Educational Achievement (IEA). The DPC has extensive expertise in sampling, data collection, and data preparation and has been responsible for data collection in international large-scale assessments such as the Programme for International Student Assessment (PISA). Before data collection, the DPC obtained written informed consent from all participants and their parents.

2.2. Procedure and Measures

To enable us to investigate the interplay between state self-control capacity and effort investment, all participants worked on standardized achievement tests in mathematics, physics, chemistry, and biology from the German National Educational Standards (Pant et al., 2013). The first test consisted of four 20-minute units, with a total working time of 80 minutes. After a short break of 10 minutes, the participants worked on the second test, which consisted of 15-minute units of apprenticeship-related tests in mathematics, physics, chemistry, and biology (cf., Härtig, Heitmann, & Retelsdorf, 2015); the total working time on this second test booklet was 60 minutes. During the achievement tests, state self-control capacity was assessed repeatedly (seven times; $.72 \leq \alpha \leq .77$) on a 7-point Likert scale anchored at 1 '*not true'* and 7 *'very true'*, using the five-item Brief State Self-Control Capacity Scale (Lindner, Lindner, & Retelsdorf, 2018), which is a short version of the 25-item State Self-Control Capacity Scale (Bertrams, Unger, & Dickhäuser, 2011; Ciarocco, Twenge, Muraven, & Tice, 2007). In their validation studies, Lindner et al. (2018) provide evidence that the Brief State Self-Control Capacity Scale is a valid measure for tracking the progress of changes in state self-control capacity over the course of a test. In the first test booklet (German National Educational Standards tests) of the present study, students answered the scale before the first and after the fourth (i.e., the last) test unit. In the second test booklet (apprenticeship-related tests), the scale was presented before the first and after each of the following test units. Furthermore, the "Effort Thermometer", as applied in the PISA 2000 study (Kunter et al., 2002), was repeatedly used (eight times) to assess the test-taking effort (i.e., the engagement to achieve a good performance) that students invested in the previous test unit compared to a maximum effort they would invest in a situation that is of high personal importance. This one-item measure was applied after each test unit. In a separate testing session, trait self-control was assessed using the adapted German version ($\alpha = .81$; Bertrams & Dickhäuser, 2009) of the Brief Self-Control

Scale (Tangney et al., 2004). All 13 items (e.g., "I say inappropriate things.") were rated on a 5-point Likert scale, anchored at 1 '*not at all like me'* and 5 '*very much like me'*.

2.3. Statistical Analyses

We applied bivariate latent growth curve modeling (e.g., Duncan, Duncan, & Strycker, 2006) to estimate the relation between effort investment and state self-control capacity during the test, using M*plus* 7.0 (Muthén & Muthén, 2012). The latent growth curve model describes the trajectories of effort investment and state self-control capacity over the course of the test in terms of levels (intercepts) and overall changes (slopes). In the bivariate case (i.e., effort investment and state self-control capacity), this approach enables the examination of the relationships between the intercept and slope components of the repeatedly assessed variables. In our case, the slope-slope correlations were of crucial importance (e.g., Grimm, 2007). A positive relationship indicated that stronger changes in one variable (e.g., effort investment) were accompanied by stronger changes in the same direction in the other variable (e.g., state self-control capacity). Overall, we used ten measurement points (i.e., $t_0 - t_9$) to assess state self-control capacity and effort investment. However, both constructs were not measured each time.

All of the loadings on both intercept factors were fixed to 1.00; for each slope factor, the loadings of the measures applied at time t_4 (i.e., the first time when state self-control capacity and effort investment were measured at the same time) were fixed to zero and those at time t_9 (i.e., the last measurement point) were fixed to 1.00. All further loadings were estimated freely. This specification captures any shape of nonlinear change (e.g., Bollen & Curran, 2006). The residual variance terms of effort and state self-control capacity were set to be invariant over time (Horn, 1972). Moreover, when both components were measured at the same time, correlations between their residuals were allowed.

In this model specification, both intercepts were defined with respect to measurement point t_4 in the test, which means that they assessed mean levels and variability in effort investment and state self-control capacity at t_4. The slope factors represent mean changes and individual differences in changes in effort investment and state self-control capacity from t_4 to t_9. In a second step, trait self-control (mean-centered) was included as a covariate in order to predict the intercepts and slopes of both state self-control capacity and invested test-taking effort.

The Full Information Maximum Likelihood estimator was applied to account for missing item responses (max. 10% missing). The goodness-of-fit was assessed by means of the chi-square statistic (χ^2), the Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), the Comparative Fit Index (CFI; Bentler, 1990), the Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1993), and the Standardized Root Mean Square Residual (SRMR; Jöreskog & Sörbom, 1993). As the chi-square statistic is known to be highly sensitive to sample size and to small deviations from a perfect fit, we followed the recommendations of Marsh, Hau and Wen (2004) and Browne and Cudeck (1993), who noted that the TLI and CFI should be .90 or greater, whereas the RMSEA should generally be .08 or smaller. Grimm and Ram (2009) noted that RMSEA values of less than .10 can be interpreted as marginal or even adequate for nonlinear latent growth curve models (cf. Grimm, Ram, & Hamagami, 2011). SRMR values should be below .08.

3. Results

In a first step, we explored the changes in state self-control capacity and effort investment that occurred over the course of the test. In order to facilitate the interpretation of our results, both variables were standardized with respect to the means and standard deviations determined for the first measurement point t_0 ($M = 0$, $SD = 1$). As can be seen in Fig. 1, the trajectories of both standardized variables indicated the expected decrease in state self-control capacity and effort investment over time ($t_0 – t_9$). A short break of 10 minutes between working on the first and second test booklet led to a small recovery in students' state self-control capacity.

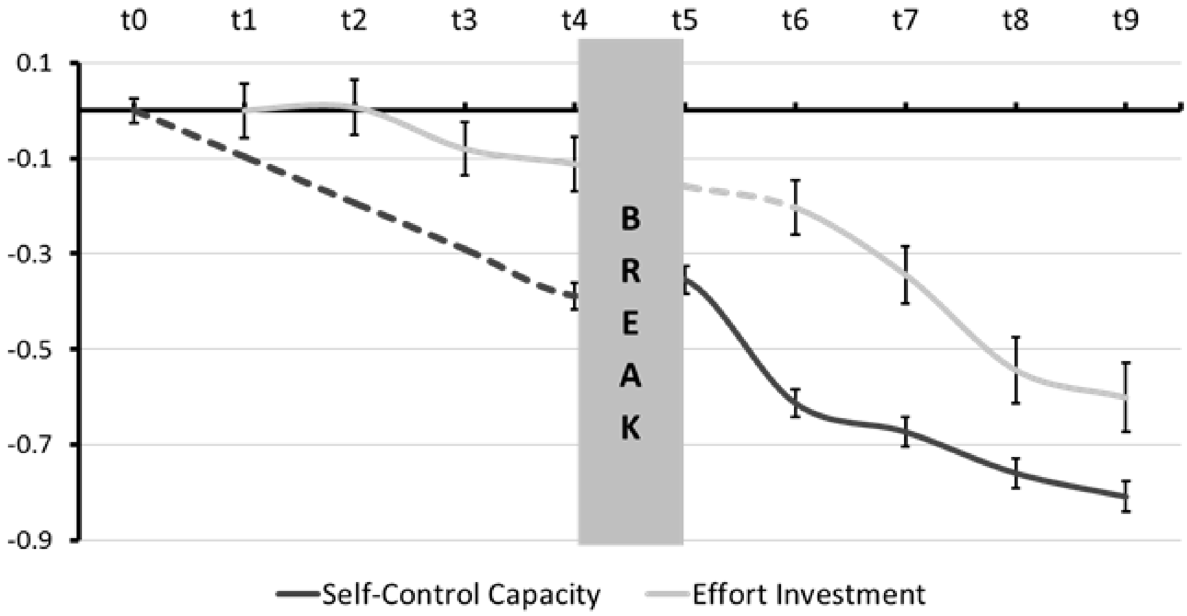

Fig. 1 Standardized changes in effort investment and state self-control capacity over the course of the test ($t_0 – t_9$: measurement points). Dashed lines indicate measurement intervals when the corresponding variable was not continuously assessed. The gray block between t_4 and t_5 indicates a break of 10 minutes. Error bars indicate standard errors.

The model fit for the bivariate latent growth curve model with trait self-control as a covariate was satisfactory: χ^2 (114) = 2035, TLI = .897, CFI = .902, SRMR = .053, and RMSEA = .096. Unless otherwise mentioned, all estimated model parameters were statistically significant at $p \leq .001$. All of the tests conducted were two-tailed.

The intercept of state self-control capacity was M_{SSCC} = -0.42 (*SD* = 0.86) and the intercept of effort investment was M_{effort} = -0.07 (*SD* = 0.85), each with significant variances. The negative values for both intercepts were due to the standardization of both variables with respect to their means and standard deviations at t_0. We also found interindividual variability concerning the decrease in state self-control capacity (M_{SSCC} = - 0.40, *SD* = 0.47) and effort investment (M_{effort} = - 0.54, *SD* = 0.86) over the course of the test. As can be seen in Fig. 2, we found a positive intercept-intercept correlation between the effort investment and state self-control capacity at t_4 (r = .14, *SE* = 0.03, p < .001). In line with our expectation, we found a positive correlation between the slopes of state self-control capacity and effort investment (r = .20, *SE* = 0.03, p < .001), indicating that decreases in state self-control capacity went hand in hand with decreases in the effort that students invested when working on the test units.

Next, we focused on the relation of trait self-control to the intercepts and slopes of state self-control capacity and effort investment. Whereas trait self-control was positively related to the intercept of effort investment (β = .15, *SE* = 0.02, p < .001), no significant relation was observed between trait self-control and changes in effort over the course of the test, indicating that individuals with high trait self-control consistently invested more effort during the test. Furthermore, trait self-control was strongly related to the intercept of state self-control capacity (β = .31, *SE* = 0.02, p < .001), but was also not associated with changes in state self-control capacity.

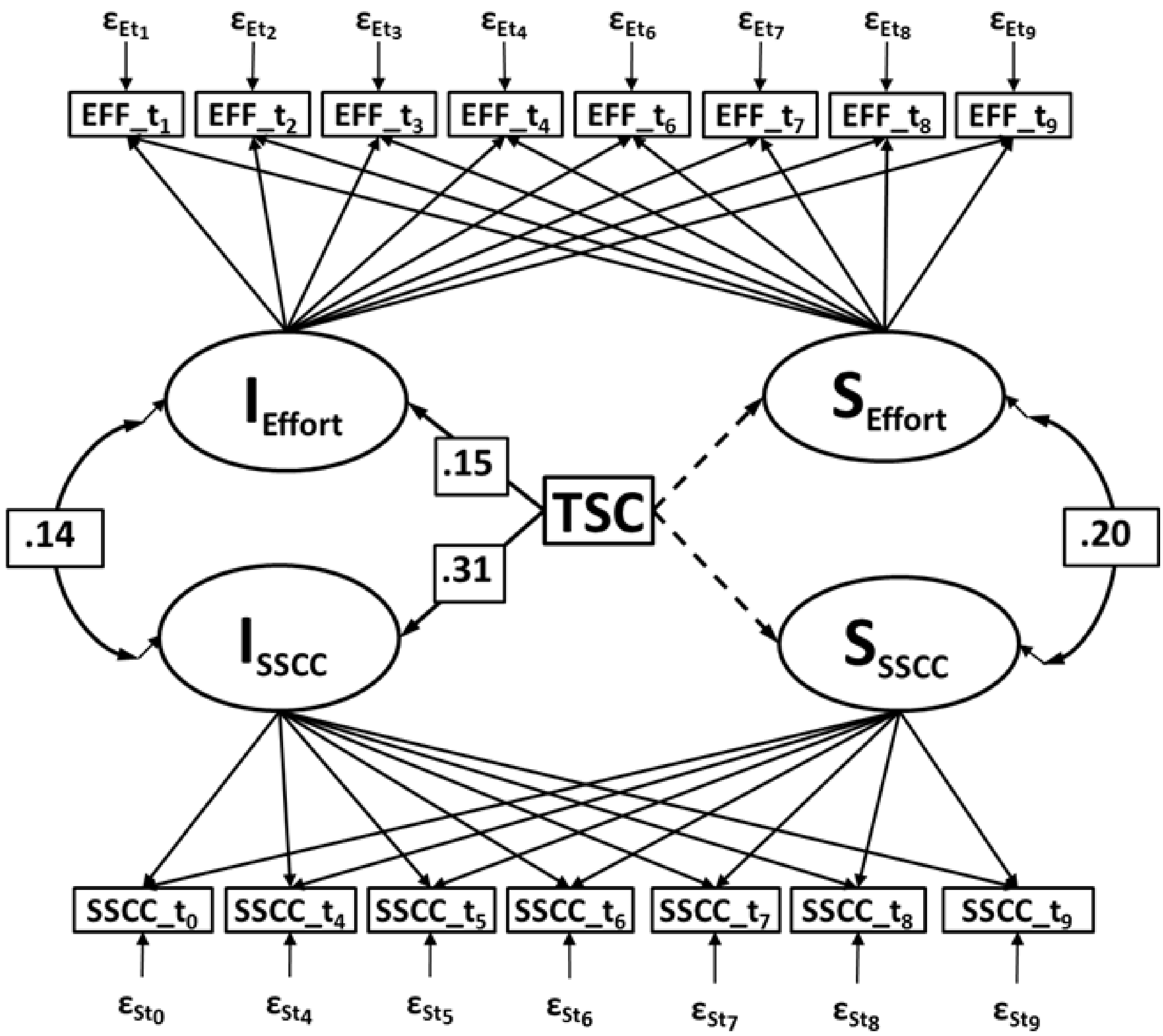

Fig. 2 Bivariate latent growth curve model intercepts (I) and slopes (S) of the factors state self-control capacity (SSCC) and invested test-taking effort (EFF). The covariate trait self-control (TSC) is included. Residual correlations and residual variances of intercepts and slopes were omitted in favor of clarity.

4. Discussion

The main goal of the present research was to investigate the theoretical assumptions of the process model of self-control (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014) concerning students' test-taking behavior when they work on achievement tests over longer periods of time.

To this end, we focused on the interplay between students' self-reported effort investment and state self-control capacity over the course of a relatively long achievement test. Furthermore, we examined the possible role that trait self-control plays in protecting individuals from a decrease in their state self-control capacity and effort investment during a demanding testing session.

First of all, the weak positive correlation we found between the intercepts of state self-control capacity and effort investment indicates that both variables represent related but also separable constructs. Thus, the general amount of effort invested on cognitive tasks seems to be relatively independent from the availability of state-dependent cognitive self-control capacities. Moreover, we found decreasing trajectories for both students' state self-control capacity and effort investment over the course of the testing session. These decreases in state self-control capacity and effort investment were also correlated. Although the correlation was rather small, it nevertheless supports the hypothesis that decreased state self-control capacity is reflected in a decline in motivational effort (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014); this motivational effort is needed when working on an achievement test that requires the exertion of self-control in order to stay focused on the test items over longer periods of time. Therefore, our result provides support for the assumptions of the process model of self-control (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014). Furthermore, the pattern of the correlated decreases in state self-control capacity and effort investment is similar to the results reported by Ackerman and Kanfer (2009). They found that students who indicated a reduction in invested effort when working on an intelligence test experienced higher levels of mental fatigue during the testing session. Thus, our result also supports the assumption that low state self-control capacity is related to mental fatigue and that self-control decrements might represent a phenomenon that takes longer to materialize (cf., Hagger et al., 2016). In addition to the average decreases in students' state self-control capacity and test-taking effort, we found interindividual variability in both variables' intercepts and slopes. We assumed that trait self-control could be a key predictor of this variability.

As expected, trait self-control positively predicted students' effort investment during the testing session. This result is in line with the findings of Lindner et al. (2017). In their study, students with high trait self-control tended to invest more time-on-task throughout achievement tests and reported higher levels of test-taking motivation and effort than students with lower trait self-control. This suggests that high trait self-control supports students' test-taking effort and might be necessary in order for them to be able to initiate controlled information processing when working on problem-solving and reasoning tasks during achievement tests in mathematics and science. Thus, the assumption that trait self-control constitutes an effort investment trait is supported by our data (Duckworth et al., 2015; Lindner et al., 2017).

Furthermore, individuals with high trait self-control started and finished with higher levels of state self-control capacity than individuals with low trait self-control. Thus, high levels of trait self-control seem to support the ability to persist in working on the test in a goal-directed manner. This is in line with the assumption that individuals with high trait self-control have more adaptive routines and might use more efficient and self-control strategies for dealing with response conflicts (Gillebaart & De Ridder, 2015).

On the other hand, we did not find any relations between trait self-control and changes in either state self-control capacity or effort investment. These results indicate that even high amounts of trait self-control cannot prevent individuals from experiencing a decrease in state self-control capacity and effort investment over the course of an achievement test. Thus, the assumption of Gillebaart and De Ridder (2015), who state that individuals with high trait self-control seem to use more effortless self-control strategies, which might protect them from increasing self-control depletion effects, is not supported, since we did not find any significant relations between trait self-control and either variables' slope factors.

For this reason, we strongly recommend that future research investigates variables that might alternatively explain the simultaneous decrease in state self-control capacity and effort investment over the course of time. One such variable is assumed to be attention control (e.g., Inzlicht et al., 2014; Schmeichel, 2007). Executive attention, as a function of the working memory system, determines the effectiveness in performing task-relevant operations on the information stored in long-term memory (Hofmann, Schmeichel, Friese, & Baddeley, 2011). Studies have found that executive attention is negatively related to the number of intruding thoughts that people have while working on thought suppression tasks (Brewin & Beaton, 2002; Brewin & Smart, 2005). Similar results were reported by Bertrams et al. (2013), who found that students with low state self-control capacity were distracted more often by worrying thoughts during an arithmetic test, implying that they were not able to keep their attention focused on the items' content. Furthermore, Inzlicht et al. (2014) suggest that such attentional shifts toward distractors go hand in hand with reduced effort investment on the self-control-requiring task at hand. With regard to the discussion about the replicability of experimentally induced self-control depletion effects, two high-powered preregistered experimental studies recently provided evidence that self-control depletion is a real phenomenon that is related to poor attention control (Garrison, Finley, & Schmeichel, 2018). Therefore, we hypothesize that attention control might play a crucial role in predicting decreases in state self-control capacity and effort investment, as we found in the present study.

Furthermore, in future research, it would be interesting to examine the relations between students' state self-control capacity, their effort investment, and their performance during achievement tests. Unfortunately, in the present study, we were not able to investigate these relations due to the varying sets of domain-specific items that were included in the different multimatrix test booklet versions used. Thus, we did not infer students' state self-control capacity from their achievement-test performance; rather, we repeatedly applied the five-item Brief State Self-Control Capacity Scale (Lindner, et al., 2018) to measure students' perceived state self-control capacity over the course of the achievement test. This self-report measure can only be interpreted as an indicator of the degree of state self-control capacity, and cannot display the full depth of self-control depletion, which is generally not a completely conscious phenomenon. However, Clarkson, Hirt, Jia and Alexander (2010) provide evidence that the perceived level of state self-control is more predictive of subsequent self-controlled behavior than the actual self-control depletion level that is induced by working initially on self-control requiring tasks. In order to investigate dynamic self-control processes in greater detail (cf. e.g., Inzlicht & Schmeichel, 2012), the Brief State Self-Control Capacity Scale (Lindner, et al., 2018) seems to be an appropriate measure for assessing changes in students' state self-control capacity in achievement-test situations. Thus, our findings are among the first to shed light on the interplay between students' state self-control capacity and test-taking effort over the course of an achievement test, while considering trait self-control as a covariate.

5. Conclusion

In conclusion, the present study provides first insights into the effects of trait self-control on the interplay between students' state self-control capacity and effort investment over the course of a long achievement test. We have demonstrated the benefits of modeling the relation between progressive changes in state self-control capacity and effort investment over test-taking time, which may be a useful approach in future research for investigating students' test-taking behavior as well as the underlying mechanisms of self-control. Up until now, there has not been much evidence to show that self-control depletion is related to reduced motivational effort (Baumeister, 2014). In our study, we found correlated decreases in state self-control capacity and effort investment and our results thus support the process model of self-control (Inzlicht & Schmeichel, 2012; Inzlicht et al., 2014). Furthermore, high trait self-control was found to be supportive in keeping students' test-taking effort and their state self-control capacity at a higher level over the course of the test.

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