
**Doctoral thesis submitted to
the Faculty of Behavioural and Cultural Studies
Heidelberg University
in partial fulfillment of the requirements of the degree of
Doctor of Philosophy (Dr. phil.)
in Psychology**

Title of the thesis
Scrum and Self-Control

How a team-based software development methodology
can support team members' self-control

presented by
Philipp Heß

year of submission
2015

Dean: Prof. Dr. Klaus Fiedler
Advisor: Prof. Dr. Klaus Fiedler

Danksagung

Über die Jahre haben mich viele Menschen bei der Erstellung dieser Arbeit unterstützt. Bei ihnen will ich mich an dieser Stelle recht herzlich bedanken.

Ein ganz besonderer Dank gilt meinem Betreuer Klaus Fiedler, der mir die Erstellung dieser Arbeit überhaupt erst ermöglichte. Die langjährige vertrauensvolle, wertschätzende und sehr lehrreich Zusammenarbeit in einer Reihe von Projekten sowie im Hinblick auf meine Dissertation bedeutet mir persönlich sehr viel und war für mich eine im besten Sinne prägende Erfahrung. ~ Meiner Frau Nicole kann ich nicht genug danken. Ohne ihre Unterstützung hätte diese Arbeit nicht realisiert werden können. Meinen Töchtern Gwenda und Lia danke ich für ihre – altersgemäß – aufgebrauchte Geduld mit ihrem ständig am PC sitzenden und arbeitenden Papa. ~ Ein sehr herzlicher Dank gilt Susanne Beier für die unzähligen ernsthaften, lustigen, aufschlussreichen und interessanten Unterhaltungen im Institut und auch für ihre Unterstützung, nachdem wir uns schon nicht mehr allfreitäglich im gemeinsamen Büro trafen. ~ Für die umfangreiche Hilfe, weiterführenden Anmerkungen, nützlichen Kommentare und inspirierenden Diskussionen auch vielen Dank an André Mata, Anja Geiger, Christian Schneider, Dirk Völz, Florian Kutzner, Heike Dietrich, Hilmar von Strünck, Joachim Schnitter, Jule Kunkel, Mandy Hütter, Markus Nagler und Sabine Scholl. Für die viele weitere, direkte oder indirekte Unterstützung in den zurückliegenden Jahren danke ich noch meinen CRISPIes sowie Frederick Wein, Heidrun Kleefeld, Karin Bartl, Sebastian Wieczorek und Ute Lorenz.

Vielen Dank!

Für
Nici, Gwenda & Lia

Contents

Abstract	6
1 Introduction	7
1.1 Self-Control	8
1.1.1 Control Theory	9
1.1.2 Ego Depletion	10
1.1.3 Improving Self-Control	11
1.2 Agile Software Development with Scrum	13
1.2.1 Roles	14
1.2.2 Artifacts	15
1.2.3 Temporal Structure: The Sprint	15
1.2.4 Development Teams as Self-Managing Work Teams	17
2 Scrum and Self-Control	22
2.1 Scrum Supports High Self-Control	24
2.1.1 Concrete Planning	28
2.1.2 Progress Monitoring	31
2.1.3 Short Iterations	32
2.1.4 Process Improvements	34
2.1.5 Construal Level Switch	36
2.1.6 Team Autonomy	37
2.2 Trait and State Self-Control	39
2.3 Effects of High Self-Control	41
2.3.1 Increased Team Performance	42
2.3.2 Lower Stress Level	43
2.3.3 Improved Health	46
3 Study 1	48
3.1 Method	48
3.1.1 Participants and Design	48
3.1.2 Materials	49
3.1.3 Procedure	55
3.2 Results and Discussion	56
3.2.1 Pretest of Scales	56
3.2.2 Data Preparation and Regression Analyses	58

3.2.3	Scrum Supports High Self-Control	59
3.2.4	Effects of High Self-Control	71
3.2.5	Final Thoughts	82
3.2.6	Summary	88
3.2.7	Post-hoc Analysis	90
4	Plan Specificity and Self-Control	91
4.1	Experiment 1	93
4.1.1	Method	94
4.1.2	Results and Discussion	97
4.2	Experiment 2	114
4.2.1	Method	114
4.2.2	Results and Discussion	116
4.3	Discussion	123
4.3.1	Plan Specificity and Self-Control	123
4.3.2	Self-Control and the Stroop Task	127
4.3.3	Summary	134
5	Conclusion	135
5.1	Scrum and Development Team Members' Self-Control	136
5.2	Practical Implications	138
5.2.1	Plan and Monitor	139
5.2.2	Take Sprints Seriously	140
5.2.3	Foster Process Improvements	141
5.2.4	Support Team Autonomy	142
5.2.5	Core Principles of Scrum	143
5.3	Summary	144
	References	146
	List of Tables	170
	List of Figures	171
	List of Abbreviations	172
	Appendix	173
	Items per Scale (Study 1)	173
	Complete Questionnaire (Study 1)	176
	Declaration	181

Abstract

Scrum is an agile software development methodology that suggests highly structured and iterative processes of software development by small autonomous teams (Schwaber & Sutherland, 2011). It is hypothesized that Scrum can be implemented in a way that supports and potentially improves Development Team members' self-control. High self-control yields positive effects in countless life domains (Tangney, Baumeister, & Boone, 2004). One correlative study with 23 Development Teams and a total of 171 team members from an international software company investigated relevant conditions of Scrum to support and improve the self-control of Development Team members. Findings indicate a potential self-control improvement by the creation of a moderate concrete plan, the Sprint Backlog, at the beginning of a development cycle (Sprint), and performing an active team internal progress monitoring during the Sprint in short daily meetings (Daily Scrum Meetings). Planning and monitoring correlated simultaneously with high trait self-control and with low state self-control, indicating a possible self-control improvement through Scrum. Frequent team internal discussions targeting process improvements in Sprint Retrospective Meetings were related to high state self-control. In addition to correlations found with team members' self-control, high team performance correlated with finishing committed Sprint Backlog Items by the end of the Sprints and reviewing these in the Sprint Review Meetings. Development Team members' good health and low stress correlated with high team members' self-control. High team autonomy was an essential requirement of the potential self-control improvement process. Moreover, high team autonomy correlated positively with high team performance and low experienced stress of Development Team members. Adding to these results, one laboratory experiment found indications that Sprint Backlog Item specificity may affect self-control during the processing of that item, suggesting a preference for moderate as opposed to low or highly specific Sprint Backlog Items. A second laboratory experiment failed to reproduce and extend this finding, probably because of the plan specificity operationalization. Overall, theoretical considerations and empirical indications are presented that Scrum could be implemented in a way that supports and potentially improves Development Team members' self-control and health, reduces Development Team members' experienced stress, and improves performance of the Development Team.

1 Introduction

”If we don’t discipline ourselves,
the world will do it for us.”

William Feather

Software development and self-control research seem to be very distinct spheres. They do not seem to be linked at all. However, two recent developments in both these spheres coincidentally bring them closer together. For some years, the focus of self-control research was on ways to improve self-control. Some years ago, in software development a new paradigm originated. Agile software development was and is a new way of implementing software. Within the agile software development paradigm, Scrum is a very important method of project management. These two developments are not connected at first sight. However, on second, closer investigation suggests they can be related. In fact, it appears as if agile software development with Scrum unwittingly translates recommendations from empirical self-control research into action.

In other words, process descriptions of Scrum still leave room for interpretation of how these processes should be implemented concretely. As experienced by the author of this dissertation, Software development practitioners tend to apply a rather technical perspective to software development processes. They tend to focus on such aspects as information- and value-flow rather than on psychological processes of the human beings involved. Team members are regarded ”resources” who contribute to the team’s outcome; but psychological aspects, such as team cohesion, team members’ motivation, and their need for connectedness and mastery, are not really the focus for software development practitioners. Sometimes there is a lack of clarity about how a described software development process should be established and how the interpersonal interactions should actually be shaped. In these cases, psychological research in general and self-control research in particular can help with recommendations from empirically well funded results. This topic is the focus of present research of this dissertation.

I investigated the Scrum processes in an organizational context and supplemented the results of the study with two laboratory experiments. The results demonstrate the fruitful applicability of psychological self-control research on software development processes of Scrum.

In the following sections, a short introduction to self-control research will be given, followed by an introduction to agile software development with Scrum. The subsequent Chapter 2 *Scrum and Self-Control* develops the theoretical background of the relationship between Scrum and self-control. This relationship will be investigated empirically, and results will be discussed in Chapter 3 *Study 1*. Study 1 reveals that Scrum and self-control correlate. Still, the results of Study 1 are not suitable for deciding on which of the two elements, Scrum and self-control, influences which. To substantiate the claim that Scrum can positively influence self-control, one partial finding of Study 1 will be analyzed, as a prototype, in more detail. Two laboratory experiments conducted are described and discussed in Chapter 4 *Plan Specificity and Self-Control*. Finally, Chapter 5 *Conclusion* gives a brief conclusion regarding present research findings, and derives practical implications.

1.1 Self-Control

Briefly put, self-control is the ability to act according to long-term goals rather than by short-term impulses (Baumeister, Vohs, & Tice, 2007; Hagger, Wood, Stiff, & Chatzisarantis, 2010). Recent findings show strong positive relations between high self-control and increased performance; better psychological adaptation (including higher self-esteem and better emotional reaction); and higher interpersonal competencies (leading to better interpersonal relationships; Tangney, Baumeister, & Boone, 2004). Moreover, no negative effects of very high levels of self-control have been found so far. It seems that there is no such thing as too much self-control (Baumeister & Alquist, 2009a; de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2012). Thus, the overall conclusion at this point is: the higher a person's self-control, the greater the benefit for that person. Additionally, a lack of self-control is related negatively to health, well-being, and wealth (Steel & Ferrari, 2013).

Broadening the perspective, self-control is more than a beneficial individual characteristic. Indeed, self-control can be characterized as *the* central human capability. Self-control enables humans to transcend current situations for adapting their behavior. People are not tied to simple stimulus-response behavior stemming from the here and now, but may show behavior based on long-term goals or abstract cognitive constructs (Baumeister & Vohs, 2004). This alone enabled the rich development of filigreed cultural and social human environment as well as technical achievements. Even today, human societies benefit on a large scale from high self-control of their individual members (Moffitt et al., 2011).

1.1.1 Control Theory. There is a multitude of theoretical approaches to self-control. One outstanding framework that can be used to organize self-control research is control theory (Carver, 2004; Carver & Scheier, 1982; Sheeran & Webb, 2012). According to this theory, self-control can be categorized by four main processes. Firstly, a goal needs to be set that someone wants to reach. Secondly, progress toward the goal needs to be monitored. Thirdly, to enable approaching the goal, behavior has to be adapted accordingly. This implies that automatic behaviors or impulses may have to be altered or overridden. And fourth, in the light of the actual goal-progress the goal itself may need to be revised, or a disengagement from the goal may be required. These four processes constitute a feedback loop that is processed until the goal is reached or abandoned.

The four processes are sometimes subsumed under the term "self-regulation", referring broadly to any conscious or unconscious, effortful or automatic, deliberate or impulsive goal-directed behavior. According to these concepts, self-control is primarily distinguished from self-regulation by referring only to specific aspects of conscious impulse control (Baumeister & Vohs, 2004; Baumeister et al., 2007; Förster & Jostmann, 2012; Hofmann, Schmeichel, & Baddeley, 2012). In another conceptualization, high self-control is seen in the ability to delay gratification (Mischel, Shoda, & Peake, 1988; Mischel, Shoda, & Rodriguez, 1989). More generally, self-control can be understood as solving conflicting dual-motive situations in terms of advancing distal over proximal goals (Fujita, 2011). Dual-process theories from different research approaches converge

in a similar distinction. In sum, successful self-control can be described as behavior guided by long-term goals, ideals, or rather cold cognitions, based on effortful reflection, as opposed to behavior guided by short-term goals, impulses, rather hot emotions, or behavior that is initiated by situational cues in an automatic and effortless manner (Carver, 2005; Friese, Wänke, & Hofmann, 2009; Fujita, Trope, Liberman, & Levin-Sagi, 2006; Metcalfe & Mischel, 1999).

1.1.2 Ego Depletion. Behaving according to cognitive, rather long-term goals or ideals can be exhausting at times. It may require overriding impulses; for example, if someone is following a diet and is tempted by good-smelling food. It could require controlling one's attention to stay focused or control one's thoughts or emotions to stay on track for the goal that one is pursuing. All these attempts to control oneself can be exhausting, and subsequent attempts to further control oneself are even harder (Baumeister, Bratslavsky, Muraven, & Tice, 1998; Baumeister & Vohs, 2007). This "state of diminished resources following exertion of self-control" (Baumeister et al., 2007, p. 352) is called *ego depletion*. The process of ego depletion is the center of ego depletion theory by Roy Baumeister and other researchers. According to that line of research, a crucial aspect of ego depletion is that all of these controlling processes depend on the same internal resource of energy. This means that no matter in which ego depletion occurred, effects of ego depletion can be observed in other domains as well. For instance, after resisting temptation, people have more difficulty controlling their emotions. An illustrative experimental example is Study 1 of Baumeister et al. (1998). People were invited to a study that started with a taste-perception test. Participants in the experimental group were asked to taste red and white radishes while seeing and smelling some freshly baked chocolate chips. Participants in a control condition took the taste-perception test with these chocolate chips instead of the radishes. Successive to the taste-perception test, all participants performed an unrelated task, tracing geometric figure lines without lifting their pencil. They did not know that the two tasks were in fact impossible to solve. The number of attempts to solve the figures and the time taken were noted. The experimental group was compared to the control group and an additional second control group that had done only the figure-tracing task. For the experimental group, resisting the impulse to eat chocolate chips and performing

the rather undesirable act of eating radish had a high psychic cost. These participants gave up much earlier and made considerably fewer attempts to solve the figures when compared to both control groups.

In sum, according to the current state of research, a high capacity to exert self-control is absolutely positive and does not have any negative effects (Baumeister & Alquist, 2009a). The influence of ego depletion has been demonstrated in a wide range of domains in a multitude of different studies and experiments (Hagger et al., 2010). From a societal perspective, the enhancement of individuals' self-control can be seen as desirable since many social processes depend on and require high self-control (Bauer & Baumeister, 2011).

1.1.3 Improving Self-Control. The capability to exert self-control in a given situation depends largely on the state of depletion at the time. If a person is depleted by prior self-control exertion, that person may fail to continue exerting self-control. Nevertheless self-control is a personal characteristic that is rather stable for a person over different situations (Gailliot, Gitter, Baker, & Baumeister, 2012). This trait-like quality of self-control that influences broad aspects of life is mostly stable throughout one's lifespan (Mischel et al., 1988; Tangney et al., 2004). Positive effects of high dispositional self-control have been found in a multitude of life domains. School and work performance especially benefit from high trait self-control. The ability to form and break habits appears to be a core capability for this relationship (Baumeister & Alquist, 2009a; de Ridder et al., 2012).

Despite being a stable personal trait, self-control strength can be improved by regular exercise of self-control (Baumeister, Gailliot, DeWall, & Oaten, 2006; Gailliot, Plant, Butz, & Baumeister, 2007; Muraven, 2010a; Muraven, Baumeister, & Tice, 1999). Self-control strength generalizes to a vast number of life domains. That is, improving self-control in one domain spills over to other life domains. Improving self-control, for example, by studying regularly as a student can increase self-control in refraining from impulsive spending or procrastinating in general (Oaten & Cheng, 2006a).

Concerning self-control improvement, self-control behaves similarly to a muscle (Baumeister et al., 2007; Muraven & Baumeister, 2000). This analogy is true in several respects,

one of which is of particular interest here: Exerting self-control depends on an internal resource that is depleted by repeated application of self-control and makes further self-controlled behavior difficult and unlikely. Yet again, just as with muscle, this short-term depletion can turn into a long-term improvement of the muscle's strength (Muraven, 2010a, 2010b; Muraven et al., 1999).

Besides improving core self-control strength, other approaches to support self-controlled behavior exist. Cognitive control theory suggests that the depletion effect stems from an effortful task-adaption process. Partly disagreeing with ego depletion theory, an improvement of self-control can, thus, be achieved by repeated execution of similar tasks and by leaving the task-adaption processes enough time to finish (Dang, Dewitte, Mao, Xiao, & Shi, 2013; Dewitte, Bruyneel, & Geyskens, 2009). Situations may be shaped in a way to support self-control. Procrastination, as self-control failure, can be reduced by adding stimuli to a situation that support goal striving and removing stimuli that hinder it (Steel, 2007). In an applied setting in a school canteen, for example, healthy food intake was supported by rearranging the salad bar and changing to cash payment rather than debit card for desserts and soft drinks (Just & Wansink, 2009). These simple changes in the canteen setting increased students' healthy food intake. Increased healthy food intake was interpreted as self-controlled behavior.

In addition to these methods of supporting self-control by repeated execution of similar tasks or shaping situations in a supportive way, several other methods to support self-controlled behavior exist. Particularly for health behavior change, a lot of methods have been proposed that were derived from very different theoretical backgrounds (Abraham & Michie, 2008). However, from these diverse theoretical backgrounds, methods derived from the control theory of Carver and Scheier (1982) were on the whole the most effective (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Thus, in the present research project, control theory has been chosen to organize the influences that can help improve self-control.

In sum, self-control is a core human capability. High self-control is related to a multitude of positive effects; among others, high school and work performance, better social relationships, increased well-being, and better health. Self-control is the ability to act

according to long-term goals rather than short-term impulse. A theory that allows organizing self-control research is the control theory (Carver & Scheier, 1982). Control theory describes four basic processes of control: goal setting, progress monitoring, adapting behavior to approach a goal, and revising or disengaging from a goal. On the one hand, self-control is a stable personal characteristic whose effects can be detected during an entire lifespan. On the other hand, situational settings can support or undermine self-controlled behavior. In addition, self-control strength can be trained and thus improved. This property of self-control might be especially leveraged by situational interventions to improve self-control. Scrum might be a framework that enables such intervention. Scrum will be introduced next.

1.2 Agile Software Development with Scrum

Ever since computers have existed, the complexity and size of problems tackled with these has grown. Comparing early German BTX online pages, or the first web pages, with today's dynamic applications that can be opened in a web browser, a dramatic development is visible. Video games are a second illustrative example of such drastic change: Early games with eight color block graphics have evolved to massive multi-player online games with realistic three-dimensional animated characters.

Agile software development constitutes one approach to deal with this increasing complexity. Furthermore, agile software development deals with a second important problem. Beginning of the twenty-first century it has become crucial for software companies to react more and more quickly to market-change (Baskerville & Pries-Heje, 2001; Dybå, 2000). In this situation a group of software practitioners published the *agile manifesto* (Fowler & Highsmith, 2001). This manifesto was the starting point of a movement of agile software development that has lasted more than a decade so far (Dingsøy, Nerur, Balijepally, & Moe, 2012; Sutherland, 2004). Agile software development differs from traditional software development in that it accepts that problems needing resolution are so complex that they cannot be specified fully at the outset (Dingsøy et al., 2012; Nerur, Mahapatra, & Mangalaraj, 2005; Rising & Janoff, 2000). Consequently, agile software development approaches utilize short iterative processes of software development, which

also allowed more flexible adaptation to market-change. The manifesto advocates relying on "individuals and [social] interactions" more than on strict "processes and tools"; and "responding to change" is more important than "following a plan" (quoted in Fowler & Highsmith, 2001, section, The Agile Manifesto: Purpose, para. 1). In this way software development became faster, allowing reduced reaction time to market-change and better adaptation to customers' demands.

Following this basic idea, several different approaches to organizing software development were created (Dybå & Dingsøy, 2008). One such approach is *Scrum*, which has gained a lot of attention. Scrum is a project management method. It is based on close teamwork in small teams, and as such is in line with a general shift to team-based approaches in economic fields due to increased global competition (Kozłowski & Bell, 2003). Using Scrum, a small set of roles, artifacts, and a temporal structure of meetings are defined, with the goal of enabling complex product development (Scrum.org, 2013).

1.2.1 Roles. In Scrum three main roles are defined: Product Owner, Development Team, and Scrum Master. These three roles interact in a specified way for software product development. The three roles taken together are referred to as the *Scrum Team* (Schwaber & Sutherland, 2011).

The Product Owner. The Product Owner is typically in contact with customers and knows the software market situation. With that knowledge the Product Owner defines the product to be developed. The Product Owner maintains a list of product features to be implemented. This list of features is called the Product Backlog.

The Development Team. The Development Team is composed of team members collaborating closely to develop the product features (Schwaber, 2004). Typically, Development Teams are composed cross-functionally. That means that team members fulfill different functions in the team. Team members are typically software developers, software testers, and technical writers; but team members with other functions may also be part of the Development Team. Ideally, all skills required to finish a product feature are available in the Development Team. Development Team members work together as a self-organizing team. The team size is intentionally kept small and should not exceed nine members (Schwaber & Sutherland, 2011).

The Scrum Master. The Scrum Master takes care that the Scrum processes are followed (Scrum.org, 2013). The Scrum Master is not a team supervisor but rather coaches and educates the Development Team, the Product Owner, and other affected organizational roles (such as line managers). The Scrum Master does not make decisions for the Development Team. Rather, the Scrum Master supports the Development Team by facilitating its self-organization (Schwaber & Sutherland, 2011).

1.2.2 Artifacts. During the product development, the Scrum Team creates several work products or artifacts: product increments, Product Backlog, and Sprint Backlog. The work of the Development Team results in new product features or *product increments*. The Product Owner defines the increments that should be implemented and added to the product. The Development Team implements the product increments. The development takes place in short cycles. After each development cycle, the developed product increments should be potentially deliverable to customers. This means that the product increments are not only implemented but also thoroughly tested and well documented.

All product increments are planned in advance for the next development cycle by the Product Owner and are listed in the *Product Backlog*. The Product Backlog is a prioritized list of product increments (Schwaber, 2004). The priority is determined by urgency and importance of the product increments. Product increments ranked as of highest importance or urgency are at the top of the list. Lower on the list are those increments of lower priority or urgency (Schwaber & Sutherland, 2011).

When the Development Team starts working on the product increment of the highest priority, the Development Team first breaks down the rather abstract product increment descriptions from the Product Backlog into smaller, concrete task descriptions (Schwaber & Sutherland, 2011). These more detailed task descriptions for the next development cycle are listed in the *Sprint Backlog*.

1.2.3 Temporal Structure: The Sprint. Scrum has a strict and fixed temporal structure. It defines when and how Development Team members coordinate their work on product increments, and when and how the Development Team and Product Owner interact, facilitated by the Scrum Master. Development of product increments takes

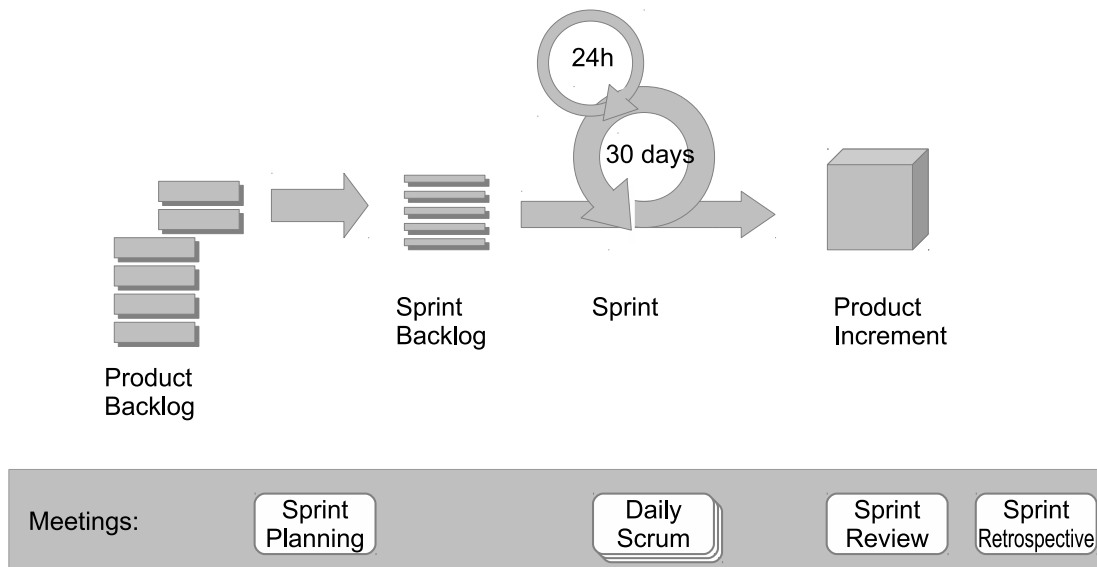


Figure 1. Scrum Artifacts and Temporal Structure

The Product Backlog is a prioritized list of software product features or product increments to be developed. Product increments with the highest priority are further refined during the Sprint Planning Meeting and are listed in the Sprint Backlog. During a development cycle, called Sprint, the Development Team coordinates and tracks progress in Daily Scrum Meetings. At the end of the Sprint, completed product increments are presented to the Product Owner and other stakeholders during the Sprint Review Meeting. Finally, the Development Team discusses internal process improvements in the Sprint Retrospective Meeting. Typically, the next Sprint starts the following day with a Sprint Planning Meeting.

place in short cycles called *Sprints*. Sprints are fixed-length intervals typically lasting four weeks or less. A Sprint starts with a Sprint Planning Meeting (see Figure 1). Daily Scrum Meetings are held until the Sprint ends with the Sprint Review Meeting and the Sprint Retrospective Meeting (Schwaber & Sutherland, 2011).

The Sprint Planning Meeting. Each Sprint starts with a Sprint Planning Meeting. The Product Owner presents the Product Backlog to the Development Team, answering *what* is planned for the upcoming Sprint. The Development Team estimates the effort for the Product Backlog Items and decides how many Product Backlog Items can be realized in the upcoming Sprint. The Development Team commits itself to finishing the selected Product Backlog Items by the Sprint Review Meeting. The selected Product Backlog Items comprise the Sprint Goal. In the second part of the Sprint Planning Meeting, the Development Team discusses *how* the team will accomplish this Sprint Goal, and creates the more detailed Sprint Backlog (Schwaber & Sutherland, 2011).

The Daily Scrum Meeting. During the Sprint, the Development Team members regulate the software development process by daily inspection of the progress toward the Sprint Goal in the Daily Scrum Meetings. The Daily Scrum Meeting has the role of a “key inspect and adapt meeting” (Schwaber & Sutherland, 2011, p. 11). It is limited to fifteen minutes. The purpose of the Daily Scrum Meeting is to monitor the work of the team and keep team members on track with the Sprint Goal (Schwaber & Sutherland, 2011).

The Sprint Review Meeting. The Sprint Review Meeting takes place at the end of each Sprint. In the Sprint Review Meeting, finished Product Backlog Items are presented by the Development Team and given to the Product Owner and other stakeholders. The intention of the Sprint Review Meeting is to strengthen the collaboration between the Development Team and its stakeholders (including the Product Owner), and to elicit feedback for the Development Team (Schwaber & Sutherland, 2011).

The Sprint Retrospective Meeting. The Sprint itself is officially closed by the Sprint Retrospective Meeting. The Sprint Retrospective Meeting takes place after the Sprint Review Meeting. The Development Team reviews the Sprint team internally and decides on practical improvements for the next Sprint, to make working “more effective and enjoyable” (Schwaber & Sutherland, 2011, p. 12).

Scrum is a project management method enabling agile software development. The Product Owner, Development Team, and Scrum Master interact closely to develop product increments. Additional artifacts, created to coordinate the collaboration, are the Product Backlog and the Sprint Backlog. Collaboration during the Sprints, which typically last up to four weeks, is structured by the Sprint Planning Meeting, the Daily Scrum Meeting, the Sprint Review Meeting, and the Sprint Retrospective Meeting.

1.2.4 Development Teams as Self-Managing Work Teams. Development Teams of Scrum can be characterized as self-managing work teams (SMWT). SMWTs originated in the 1970s. With SMWTs, working conditions fundamentally changed from a Tayloristic-inspired approach to a group-based approach. In a Tayloristic approach, planning and execution of processes are strictly separated. Often the defined, optimal processes were meaningless, repetitive and mechanistic for the workers (Nerdinger,

Blickle, & Schaper, 2008; Ulich, 2005). Group based approaches were first tried in Scandinavian countries. Assembly-line workers were formed into groups that were given the autonomy to decide on team-internal processes (Antoni, 1996). In Germany the program for "humanization and democratization of work" also included experimentations with group work. However, there was no sustainable progress on group work until the 1990s, when companies experimented with group work once again. This time it was driven by the companies' need due to increased market competition, which demanded higher flexibility, quality, and productivity (Antoni, 1996). SMWT take over whole and identifiable pieces of work for which they have responsibility. This is one key difference from classical work groups. Classical work groups are organized around one supervisor who is responsible for the planning and assignment of tasks to group members, as well as for the result of the work group (Antoni, 1996).

The Development Teams of Scrum are also organized in a group-based way. One major difference between Scrum's Development Teams and SMWTs is that SMWT originated and were primarily implemented in manufacturing companies. Software development is performed by knowledge-based workers, who differ from classical employees on an assembly line in manufacturing companies. Most obviously, knowledge workers are not engaged in physical labor but instead in rather creative work (for software development in particular) that is cognitively complex and non-repetitive. Nevertheless, that distinction aside, Development Teams of Scrum are rather similar to SMWTs. Conceptually, SMWTs are small teams that constantly interact in their day-to-day work (Antoni, 1996). They are in charge of production of a (partial) product and take over all required tasks for that. Additionally, SMWTs take care of planning and monitoring of task execution and the controlling of results. SMWTs are self-regulating in the sense that they decide internally on details and work-assignment of task execution and monitor process improvements.

SMWTs and Development Teams of Scrum seem to be organized quite similarly. As with SMWTs, Development Teams work together constantly in a day-to-day fashion. It is intended that Development Teams take over whole and identifiable pieces of work. This is also visible in the advice that Product Owners create a summary statement

with a cohesive theme of the planned Sprint to present to the Development Team in the Sprint Planning Meeting (Deemer, Benefield, Larman, & Vodde, 2012). The Development Team makes a detailed plan of the tasks required (Sprint Planning Meeting), the assignment of these tasks, and the monitoring of work progress (Daily Scrum Meeting). The Development Team is in charge of quality insurance and delivers the finished product increments (Sprint Review Meeting). Finally, the Development Team itself takes care of process improvements (Sprint Retrospective Meeting). Typically, there is no team speaker for a Development Team, but the Scrum Master supports the team by facilitating the team's meetings (Schwaber, 2004; Schwaber & Sutherland, 2011; Scrum.org, 2013). SMWTs can decide on a team speaker who acts as the contact-person for management and facilitates team meetings. A leader of a SMWT should support self-management of the team. To improve team effectiveness, a leader of a SMWT should support a democratic culture in the team and, ideally, a leader should be involved only passively in the team's progress (Kozlowski & Bell, 2003). From that perspective, a Scrum Master in a Development Team resembles this ideal-typical leader of a SMWT. Development Teams of Scrum autonomously decide how to implement new product increments. According to the model of Gulowsen (1972; see also Susman, 1976; Alioth, 1980; all as cited in Antoni, 1996, pp. 27–29) autonomy can be divided into self-regulation, self-determination, and self-administration. For all three aspects, some degree of autonomy is granted to Development Teams.

Firstly, in the model of Gulowsen (1972; as cited in Antoni, 1996, pp. 27–29) self-regulation comprises decisions about which team member assumes which tasks, how tasks are executed, whether the group has an internal leader and who that group leader is; finally, the group may decide on group membership in general. Scrum's Development Teams can decide the internal task assignment, and team members can freely choose tasks they work on. However, Development Teams are not allowed to decide on team membership or who should be an internal leader. The Scrum Master's role is defined as supporting team self-organization, which possibly includes preventing the team from electing a formal leader.

Secondly, self-determination comprises where and when the team members work, whether the team takes over additional optional tasks, and which tools are used. Self-determination is basically granted to Scrum's Development Teams. This criterion of self-determination is only partly applicable to software development, which is more flexible for employees than work on a manufacturing assembly line. Thus, decisions of where and how to work, which tools to use, or if optional tasks are taken up are mostly up to the Development Team.

Thirdly, self-administration comprises decisions about quantity and quality of goals and the decision on who, if anyone, represents the team to the outside world. Scrum's Development Teams are also largely self-administrated. Teams can influence and decide in part on their quantity- and quality-goals. Teams are free to decide how many Product Backlog Items they commit to in the Sprint Planning Meeting, and thus can decide on the quantity of goals. The quality of goals can be influenced indirectly. To create a realistic and feasible Product Backlog, Product Owners typically need to consult Development Teams for technical advice. Therefore, Development Teams are involved practically right from the early stages of Product Backlog creation and can influence the quality of goals implicitly. Concerning team representation to the outside world, Development Teams can choose a team member, although this task is not formally defined in Scrum literature. All in all, based on the Gulowsen model of autonomy (1972; as cited in Antoni, 1996, pp. 27–29), Scrum's Development Teams can be described as SMWTs with certain aspects of autonomy granted them.

The introduction of SMWTs can have diverse effects. Normative models suggest positive effects, such as increasing the quality and quantity of the teams' output. For employees, positive effects are expected, such as promoting personal development. However, empirical results regarding these assumed benefits are mixed (Antoni, 1996). The introduction of SMWTs does not always lead to expected improvements, since the implementation requires difficult changes in employee-job relationship throughout the organization (Elmuti, 1996; Yeatts & Barnes, 1996). It appears that introducing SMWTs does not guarantee the expected positive effects but instead increases the potential of humanized working conditions (compared to non-group-based organiza-

tions; Antoni, 1996). Positive effects have been reported. Increased job satisfaction due to the installment of SMWTs has been found; in addition, positive changes of working conditions for employees, signaled by a decrease in physical and psychophysical complaints, have been found in a service company (Myers, 1986, as cited in Ulich, 2005, pp. 250–251; Van Mierlo, Rutte, Kompier, & Doorewaard, 2005). Changing working conditions to group work and to working on whole and identifiable pieces of work are promoted by corporate health management. Due to positive effects on employees' self-esteem, internal control beliefs, motivation, health, and performance ability, the installment of these working conditions can also lead to an overall increase in productivity, quality, and flexibility of organizations (Ulich, 2005).

Outcomes similar to those depicted from the interventions of corporate health management may be expected for the employment of SMWTs as well, since with SMWTs group work and working on whole and identifiable pieces of work are also employed. The organizational effects of improved performance and quality by the installment of SMWTs are supported empirically by different studies (Attaran & Nguyen, 1999; Mathieu, Gilson, & Ruddy, 2006; McCafferty & Laight, 1997). These studies are not restricted to merely those manufacturing companies where the change to SMWTs originated (cf. Attaran & Nguyen, 1999; McCafferty & Laight, 1997). Instead, positive results have also been reported from the health sector and from service-oriented companies (Davies, 2003; Myers, 1986; as cited in Ulich, 2005, pp. 250–251).

Development Teams of Scrum can be regarded as SMWTs. As such, positive effects of the introduction of SMWTs into organizations can be expected for individual employees as well as the whole organization. For individual employees, these effects are due to promoting personal development. For whole organizations, these effects are due to increasing flexibility, quality, and productivity.

In sum, Scrum is an agile software development method that emerged in reaction to increasing software market competition. The increasing competition required greater speed and flexibility of software development while being confronted with increasingly complex problems. Scrum defines a set of roles, artifacts, and a fixed meeting structure for short cyclic, iterative, and incremental software development. With that, Devel-

opment Teams of Scrum potentially leverage positive effects, such as improved quality or productivity, by merely introducing group work similar to SMWTs. In addition, processes introduced by Scrum might unwittingly implement measures that support self-control of Development Team members. Self-control is a core human capability. High self-control is related to a multitude of positive outcomes, such as improved school and work performance, better social relationships, and better health. Besides being a stable personal characteristic, self-control can be trained and improved. Scrum might help to improve self-control of Development Team members. Details of this process will be explained next.

2 Scrum and Self-Control

What does Scrum have to do with self-control? It is commonly agreed on by Scrum practitioners that Scrum requires high self-discipline (Ambler, 2007, 2009; Wang, 2013). Scrum defines only a small set of rules, but it is very difficult to constantly follow these; therefore, lot of self-control is necessary. To give an example, Sprints and all Scrum meetings are intentionally kept short and are time-boxed. Time-boxing means that the duration is fixed and cannot be extended. For instance, the Daily Scrum Meeting lasts only fifteen minutes. To stay within this time frame, the Development Team members need to be focused the entire time and cannot discuss off-topics even for a moment. This requires a high level of constant self-monitoring and impulse suppression. As a result, high Development Team members' self-control most likely supports implementing Scrum.

However, the opposite influence might exist as well: Implementing Scrum might support self-control of the Development Team members. In self-control research, positive effects of high self-control on high performance, reduced stress, and good health have been shown (Oaten & Cheng, 2006a). The question now is, if Scrum supports self-control and, if it does, might it also elicit these positive effects of high self-control?

This chapter will elaborate on the relation between Scrum and self-control, including how Scrum can contribute to Development Team members' self-control, how it can contribute to lower stress, better health, and to higher team performance.

The relationship of Scrum and self-control is most likely mutual. On the one hand, high self-control is required for and supports the Scrum processes. Team members with high self-control are most likely able and perhaps also more willing to work in a Scrum environment with high demands on self-organization and self-control. On the other hand, the processes of Scrum might support team members' self-control. Frequent practice of self-control and habituation of self-controlled behaviors by executing the Scrum processes may improve team members' self-control (Muraven et al., 1999; Palfai, 2004). Although investigating both causal directions would certainly yield interesting results, the focus will further be on the second causal direction, investigating how Scrum can positively influence self-control of Development Team members.

To derive a research model of Scrum influencing Development Team members' self-control, the core principles of the Scrum meetings can be described as follows. Firstly, a concrete planning is performed in the Sprint Planning Meeting; secondly, a thorough progress monitoring is performed in the Daily Scrum Meetings throughout the Sprint; thirdly, the Development Team works in an iterative process with short (maximum four weeks) deadlines marked by the Sprint Review Meetings; and, fourth, team processes are continuously improved in the Sprint Retrospective Meetings. Additionally, at the core of Scrum there is the autonomous Development Team, that is, a team-based working mode in a SMWT.

The overall research model is depicted in Figure 2. The model summarizes the predicted associations between the Scrum principles of concrete planning, progress monitoring, short iterations, process improvements, team autonomy, and Development Team members' self-control. Additionally, a switching of the construal level evoked by the Scrum processes might support Development Team members' self-control. This relation will be described in Chapter 2.1.5 *Construal Level Switch*. Development Team members' self-control is in turn associated with Development Team performance, Development Team members' low stress, and better health. In the following chapter, the relationship between the Scrum principles and self-control will be described. The differences between trait and state self-control are outlined in the subsequent chapter. After that, the next chapter describes expected effects of Development Team members' self-control on

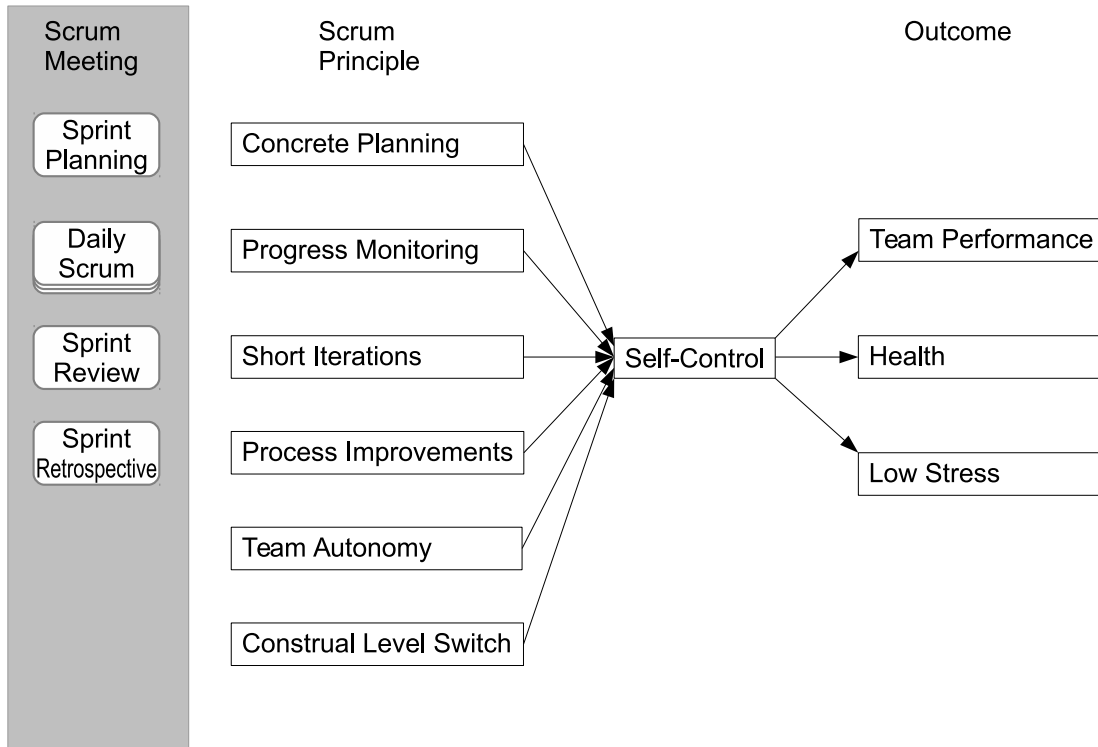


Figure 2. Research Model (Study 1)

The Scrum meetings are depicted on the left with their derived Scrum principles on the right. In Sprint Planning Meetings a concrete planning is done, while daily Scrum Meetings support progress monitoring. Sprint Review Meetings finish the Sprints of a fixed duration of four weeks or less, resulting in a software development process with short iterations. Sprint Retrospective Meetings foster process improvements of team processes. Two additional Scrum principles are that the Development Team has a high team autonomy and that Scrum may evoke a frequent construal level switch of Development Team members. The Scrum principles are expected to support Development Team members' self-control. High self-control, in turn, is known to relate to high individual and potentially to high team performance, to low experienced stress, and to good health. Most likely, direct influences of Scrum principles on team performance, stress, and health exist as well. These direct influences are not included in the figure, because these are not in the focus of present research.

team performance, team members' low experienced stress, and health. In addition, direct relationships between Scrum principles and Development Team performance, team members' low stress, as well as better health will be discussed.

2.1 Scrum Supports High Self-Control

Research shows that self-control can be improved by situational interventions. Controlling stimuli in a situation can reduce procrastination and, thus, support goal-directed behavior (Steel, 2007). Healthy eating, considered as self-controlled behavior, was

increased in a canteen by simple rearrangement of the salad bar and changing to cash payment instead of debit card for desserts and soft drinks (Just & Wansink, 2009). If a setting supports focusing on costs instead of benefits of an impulsive action, self-control will be likely supported (Trudel & Murray, 2013); or if a situation increases self-awareness of ego depleted persons, this can increase motivation and thereby help to overcome the performance decline due to ego depletion (Alberts, Martijn, & de Vries, 2011).

Oaten and Cheng (2006a) gave an impressive demonstration of an intervention in an applied setting. Students were supported for one semester in improving their self-control. Based on the ego depletion model, Oaten and Cheng created a self-control reinforcing treatment (Baumeister, Heatherton, & Tice, 1994; Muraven et al., 1999; Muraven, Tice, & Baumeister, 1998). At the beginning of the semester, students had to create a detailed plan of their learning activities. During the semester, students monitored their progress via daily learning diary and a daily record of their learning hours. In addition, Oaten and Cheng imposed artificial early deadlines by when students had to complete their learning activities. The outcome of these interventions was very positive on different measures. Students in this experimental group were compared to students in a control group and to their own baseline at the beginning of the semester. The second measure point was in the middle of the exam phase at the end of the semester. Nevertheless, as measured by a visual tracking task, students in the experimental group showed an increased self-control capacity. Students in the control group showed a reduced self-control capacity, apparently caused by an increased stress level they experienced during the exam phase. For students in the experimental group, the stress level was by no means increased compared to the beginning of the semester. Students in the experimental group also reported increased self-care habits, more healthy eating, more physical activity; they reported decreased impulsive purchasing and binge eating, less procrastination and, moreover, a reduced intake of caffeine, alcohol, and reduced smoking. For all of these dimensions, students in the control group reported a decline of advantageous, self-controlled behaviors during the exam phase. Students' grades, as indicator of performance, were not recorded.

However, students in the experimental group spent twice as much time learning per week compared to the beginning of the semester. Students in the control group did not spend more time learning. Hence, assuming a positive relation between learning time and good grades, which is supported empirically (Keith, 1982; Stinebrickner & Stinebrickner, 2004; but see contradicting results found by Mercier & Ladouceur, 1983; Morgan, 1985), a better performance of students in the experimental group can be expected.

The setting of Scrum is strikingly similar to the self-control improvement program of Oaten and Cheng (2006a). Similar to the setting of the self-control improvement program, Scrum implements a planning of the next Sprint in the Sprint Planning Meeting; the monitoring of task progress in Scrum is performed in the Daily Scrum Meeting and the Review Meeting at the end of the Sprint. Finally, Scrum also implements artificial early deadlines, as new product increments are typically not delivered to customers after each Sprint, but only after a few Sprints (cf. Rising & Janoff, 2000). For instance, an actual delivery could take place after six Sprints. In this example, the end of the Sprints except for the sixth Sprint are artificial early deadlines, which are similar to the artificial early deadlines imposed on the students by Oaten and Cheng. Regarding this overall similarity, the implementation of Scrum in software development teams should lead to an improvement of the Development Team members' self-control.

One major difference between the self-control improvement program of Oaten and Cheng (2006a) and a Scrum environment is that Oaten and Cheng were dealing with individual students whereas Scrum is dealing with groups of employees. Most of the literature concerning self-control furthermore deals with self-control of individuals rather than groups. However, in different research domains, self-control related effects on group level have been empirically shown. Goal setting has been applied successfully to groups as well as to individuals to improve performance (Locke & Latham, 2002, 2006). Planning in groups can improve group performance (Mehta, Feild, Armenakis, & Mehta, 2009; Weingart, 1992; Weldon, Jehn, & Pradhan, 1991). Although the group setting can also have detrimental influence on individuals' self-control (Fitzsimons & Finkel, 2011), it yet seems possible to apply research findings from individual level to

group level with some care (for implementation intentions applied to the group level see for instance Wieber, Thürmer, & Gollwitzer, 2012).

I expect the Scrum principles to take effect in two ways. Firstly, at the group level a kind of emergent group self-control may be effective. That means that due to planning and monitoring on group level the group itself might increase its overall performance. Self-control theories originate from theories on cybernetics, which can describe different kinds of systems, such as biological, psychological, or social systems (Carver & Scheier, 1982, 2012; MacKenzie, Mezo, & Francis, 2012; Von Bertalanffy, 1950, 1972). From that perspective, direct effects on group-level through the Scrum principles may exist as well.

Secondly, Scrum assumedly creates an environment for the individual Development Team member that supports and improves self-control. Scrum has strict rules for planning and daily monitoring. All Development Team members have to adapt their day-to-day behavior to comply with the Scrum methodology. Scrum requires that Development Team members work in a very self-controlled way, which could train and improve self-control. For instance, Scrum is strictly priority driven (Schwaber & Sutherland, 2011). The Development Team should focus strictly on the items with the highest priority on the Sprint Backlog. In some cases, team members might prefer discussing items with lower priorities, but Scrum requires that the Development Team members work in a controlled and self-monitored fashion. Although it is not totally clear under which circumstances self-control exertion leads to self-control improvement, the working mode of Scrum may train and improve the Development Team members' self-control (Mann, de Ridder, & Fujita, 2013).

Effectively improving self-control requires that the different processes of self-control are addressed simultaneously. For health behavior, improving self-monitoring seems to be the most effective intervention if only a single process is changed. Yet, a combination with other strategies derived from control theory is probably more effective (Carver & Scheier, 1982; Michie et al., 2009). Self-regulated learning was improved only if planning, monitoring, and self-reward were addressed simultaneously by an intervention program (Greiner & Karoly, 1976). In a different study, a planning intervention

alone proved to be insufficient compared to a combined planning and self-regulation intervention (Sitzmann & Johnson, 2012). Another finding was that a self-monitoring intervention alone led to less learning compared to a combined self-monitoring and goal setting intervention (Mercier & Ladouceur, 1983). Consequently, self-control improvements should best address multiple processes of self-control simultaneously.

In the following chapters, more details will be provided about how the Scrum principles can support self-control. The core Scrum principles comprise concrete planning, progress monitoring, short iterations, and process improvements. The different chapters focus on these principles individually, despite being well aware that these interventions will improve self-control best if not used solitarily. Additional Scrum principles, which might influence self-control, are construal level switch, which will be introduced further below, as well as team autonomy. Team autonomy may, in addition, mediate the influence of the core Scrum principles on self-control. Finally, the differentiation between trait and state self-control will be discussed.

2.1.1 Concrete Planning. One part of the intervention of Oaten and Cheng (2006a) to improve students' self-control was the creation of a learning schedule before the actual exam preparation started. The schedule was very concrete with specific dates and times of planned studying tasks. This high specificity of the schedule enabled the detection of discrepancies between planned and actual progress of learning activities.

In general, planning is a fundamental process of self-control. Although the term *planning* is used in different ways, the basic concept is mostly similar. Research on implementation intentions differentiates between "goal intentions (goals)" and "implementation intentions (plans)", with the latter being if-then rules that "specify when, where, and how an instrumental goal-directed response is to be implemented" (Gollwitzer, Fujita, & Oettingen, 2004, p. 211; see also Masicampo & Baumeister, 2011, 2012). Initiation of plan execution is bound to specific situational cues enabling an automated, unconscious initiation and effortless execution of a plan (Gollwitzer & Sheeran, 2006; Webb & Sheeran, 2003). Hence, plans need to be fine-grained sequences of concrete actions that can be partially executed automatically. Contrary to that, other researchers use a more coarse-grained concept of planning according to which

plans cover weeks or even months (Greiner & Karoly, 1976; Kirschenbaum, 1985; Oaten & Cheng, 2006a; Pychyl, Morin, & Salmon, 2000; Sitzmann & Johnson, 2012). Nonetheless, coarse-grained and fine-grained plans share the same underlying principle: A plan describes the concrete steps or concrete subgoals to achieve an overall goal. Thus, as Kirschenbaum (1985) puts it: "behaviors or accomplishments as steps toward such goals . . . will be considered a plan. Thus, all plans are directed to a goal, making goal setting one component of planning" (p. 491).

Planning is of fundamental relevance for goal striving (Sheeran & Webb, 2012). According to self-control research with focus on ego depletion, clearly defined standards are a main ingredient of self-control (Baumeister & Vohs, 2007). Plans support action initiation and could sometimes even be executed automatically (Masicampo & Baumeister, 2011; Webb & Sheeran, 2003). Attainment of an overall goal also becomes more likely by planning (Brandstätter, Lengfelder, & Gollwitzer, 2001). To improve planning has proven to be an effective intervention strategy for exam preparation (Oaten & Cheng, 2006a), and to improve planning supports health related behavioral change (Luszczynska & Schwarzer, 2003; Wiedemann, Lippke, Reuter, Ziegelmann, & Schüz, 2011). Especially complex tasks benefit from the dismantling of abstract tasks into concrete subtasks (Kruger & Evans, 2004). Generally, planning can free cognitive resources by reducing the persistent cognitive activation of unfulfilled goals (Masicampo & Baumeister, 2011). Proximal goals, when achieved successfully, can increase motivation and support persistence (Bandura & Schunk, 1981; Stock & Cervone, 1990). Planning interventions have also been applied successfully on group level (Wieber et al., 2012).

The self-regulation feedback loop can be described as starting with setting a goal (Carver & Scheier, 1982). Hence, the first intervention to improve self-regulation is to improve goal setting and reflection, which is required for this process. In fact, most intervention programs in the health domain rely primarily on this concept by influencing the standards that persons try to achieve (Friese, Hofmann, & Wiers, 2011). Consequently, the planning process is of high importance for health behavior change (Luszczynska & Schwarzer, 2003). Also in the domain of self-regulated learning,

improving goal setting and the planning phase were found to be crucial for learner's success (Bonestroo & de Jong, 2012).

Goals and plans should be specific and realistic. Specific and difficult goals lead to higher performance compared to asking people to just do their best (Locke & Latham, 2002, 2006). Highly specific plans support initiation of actions (Taylor, Pham, Rivkin, & Armor, 1998), which matches the finding that implementation intentions with higher specificity lead to higher performance (Austin & Vancouver, 1996; de Vet, Oenema, & Brug, 2011; Gollwitzer & Sheeran, 2006; Osch, Lechner, Reubsaet, & De Vries, 2010). Implementation intentions require goals that are highly specific to be effective (de Vet et al., 2011). Breaking down goals into proximal and attainable subgoals increased persistence, with subgoals supposedly being more specific and concrete compared to the overall goal (Stock & Cervone, 1990). Specific compared to abstract goals are more suitable for supporting self-control, because it is not only easier to derive actual behavior from specific goals, but also easier to monitor the behavior (Vohs & Schmeichel, 2007).

Applied to Scrum, it appears advisable that Sprint Backlogs are specific and realistic. In the second half of the Sprint Planning Meeting, the Development Team derives concrete tasks from the selected Product Backlog Items and creates the Sprint Backlog (Schwaber & Sutherland, 2011). The Sprint Backlog is used throughout the Sprint to track the progress. Taking the research findings reported before into account, the Sprint Backlog should be concrete and realistic so that it is a helpful instrument for progress monitoring of the Development Team.

A specific and realistic plan is only useful if goals are clear and circumstances are predictable. Therefore, at least the next Sprint should be predictable for the Development Team. Otherwise planning might not support performance. If the Development Team cannot anticipate the next Sprint, such as team members expecting a high number of disruptions during the Sprint, they will most likely not take planning in the Sprint Planning Meeting seriously. In this case, specific and realistic planning is unlikely.

In sum, different research approaches demonstrate benefits of improved planning for self-control, goal achievement, and individual and team performance. One essential attribute of planning is its specificity. Positive outcomes are related more likely to

highly specific plans compared to low specific plans. However, for effective planning, predictability is required for the time-span that the plan covers. A more specific Sprint Backlog and higher predictability of the Sprints should, thus, predict higher self-control of the Development Team members.

2.1.2 Progress Monitoring. Another part of the self-control improvement program of Oaten and Cheng (2006a) was to facilitate self-monitoring processes for students. The participants were asked to record the hours they spent learning every day. Additionally, they created a study diary in which they reflected on their daily learning progress and compared it with their study schedule. In that way, students became aware of discrepancies between their planned and actual progress.

For self-control, monitoring is one of the fundamental processes (Baumeister & Vohs, 2007; Carver & Scheier, 1982). Lack of monitoring likely leads to self-control failures. This can happen, for instance, if people willingly decide not to monitor their behavior (Baumeister & Heatherton, 1996). Failures to monitor might lead, for example, to impulsive purchasing (Baumeister, 2002). To put this positively, monitoring is crucial for self-regulated learning (Koriat, 2012). Improving self-monitoring is a very effective intervention strategy to improve self-control for health related behavior (Michie et al., 2009).

Development Teams track their progress toward the Sprint Goal in the Daily Scrum Meetings. Ideally, the Daily Scrum Meetings answer the question if the Sprint Goal is still achievable based on a comparison between planned and actual progress. If this is not the case, the team needs to re-plan (Schwaber & Sutherland, 2011). Thus, Scrum suggests to work strictly goal oriented and to actively follow up on the Sprint Backlog. In the Daily Scrum Meeting, every Development Team member points out his or her current progress and next steps planned for that day (Scrum.org, 2013). Therefore, Scrum requires every team member to at least partly structure his or her work based on tasks from the Sprint Backlog. In that way, the individual's work organization is influenced by the team level processes of Scrum. Scrum furthermore requires planning and daily monitoring on team level, which promotes planning and daily monitoring on team member level.

Daily Scrum Meetings facilitate communication within the Development Team and support coordination of individual efforts toward the Sprint Goal. As a consequence, Daily Scrum Meetings support a thorough monitoring in the Development Team and might thereby also directly influence team performance positively.

In summary, progress monitoring is a fundamental aspect of self-control. A positive correlation between the monitoring of progress toward a goal and self-control as well as performance is likely to exist. In a Scrum environment, a Development Team's monitoring in the Daily Scrum Meetings is likely to facilitate individual team members' monitoring. In addition, team internal coordination in the Daily Scrum Meetings may directly support actual team performance.

2.1.3 Short Iterations. The third intervention to improve students' self-control by Oaten and Cheng (2006a) was setting artificial early deadlines for students' exam preparations. These deadlines forced students to create concrete, specific, and proximal subgoals by breaking down the overall learning goal. In that way, achievable goals were created which supported the students' self-monitoring.

Setting deadlines as such can reduce procrastination and hence indirectly increase self-control (Ariely & Wertenbroch, 2002). Especially setting proximal goals was found to efficiently support performance as proximal goals support persistence (Stock & Cervone, 1990). Furthermore, proximal as opposed to distal goals support self-directed learning (Bandura & Schunk, 1981). Combining proximal and distal goals is likely to be most efficient in supporting high performance by goal setting (Latham & Seijts, 1999). Achieving distal goals assumedly requires a high level of self-control to stay on track. A combination of distal and proximal goals will probably not only support attaining goals, but may implicitly also support high self-control.

Scrum Sprint ends are equally spaced and artificial early deadlines before the final deadline. Sprints are time-boxed, that is, Sprints have a fixed duration that cannot be extended. In the Sprint Review Meeting, the Development Team should present finished Sprint Backlog Items, which are potentially deliverable product features (Schwaber & Sutherland, 2011). Typically, finished Product Backlog Items are not delivered to customers after each Sprint, but, for instance, only after six Sprints. Hence, the five

Sprint ends before the final sixth Sprint are equally spaced but artificial deadlines for the Development Team. Each of these five Sprints ends with a Sprint Review Meetings in which committed Backlog Items from the Sprint Planning Meeting should be demonstrated and possibly handed over. The delivery to customers after the sixth Sprint can be seen as a distal goal. This distal goal is broken down into proximal subgoals of the five Sprints before. Therefore, Scrum inherently enforces the breakdown of long-term goals into more concrete subgoals. Scrum requires that Sprint Backlog Items are completed by the Sprint Review Meeting and demonstrated to the Product Owner (Schwaber, 2004). Thus, Scrum enforces completion of prior subgoals before proceeding with later subgoals. Goal setting research findings predict positive effects of this approach (Latham & Seijts, 1999). The mere setting of frequent deadlines has been found to support performance; and, additionally, being forced to finish prior subgoals before continuing on successive subgoals can have a positive impact on performance (Fulton, Ivanitskaya, Bastian, Erofeev, & Mendez, 2013; Herweg & Müller, 2011; Perrin et al., 2011).

Meeting the iteration deadlines can be supported by planning in the execution phase as opposed to planning in the orientation phase of a project (Gevers, Rutte, & van Eerde, 2006; Gevers, van Eerde, & Rutte, 2009; Weingart, 1992). In Scrum, the planning process is separated into two parts. The rough, long-term plan for the product is set by the Product Owner and presented in the first part of the Sprint Planning Meeting. The detailed or execution plan with concrete tasks is created by the Development Team in the second part of the Sprint Planning Meeting and is continued as an ongoing process throughout the Sprint in the Daily Scrum Meetings (Schwaber & Sutherland, 2011).

During plan execution, a reminder of a deadline further supports meeting that deadline (Gevers et al., 2006). In Scrum, the Development Team meets throughout the Sprint in the Daily Scrum Meetings, which are also understood as small re-planning meetings for tasks to be done until the end of the Sprint (Schwaber & Sutherland, 2011). Hence, the Daily Scrum Meetings will support focusing the Development Team on the end of the Sprint and will serve as a frequent reminder, which supports meeting that deadline.

In summary, setting deadlines may increase self-control and performance. An iterative process to attain distal goals with frequent proximal deadlines is likely to support performance and self-control. This approach is inherent in Scrum. In addition, a solid execution planning and frequent reminders of the end of the Sprint in the Daily Scrum Meetings can further support performance by supporting meeting the Sprint Goal by the end of the Sprint.

2.1.4 Process Improvements. In the Sprint Retrospective Meetings, concrete changes of team internal processes are discussed that should be implemented in the following Sprint (Schwaber, 2004). These changes could be, for example, to ask for support from other teams or to request a new tool infrastructure for development. Planned changes are, however, often concrete behavioral changes of team members. The team may decide, for example, to change collaboration between team members or it may decide that all team members should be standing during the Daily Scrum Meetings to keep these meetings short. Decisions from the Sprint Retrospective Meetings, thus, possibly require overriding impulses to perform the former behavior and execute the new behavior. Practicing this overriding of impulses may directly improve self-control (Muraven, 2010a).

Self-control can be improved by adapting situations in a self-control supporting way (Mahoney & Thoresen, 1972; Schelling, 1984; Thaler & Shefrin, 1981). In everyday life, temptations are very frequent and the situational setting has a large impact on self-control (Hofmann, Baumeister, Förster, & Vohs, 2011). Tempting and distracting stimuli should be removed, whereas goal supporting stimuli should be placed in situations (Steel, 2007). The improvements from the Scrum Retrospective Meetings will focus on performance and ease of working. However, these goals may inherently also support self-control. In addition, Sprint Retrospective Meetings may directly support team performance by improving team internal collaboration as well as team internal and team external processes.

Situational improvements may also refer to the social situation. The Sprint Retrospective Meetings support solving interpersonal conflicts. Social interactions require self-control, in particular if they are conflict-laden (Baumeister & Alquist, 2009b;

Baumeister et al., 2007). Hence, solving conflicts can reduce self-control demands due to the social interactions. On the opposite side, positive emotions and people fulfilling social goals such as helping others, is likely to have a positive effect on team members' self-control (Baumeister et al., 2007). For Scrum, practitioners explicitly state that the goal of the Sprint Retrospective Meeting is to make the team collaboration "more effective and enjoyable for the next Sprint" (Schwaber & Sutherland, 2011, p. 12). It appears that self-control is supported implicitly and unplanned by the Sprint Retrospectives Meetings.

In summary, self-control can be improved by the Sprint Retrospective Meetings. Process improvements from the Sprint Retrospective Meetings may support self-control directly. Process improvements could require actual behavioral changes, which include impulse-overriding and thereby may train self-control. Additionally, situational conditions can be improved to further support self-controlled behavior. Finally, Scrum literature explicitly states that Development Teams should strive for positive team collaboration and making the daily work "enjoyable". This could again support actual self-control by improving social interactions in the team, reducing conflicts, and building up social support. Team performance may also be improved through improved team internal collaboration, which is likely to result from Sprint Retrospective Meetings.

Besides the core Scrum principles—concrete planning, progress monitoring, short iterations, and process improvements—other influences on Development Team members' self-control can also be effective. Two additional influences are likely to be relevant. Firstly, the cognitive representation of Development Team members' tasks may influence Development Team members' self-control. This cognitive representation can differ in respect to its construal level, which will be discussed in the next chapter. Secondly, autonomy of the Development Team may have a direct influence on Development Team members' self-control, and additionally, Development Team's autonomy may mediate the influence of the core Scrum principles on Development Team members' self-control. These topics will be discussed in a subsequent chapter.

2.1.5 Construal Level Switch. Mental representations can be construed in different ways. Seeing a broom may, for example, evoke thoughts about cleaning the house or it may evoke thoughts about how exactly one takes the broom into one's hand and sweeps the floor (Vallacher & Wegner, 1987, 1989). Planning requires a mental representation of the intended actions (Mumford, Schultz, & Van Doorn, 2001). As such, a plan or a goal can be represented in different ways in different situations.

A goal can be represented either on a high construal level, relatively abstract, superordinate and focusing on central aspects. Conversely, a goal can be constructed on a concrete, subordinate level with secondary, incidental features. High construal levels tend to center around *why* reaching a goal is important; low construal levels tend to center around *how* a goal can be reached (Trope & Liberman, 2003, 2010).

High as opposed to low construal levels facilitate self-control exertion (Agrawal & Wan, 2009; Chiou, Wu, & Chang, 2013; Fujita & Roberts, 2010; Fujita, Trope, & Liberman, 2010; Fujita et al., 2006). In one experiment, participants, who were procedurally primed on high as opposed to low construal level, showed higher endurance in a secondary, ostensibly unrelated task of squeezing a physically exhausting hand grip (Fujita et al., 2006, experiment 3).

However, conversely, a low construal level can also support self-control, for instance, by reducing procrastination (McCrea, Liberman, Trope, & Sherman, 2008). High construal levels are abstract representations and may not lead to behavior initiation, as cues for initiation of the behavior are missed (Gollwitzer et al., 2004).

Thus, both high and low construal levels may support self-control (Schmeichel, Vohs, & Duke, 2011). High and low construal levels are related to psychological distance of events, objects, or persons. Psychological distance can be spatial distance, temporal distance, social distance, and hypotheticality (Trope & Liberman, 2010). High construal level relates to high psychological distance. Events far away (spatial), in the far future (temporal), related to strangers (social), or that are improbable (hypotheticality) tend to be construed more abstractly. Events that are psychologically near on these dimensions tend to be construed concretely. The different distances, spatial distance, temporal distance, social distance, and hypotheticality are closely related (Fiedler,

Jung, Wänke, & Alexopoulos, 2012). This psychological distance perspective may be applied to goal setting research, which has shown that performance is best if distal goals are supplemented with proximal goals (Latham & Seijts, 1999; Manderlink & Harackiewicz, 1984). Thus, this line of research would suggest a combination of temporal low and high distant goal representations as being most effective for behavior enactment.

In summary, the construal level of goal and plan representations can differ. High as well as low construal levels can support high self-control and performance. The simultaneous availability or a frequent switching between high and low construal levels might best support performance and self-control.

2.1.6 Team Autonomy. In addition to the core Scrum principles and construal level, autonomy of the Development Team is likely to influence Development Team members' self-control. Team autonomy might represent a prerequisite of self-control in a team setting (Langfred, 2000). Empirically, a positive influence of high team autonomy on high team productivity and effectivity in self-organizing work teams is already known (Haas, 2010; Wall, Kemp, Jackson, & Clegg, 1986). Additionally, increased motivation and an increased outcome of teamwork are likely consequences of an increased team autonomy (Janz, Colquitt, & Noe, 1997). In the software development domain with mostly innovative projects, low external influence on team internal processes are related to higher quality of the teamwork, increased team cohesion, and team members' increased effort (Hoegl & Parboteeah, 2006). High team autonomy improves efficient reaction of software development teams to environmental changes with on-time and on-budget completion of software functionality (Lee & Xia, 2010).

Scrum's Development Teams are empowered, cross-functional teams that self-organize their work while being accountable for work results only as whole team (Schwaber & Sutherland, 2011). A certain level of team autonomy is inherent in Scrum. This is also seen that way by a lot of organizations adopting Scrum (Kim, 2013). Increased autonomy on team level potentially increases team performance. Development Teams should be autonomous in regard to planning their Sprints and in defining their team internal processes. In Scrum literature this point is also highlighted. The Scrum Master

should actively support the team's self-organization and shield the team from external influences (Deemer et al., 2012; Schwaber & Sutherland, 2011).

It needs to be distinguished to whom autonomy is granted in a team setting. It makes a difference, if the team itself is autonomous as one unit, or if the team members are autonomous (Markham & Markham, 1995). Teams with high team cohesion, which implies a relatively low team members' autonomy, have been found to be more effective (Langfred, 2000). Especially if teams are working on topics with highly interdependent tasks, high team autonomy with low team member autonomy has been found to best support team performance (Langfred, 2005). To support self-control of individual team members, a similar setting is assumedly best in a Scrum environment. That is, high team level autonomy could give a sense of autonomy; low individual autonomy could support that the Scrum rules are followed and that the Sprint Goal is achieved.

Research findings on autonomy of individuals are relevant for the team setting. External control, as is exerted by the team on its team members can substitute individual's self-control (Fishbach & Trope, 2005; Levine, Alexander, & Hansen, 2010). However, it is necessary that team members experience the goal as self-selected, because otherwise detrimental effects of experienced external control are probable. As long as team members feel autonomous in selecting the team goal, the positive effects of experienced autonomy on the team level may still show positive effects on the individual level. Individual learners show an increased performance as a result of increased autonomy (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). The same positive effect has been found in the sports domain. Competitive swimmers supported by coaches by giving autonomy support in contrast to controlling them, showed higher persistence (Pelletier, Fortier, Vallerand, & Brière, 2001). Increased autonomy also reduces the ego depletion effect (Moller, Deci, & Ryan, 2006; Muraven, 2008); and even a very subtle undermining of autonomy by giving a performance contingent reward could lead to an increased ego depletion effect (Muraven, Rosman, & Gagné, 2007). In another experiment, supporting autonomy helped to increase self-control (Muraven, Gagné, & Rosman, 2008). Yet, the mere increase of team autonomy in a Development Team might not directly influence trait self-control of the team members. However, high

team autonomy is a prerequisite for the process of improving self-control in the long-run. With high team autonomy, the implementation of Scrum with concrete planning and thorough progress monitoring could result in an increase of self-control.

However, team autonomy is not relevant for all of Scrum's core principles. A sense of autonomy supports self-control in the phase of goal selection, but it is less relevant in the phase of execution (Fishbach & Trope, 2005). Taking this distinction into account, the Sprint Planning Meeting requires high Development Team autonomy, but the Daily Scrum Meetings during the execution phase would not require high team autonomy. On the other side, according to the Scrum rules, the Daily Scrum Meeting also has a re-planning aspect and is not just a tool for simple monitoring (Schwaber & Sutherland, 2011). Thus, autonomy will perhaps be relevant for the Daily Scrum Meeting as well. The Sprint Retrospective Meeting requires that the team members can openly discuss with each other to improve processes and solve team internal conflicts. The Daily Scrum Meeting and the Sprint Retrospective Meeting hence both seem to depend on high team autonomy. Contrary to these, meeting the Sprint deadline, that is, finishing the Sprint Backlog Items until the Sprint Review Meeting does not depend on high team autonomy.

In summary, high autonomy influences self-control as well as performance on individual level in a positive way. On team level, high autonomy may improve team performance. Team autonomy and team members' autonomy have to be distinguished. High team autonomy is demanded by Scrum. High team autonomy is required for the Sprint Planning Meetings, the Daily Scrum Meetings, and the Sprint Retrospective Meetings. Only the Sprint Review Meetings, that is, finishing the Sprint Backlog Items by the end of the Sprint, will not require high team autonomy.

2.2 Trait and State Self-Control

The expected influence of the Scrum principles on self-control needs to be differentiated for trait and state self-control. The relationship of trait and state self-control is not clear yet. One assumption is that high trait self-control may support high state self-control. Other than that, trait self-control might be unrelated to state self-control or

even a negative relationship might exist. It is possible that individuals with high trait self-control do not have high state self-control, but are proactively avoiding tempting situations (Imhoff, Schmidt, & Gerstenberg, 2014). Individuals with high trait self-control might feel less tempted in daily life, and, when faced with temptations, are not used to resisting. Yet, the relationship between trait and state self-control needs further research.

State self-control will be reduced at the beginning of Scrum implementations. Scrum demands working in a very self-monitored, controlled, and impulse suppressing way, for instance, in regard to finishing meetings in time, sticking to the current topic, strictly working on tasks with higher priority first, or ensuring close social interactions inside the Development Team. All of these processes require impulse inhibition and depend on self-control resources (Baumeister & Alquist, 2009b; Baumeister et al., 2007). Planning concretely, monitoring progress thoroughly, and meeting the short iteration deadlines is thus likely to increase ego depletion at the beginning of a Scrum implementation. Yet, if the Development Team succeeds in implementing the Scrum processes, the processes will gradually become habituated. Due to this automation, execution of these processes will require less self-control capacity (Palfai, 2004). Additionally, at the beginning of a Scrum implementation with increased self-control demands, the frequent exertion of self-control could already improve long-term self-control resources (Muraven, 2010a). Consequently, in the long-run, Development Team members should show lower ego depletion or, put differently, they should show higher state self-control.

Arguably, automation of behaviors that could occur in Scrum implementations might increase trait self-control of the Development Team members. Following the Scrum rules, especially performing a concrete planning, a thorough progress monitoring to meet the short iteration deadlines, and reflecting every Sprint on process improvements establishes a lot of self-monitoring processes. Habituation of such self-monitoring processes might spill over to life domains outside of Scrum. From that perspective, Scrum implementations may support the improvement of overall trait self-control in the long-run as well.

High trait self-control might support state self-control. Yet, high state self-control capacity might show trait-like characteristics and might, conversely, support trait self-control. State self-control capacity can be improved by training, that is, by frequent exertion of self-control (Muraven, 2010a; Muraven & Baumeister, 2000). It appears that the properties of a muscle are a valid analogy for the properties of state self-control capacity (Baumeister et al., 2007; Muraven & Baumeister, 2000). Applying this muscle analogy to state self-control, it seems that by training state self-control its "stamina" will increase and not so much its "power" (Oaten & Cheng, 2006b). A muscle's stamina can be improved by training or it reduces without training. However, the change does not happen in short-term and requires practicing intensively. Applying this property from the muscle analogy to state self-control capacity, this means that state self-control capacity will probably be a fairly stable property. Self-control capacity would be changeable, but only slowly. Compared to trait self-control, state self-control capacity can probably be changed in shorter time. Still, caused by this inertia of state self-control capacity it has probably a trait-like characteristic and perhaps increasing state self-control capacity might manifest itself in increasing trait self-control.

In summary, trait self-control needs to be distinguished from state self-control. The relationship between trait and state self-control is not clear yet. Scrum probably supports state self-control capacity in the long-run. State self-control may be reduced at the beginning of a Scrum implementation as the team members have to adapt to the new work processes, which strongly emphasize self-monitoring. Trait self-control is perhaps improved by increased state self-control capacity and by habituation of self-monitoring behavior, which support self-control.

2.3 Effects of High Self-Control

High self-control is related to a multitude of positive outcomes, amongst others high performance, low experienced stress, and good health (Oaten & Cheng, 2006a; Tangney et al., 2004). These different aspects will be elaborated further in this chapter.

2.3.1 Increased Team Performance. Empirical findings of the relation between self-control and performance of individuals are mostly available from school and work settings. High self-control is related to high performance, that is, to better grades of students or to overall work performance (de Ridder et al., 2012; Duckworth & Seligman, 2005; Tangney et al., 2004). Already a simple guidance on creating a learning plan and monitoring learning progress can improve learning performance (Sitzmann & Johnson, 2012).

Conversely, procrastination as a major self-control failure is related to lower grades (Tice & Baumeister, 1997). Procrastination leads to poorer performance, if projects are finished at all (O'Donoghue & Rabin, 2008; Steel, 2007).

Team performance is not simply the sum of team members' performance, but the team's internal interactions need to be considered (Stewart & Barrick, 2000). However, high individual performance of team members is likely a prerequisite and precursor of high team performance. Therefore, supporting individual performance can support overall team performance as well. A prerequisite of increased team performance is that the goals of the team members are aligned. Otherwise, the team performance might not be increased despite an increase in individual performance (Kleingeld, van Mierlo, & Arends, 2011). For a team with group norms supporting self-control, planning, and monitoring an increased team performance can be expected (Hackman, 1983).

In addition to improving team performance indirectly by improving team members' performance, direct relations of the Scrum principles on team level are likely to have direct effects on team performance, as elaborated in the chapters above. Yet, briefly summarized, planning in the team may support team performance by clarification of goals, by supporting communication and, along with that, supporting coordination in the team (Mumford et al., 2001). Planning can contribute to team performance by mediating the effect of group goal setting on group performance (Mehta et al., 2009; Weldon et al., 1991). Goal setting and progress monitoring alone can increase team performance (LePine, Piccolo, Jackson, Mathieu, & Saul, 2008). Performance can also increase by setting deadlines and, especially, by setting proximal goals (Gevers et al., 2006; Stock & Cervone, 1990). Process improvements from the Sprint Retrospective

Meetings probably also increase team performance by improving team internal processes. In addition, high team autonomy, as required by Scrum, supports high team performance (Haas, 2010; Janz et al., 1997; Wall et al., 1986).

Switching between different construal levels should also increase team performance. Supporting team members' self-control by emphasizing high construal levels should improve team members' performance (Fujita et al., 2006; McCrea et al., 2008). Emphasizing high construal levels, so distal, abstract goals may increase team performance directly on team level. This performance increase may stem from supporting that the team members align their efforts toward these distal goals. Low construal levels, conversely, prevent procrastination and thereby support high self-control and performance indirectly (McCrea et al., 2008).

In summary, high team members' self-control is necessary but not sufficient for high team performance. Planning concretely in a Development Team with high team autonomy, monitoring progress thoroughly, meeting the short iteration deadlines, improving team internal processes, and switching construal levels may also directly influence team performance positively.

2.3.2 Lower Stress Level. High stress can have negative consequences. High stress in organizations is related to poor health and decreased well-being of employees as well as to interpersonal conflicts and increased turnover on organizational level (Sonnetag & Frese, 2003). Experienced stress could be reduced in a Scrum setting in two ways. High self-control could act as a buffer against job strain, and the changed processes introduced by Scrum could directly influence experienced stress.

High self-control capacity can reduce experienced stress. One source of stress in today's working environments is high self-control demands. Employees have to control their impulses at work, overcome inner resistance, and resist distractions. These self-control demands are a source of stress that in turn relates to burnout and absenteeism (Neubach & Schmidt, 2008; Schmidt & Neubach, 2010). High self-control demands are also likely to be present in Development Teams. To cope with stress because of high self-control demands, high self-control capacity can function as a buffer (Schmidt, Hupke, & Diestel, 2012). In that way, high self-control capacity can reduce experienced stress.

Furthermore, Scrum may directly help to reduce employees' experienced stress. To experience stress, the individual's cognitive appraisal of stressors is of high importance. The subjective experience, rather than what objectively happened, centrally determines stress. Three attributes are central for experiencing stress: unpredictability, uncontrollability, and overloading (S. Cohen, Kamarck, & Mermelstein, 1983). These three attributes are all directly or indirectly addressed by Scrum.

Firstly, predictability is supported by Scrum's short iterations, by its high team autonomy, and concrete planning. Scrum positively enhances predictability by suggesting short iterations. Only short iterations allow creating valid predictions in complex and changing environments (Schwaber & Sutherland, 2011). During a Sprint, the Sprint Goal should stay stable. This ensures a high predictability for the Development Team throughout the Sprint. The Product Owner is only allowed to hand over new Product Backlog Items to the Development Team at the beginning of a new Sprint. However, to ensure stability of the Sprint Goal, the Development Team needs to have high team autonomy. Only with high team autonomy, the Development Team will be able to resist executing urgent development requests immediately and instead schedule these for the next Sprint. Performing a concrete planning at the beginning of a Sprint is also likely to enhance predictability of that Sprint. All in all, predictability is improved with Scrum by its short iterations, by keeping the Sprint Goal stable during a Sprint (which requires high team autonomy), and by planning concretely in the Sprint Planning Meeting.

Secondly, controllability is improved by high team autonomy of the Development Team and the thorough progress monitoring. The Development Team is working as a small, self-organizing, and autonomous team. This ensures that all Development Team members will be involved in team decisions and are able to influence these. This should already give Development Team members a high sense of control over large parts of their working conditions. High team autonomy, again, is a prerequisite for this increased sense of controllability. The Scrum Master supports high team autonomy by actively shielding the Development Team from team external influences (Deemer et al., 2012; Schwaber & Sutherland, 2011). The feeling of control should additionally be increased by the thorough progress monitoring in the Daily Scrum Meetings. In

these meetings, the actual progress is compared to the planned progress and deviations are taken care of. As a result, the Development Team is always in control of the team's progress. In sum, Scrum increases the sense of control by self-organization of the autonomous Development Team and by the thorough progress monitoring in the Daily Scrum Meetings.

Thirdly, Scrum counters overload with high team autonomy and concrete planning. Only the Development Team is allowed to decide on how many of the highest prioritized Product Backlog Items it commits to for the next Sprint. In that way overload can be prevented by the Development Team. The Product Owner is only informed about the created Sprint Backlog (Deemer et al., 2012). To enable the Development Team preventing overload, the team needs to have a clear understanding of what it commits to. In that way, the concrete planning of the next Sprint in the Sprint Planning Meeting supports the prevention of overload. In sum, the concrete planning from the Sprint Planning Meeting supports that the Development Team clarifies the expected efforts for the Sprint Backlog Items before the Sprint starts. Additionally, the Development Team has authority to create a Sprint Backlog that is not overloading. Nonetheless, the Development Team is bound to the priority of the Product Backlog Items and needs to work on higher priority items first. However, high team autonomy ensures that the Development Team can commit to a feasible Sprint Backlog irrespectively of urgent short-term stakeholder request. These should be put into the Product Backlog first and prioritized so these requests can be planned in the next Sprint.

In sum, Scrum takes care of all three attributes that are central for experiencing stress: unpredictability, uncontrollability, and overloading. Thereby, Scrum should help to reduce experienced stress of Development Team members.

Adding to the perceived stress criteria, social interactions will also be relevant. Interpersonal conflicts can be job-related stressors, while, conversely, social support can help to buffer job-related stress (Sonnetag & Frese, 2003). In Scrum, the close interaction in the Daily Scrum Meetings and especially the Sprint Retrospective Meetings are likely to improve the social relations within the Development Team. The Sprint Retrospective Meetings aim at improving collaboration in the Development Team, making work more

enjoyable (Schwaber & Sutherland, 2011). Scrum hence emphasizes that close and foremost positive social interactions are important, which should reduce social stress. Scrum may help to build social support, which could even act as a buffer against stress. In summary, Scrum's processes and an increased self-control capacity should help to decrease experienced stress. Firstly, high self-control capacity can act as a buffer against stress because of high self-control demands present in the Development Teams. Secondly, Scrum may establish processes that reduce experienced stress directly. Major determinants of experienced stress are predictability, controllability, and overload. All three are addressed by Scrum: short iterations, high team autonomy, and concrete planning increase predictability; high team autonomy and thorough progress monitoring enhance controllability; and high team autonomy and concrete planning can reduce overload. Thirdly, social support and reduced interpersonal conflicts inside the Development Teams, which probably result from the Sprint Retrospective Meetings, may further help to reduce stress of the Development Team members.

2.3.3 Improved Health. Health improvements are only possible on the individual team members' level. Health improvements may stem from increased self-control on the individual level, from reduced work stress, or from changed environmental setting in Scrum.

High self-control is related to better health on the individual level. People with high as opposed to low self-control tend to do more physical exercises, show healthier dietary behavior including less binge eating, report less alcohol abuse, and less psychopathological disorders (Schroder, Ollis, & Davies, 2013; Tangney et al., 2004). This positive effect of high self-control is already established for teenagers doing more physical exercises and eating more fruits and vegetables (Wills, Isasi, Mendoza, & Ainette, 2007).

A high stress level over an extended period of time is related to poor health (Sonntag & Frese, 2003). Taking this into account, reducing the stress level of Development Team members would probably influence team members' health positively in the long-run.

Scrum might support health behavior. The setting of Scrum largely resembles the experimental setting of Oaten and Cheng (2006a) as described in Chapter 2.1 *Scrum Supports High Self-Control*. Hence, similar effects could be expected for Development

Team members as were found for the students. Although Scrum is implemented at team level, all team members do a day-to-day planning and monitoring of their own work in coordination with other team members in the Daily Scrum Meetings. As a result, Scrum's process on team level influences the individual team member's work process directly. Scrum may hence directly affect individual team members by implicitly supporting improved health behavior.

To support employees' health, organizational health management typically promotes (a) that employees should be working in teamwork, (b) that tasks should be whole and identifiable pieces of work and, (c) that working time is well structured (Ulich, 2005). All of these measures are implemented by Scrum. Foremost, (a) work in Scrum is organized in small and autonomous Development Teams with the Scrum Master shielding the team from team external influences. The Development Team performs a Sprint Planning Meeting and, ideally, the Product Owner summarizes the plan for the next Sprint in one cohesive theme (Deemer et al., 2012). Furthermore, the Development Team works cross-functional, which means that the team has a wide range of skills inside the team itself. It can use these skills to finish (b) whole product features in all respects of delivery, including programming, documentation, and testing. General working hours may be set by the organization. Yet, concerning external requirements of the availability of the Development Team at specific times, for instance, for customer support, the team may coordinate internally who is responsible for which topic and at what time to support customers. Thus, structuring working time (c) is at least to some extent part of the self-organization of the Development Team. In summary, Scrum implicitly entails organizational health management measures. Expected effects of these measures are, amongst others, an improvement of employees' motivation, self-esteem, and health (Ulich, 2005).

In sum, high individual self-control is positively related to better health. Scrum may support health in the long-run by reducing stress. Scrum potentially supports health of the team members directly, as changes introduced by Scrum resemble traditional organizational health management measures. Complying to the core principles of Scrum with an autonomous team that plans concretely, monitors its progress, works in short

iterations, and improves its processes could, thus, support good health of the Scrum Team members.

Overall, it is hypothesized that Scrum supports Development Team members' self-control, improves team performance, reduces team members' experienced stress, and supports team members' health. The core principles of Scrum are its concrete planning in the Sprint Planning Meeting together with an active progress monitoring in the Daily Scrum Meetings. Further core principles are the short iterations or Sprints that end with Sprint Review Meetings, and the process improvements from Sprint Retrospective Meetings. High team autonomy is a prerequisite for the positive influence on self-control. High team autonomy should support team performance as well as reduce stress and support good health. A frequent switch of construal levels during the Sprint could additionally support self-control and team performance. The Scrum principles could influence self-control directly. Self-control in turn could positively influence team performance, reduce experienced stress, and support good health. The Scrum principles may also have direct influence on team performance, low experienced stress, and good health.

3 Study 1

To test the theoretically derived predictions, a study in an applied setting within a work organization was conducted.

3.1 Method

3.1.1 Participants and Design. The study took place in one location of an international software company. Within this work organization, 171 participants of 23 different Scrum Teams returned a questionnaire. The total number of questionnaires handed out was not tracked. On average, about ten questionnaires were handed out, so the overall response rate can be assumed to be around 60%–80%. Participants were not given any compensation for filling out the questionnaire, but it was announced that they would be invited to the presentation of the results after the study was finished.

The questionnaire contained scales with rating questions for all Scrum principles, self-control, and the presumed effects due to high self-control: team performance, team member's experienced stress, and team member's health. The data was collected in a cross-sectional design at one measurement occasion.

3.1.2 Materials. For questionnaire creation, semi-structured interviews were held with team members from different Scrum Teams inside the organization. When applied to a real-world environment, it is common for parts of the Scrum principles to be left out and not implemented (West, Grant, Gerush, & D'Silva, 2010). Hence, the interviews helped to determine the actual degree of the ongoing Scrum implementation in that organization. After that, based on the interview results, a questionnaire was created that was used to collect data from Scrum Teams inside the organization.

3.1.2.1 Interviews. The questions used in the semi-structured interviews investigated the degree of actual Scrum implementation within the Scrum Teams. The questions were open-ended questions:

- How many team members in which locations work for the Development Team?
- How are the Scrum Meetings actually held?
- How committed to finishing the Sprint Backlog is the Development Team?
- How much autonomy does the Development Team have and does it make use of its autonomy?
- How "disciplined" is the Development Team?

Interviews were held with four developers from four different Scrum Teams from the organization. Interviews lasted from twenty to forty minutes and were recorded for later analysis. Findings from the interviews were used for creation of the below-mentioned questionnaire.

3.1.2.2 Scrum Questionnaire Overview. The "Scrum Questionnaire" consisted of 80 questions in total (see original, German questionnaire in the Appendix, *Complete Questionnaire (Study 1)*). The majority of items were forced choice five-point or six-point Likert type scales (Cox, 1980). Response alternatives ranged from *strongly disagree* to *strongly agree*, with the notable exception of frequency estimations (ranging from *never* to *always*). Items covered all model components depicted in Figure 2.

The questionnaire was anonymous and participation was voluntary. Participants were informed that the results were used for research purposes only. The questionnaire consisted of two DIN A4 paper sheets with questions on front and back side, stapled together.

In the following chapters a description of all model parts and the corresponding items is given: first, items measuring Scrum principles that support self-control, then items measuring trait and state self-control, then items measuring the effects of high self-control, and finally demographic questions.

3.1.2.3 Scrum Supports High Self-Control. No established scientific questionnaire existed that measured compliance to Scrum's principles in actual Scrum implementations. Hence, items concerning the Scrum implementation were self-generated (SG) by me based on the results of the interviews, or they were derived from one public available questionnaire from a Scrum practitioner, the "Scrum Checklist" (SCL; Kniberg, 2011).

Concrete Planning. Three sub-aspects of the Scrum planning process were measured via six closed questions. One question investigated if a planning was done at all (item CP-M-1, SG, see in the Appendix, *Items per Scale (Study 1)*). A second aspect is that the plan, that is, the created Sprint Backlog, is concrete and realistic. This was measured by three questions (CP-C-1 & 2, SCL; CP-C-3, SG). A prerequisite for the creation of such a specific plan is that a certain level of predictability is given for the timespan the plan refers to. Predictability was measured with two items (CP-P-1 & 2, SG).

Progress Monitoring. The Development Team's progress monitoring was measured with nine items.

The items covered that the Daily Scrum Meeting took place at all (RM-M-1, SCL), if the monitoring was effective (RM-E-1, SCL; RM-E-2, SG), and if the outcome of the meeting typically led to an adaption of the Sprint Goal (RM-A-1, SG).

A high individual self-observation tendency should generally support the team's monitoring process. Thus, two items (RM-S-1 & 2) measured the team members' self-

observation tendency. The questions were taken from the self-leadership questionnaire from Houghton and Neck (2002).

Attending the Daily Scrum Meeting highly motivated is seen as a requirement of Development Team's progress monitoring. A thorough self-monitoring of a Development Team can only be expected if the team members support this voluntarily; that is if the team members are motivated to take up the endeavor of exerting self-control (Baumeister & Vohs, 2007). That implicates that the team members do not attend the Daily Scrum Meetings due to group pressure, but rather because the team members value the meeting as supporting the work of the Development Team. This positive and intrinsic motivation, as opposed to a negative extrinsic one, was measured with two items adapted from a questionnaire from Levesque et al. (2007) based on self-determination theory (RM-O-1 & 2; Deci, Connell, & Ryan, 1989; Ryan & Deci, 2002).

Short Iterations. The tendency of the Development Team to meet their deadlines was measured with five items. One item asked for the Sprint length (ED-M-1-3, SG; items consolidated to ED-M-0 in the analysis) and one item for the general acceptance of the Sprint length (ED-C-1, SG). One question investigated how hard the team members worked to finish the Sprint Backlog Items until the end of the Sprint (ED-C-2; derived from Janz et al., 1997) and what ratio of Sprint Backlog Items usually were completed (ED-C-4, SCL).

The rationale of these items is that some Development Teams do not commit to the Sprint Goal and try to finish the Sprint Backlog Items by the end of the Sprint. This had become apparent in the interviews. These Development Teams see development as an ongoing process. Typically, for these teams only some Sprint Backlog Items are finished and in the Sprint Review Meeting and Sprint Planning Meetings, team members rather stop development briefly to take a look at the current status, without trying to finish Sprint Backlog Items by the Sprint Review. For these Development Teams the Sprint deadlines are not effective as deadlines.

Getting feedback in the Sprint Review Meeting is supposed to increase the commitment to finish the Sprint Backlog until the Sprint Review Meeting. One item measuring this was derived from the Work Design Questionnaire (Stegmann et al., 2010; ED-C-3).

Process Improvements. Whether or not Sprint Retrospective Meetings led to actual process improvements was assessed by five items. One item assessed the frequency of the Sprint Retrospective Meetings, as findings from the interviews suggested that Sprint Retrospective Meetings were occasionally seen as optional and thus not held every Sprint (RR-M-1, SG). One question investigated whether the team members felt they could openly discuss problems and, accordingly, if an effective process level self-monitoring of the Development Team was possible at all (RR-S-1, SG). A second item for the same topic was taken from a different questionnaire that had already been conducted in the organization before. An analysis of former responses showed an acceptable response distribution. The item was included in the questionnaire (RR-S-2). Two additional questions examined if the Development Team members adapted their behavior based on the Sprint Retrospective Meeting results (RR-A-1, SG; RR-A-2, SCL).

Team Autonomy. Measurement of team autonomy was done with four items from the Work Design Questionnaire (Stegmann et al., 2010). It was assumed that team autonomy depends on the same dimensions as autonomy of single persons. Thus, four questions of the Work Design Questionnaire were adapted to the team context by changing the wording from "I" to "we". The focus of the items was not the team members' individual autonomy, but the autonomy of the whole team. The items concerned the autonomy for defining the sequence of work, autonomy for performing the planning, autonomy for choosing the means to accomplish the work, and a rating of autonomy of the work concerning decision-making (TA-O-1–4). These questions should shed light on the objective conditions of team autonomy. In addition, three items referred to the subjective autonomy impression, that is whether the team is controlled from outside, whether the team acts in a self-determined way, and whether it does make use its autonomy (TA-S-1, SCL; TA-S-2 & 3, SG).

Construal Level Switch. Six items assessed construal level effects in the Scrum process (Trope & Liberman, 2010). Items focused on assessing how far a high construal level was supported in the planning and execution of the tasks. In a Development Team, the low construal levels are inevitable in day-to-day work anyway, as these are required

to get the tasks done (CL-P-1, SCL; CL-R-1 from a former questionnaire conducted within the organization; all other CL-items, SG). To give an example, participants were asked for the number of Sprint Backlog Items of a typical Sprint Backlog, assuming a lower number of Sprint Backlog Items indicates a higher abstractness of the Sprint Backlog Items; or it was asked how often the team members reminded themselves *why* they did a specific task.

3.1.2.4 Trait and State Self-Control. Trait self-control (SC-T-0–9; see in the Appendix, *Items per Scale (Study 1)*) was measured with ten items from the Brief Self-Control Scale (Tangney et al., 2004) in a German translation by Bertrams and Dickhäuser (2009). Three items from the scale were removed as they were considered inappropriate in the organizational context (for example item number 3: "I am lazy"). The scale is a valid measure of trait self-control with known relations to high work performance, psychological well-being and adjustment, and prosocial behavior (de Ridder et al., 2012).

Self-Control Scale responses tend to correlate with social desirability (Tangney et al., 2004). Hence, two items (SD-S-1 & 2) supposedly assessing the tendency to answer in a socially desirable way were added to the questionnaire from the German short version of the Balanced Inventory of Desirable Responding scale (Paulhus, 1991; Winkler, Kroh, & Spieß, 2006). The items were taken from the impression management sub-scale. However, one item from the sub-scale was not included since it was considered inappropriate for the given organizational context (item f02140: "I have received too much change from a salesperson without telling him or her"). The remaining two items were mixed into the ten Self-Control Scale items in the questionnaire due to a similar structure, topic, and wording.

Additionally, four items measuring the current ego depletion state were added (SC-S-1–4). The measurement was done in line with the approach from Sonnentag and Jelden (2009) with four vigor items from the Profile of Mood States scale. The four items with the highest discriminatory power from the vigor sub-scale were included (Bullinger, Heinisch, Ludwig, & Geier, 1990).

3.1.2.5 *Effects of High Self-Control.*

Increased Team Performance. Team performance could not be investigated directly. Therefore, a team self-assessment approach was chosen. Seven items (PF-F-1–7; see in the Appendix, *Items per Scale (Study 1)*) measuring team performance were taken from the questionnaire of Henderson and Soonchul (1992). The items required rating the team in comparison to "other comparable project teams you have served on or observed" on the dimensions efficiency, effectiveness, and speed. The items were rephrased as assessment of the team by its own team members. Despite certain known biases in self-assessments, this kind of rating can still be seen as valid measurement for performance comparisons (Krueger & Mueller, 2002).

One additional item was taken from a questionnaire that was used inside the organization before. An analysis of former responses showed satisfactory variance for the subjective rating of how Scrum supported effectiveness of the team (PF-R-1).

Lower Stress Level. The stress level was measured with a German translation of the four item short scale of the Perceived Stress Scale (S. Cohen et al., 1983; Engling, 2010; ST-S-1–4). Items were adapted by changing from the German formal to the informal addressing of the person filling out the questionnaire to be aligned with the other items. Furthermore, the time span in question was reduced from twelve to one month to measure the perceived stress level of the duration of one typical Sprint.

The items were supplemented by two items that were used in a survey inside the organization before, measuring employees work strain (ST-A-1 & 2).

Improved Health. Health was measured with six items from the SF-12 Health Survey: One item measuring general health (HT-H-1) and five items measuring mental health (HT-H-2–6) were used (Bullinger & Kirchberger, 1998; Emery, 2004; Ware, Kosinski, & Keller, 1996). Two open items asking for frequency and duration of sports activity were included in line with the experiment by Oaten and Cheng (2006a, HT-P-1 & 2).

3.1.2.6 Demographic Questions. The questionnaire contained three additional items asking for participants' age, years of employment within the organization in total and years of experience as software developer. The age was answered in a categorical format to increase anonymity of the questionnaire (<30 years¹, 31–40, 41–50, 51–60, >60 years). Sex was intentionally not asked for, as this would have basically removed the anonymity of any questionnaires answered by the few women working in the Development Teams.

One additional open-ended item asked for any additional comments about the implementation of Scrum in the Development Team.

3.1.3 Procedure. The questionnaire was reviewed with different parties before finalization and was approved by the works committee for being distributed within the organization. The questionnaire was then presented to 23 Development Teams in their Daily Scrum Meetings within a three months period. A sufficient number of questionnaires for the Development Teams was handed over, typically to the Scrum Master. Each Development Team member filled out the questionnaire individually and anonymously put it into a collective envelope, which had also been provided to the Development Team. The envelope was closed by the Scrum Master after one to two weeks and returned via in-house mail. This procedure ensured not only the anonymity of the individual team member, but also that of the Scrum Team itself. This was a requirement of the works committee for approving the questionnaire. In addition to the Development Team members, in some teams Scrum Masters and Product Owners also participated in filling out the questionnaire. Likewise, Scrum Masters and Product Owners were allowed to participate, as long as they were working in a Sprint based, iterative fashion with frequent deadlines in fixed intervals with planning. Scrum Masters and Product Owners could not be distinguished from the Development Team members in the later analyses.

¹One participant noticed that 30 years fell erroneously between this and the next category. This participant was added to the first category.

3.2 Results and Discussion

Overall, 171 Scrum Team members returned their questionnaire from 23 different Scrum Teams (team size $M = 7.44$, $SD = 2.77$, $Mdn = 8$, range: 1–13). The majority of the team members were between 31 and 50 years old ($N_{31-40} = 63$ or 36.84%, $N_{41-50} = 74$ or 43.27%). Only a minority of team members were younger than 31 years ($N_{<31} = 17$ or 9.94%) and similarly, even less were older than 50 years old ($N_{51-60} = 5$ or 2.92%). No team member was older than 60 years old. Twelve team members (7.02%) did not answer the question concerning their age. The average time the team members had been with the organization was $M = 10.73$ years ($SD = 4.42$, $Mdn = 11$, range: 1.50–23.00, missing data $N_{NA} = 13$), which approximately matched the overall mean experience as software developer with $M = 10.04$ years ($SD = 6.06$, $Mdn = 10$, range: 0.00–28.00, missing data $N_{NA} = 17$).

The scales were pre-tested, screened and then regression analyses were performed. These steps will be described in the following chapters.

3.2.1 Pretest of Scales. A separate pre-test of the scales was difficult to perform, due to the long lasting process to get the works committee's approval for the survey. Thus, the questionnaire was conducted without separate pre-test after thorough reviews by different organizational members as well as social science researchers. To pre-test the scales also under these conditions, 11 questionnaires, each one from 11 randomly chosen teams, were used for pre-testing. From one team only a single questionnaire had been returned. This questionnaire was included into the pre-test. The scales were pre-tested with these 12 questionnaires before the main analyses were performed. The questionnaires were not included into the main analysis later.

For all scales Cronbach's alpha (Cronbach, 1951) was calculated (see Table 1). Cronbach's alphas with values $\alpha > .50$ were considered sufficiently high². From the progress monitoring scale two items were removed that increased Cronbach's alpha from $\alpha = .40$ to $\alpha = .59$. From the construal level switch scale one item was removed that increased

²Commonly, alpha values from $\alpha > .70$ are considered acceptable but without a theoretical reason (Helms, Henze, Sass, & Mifsud, 2006). Short scales tend to show lower alpha values (Pallant, 2010). Since the scales in the present study were relatively short, $\alpha > .50$ was considered acceptable.

Table 1
Cronbach's Alpha of all Scales (Study 1)

Scale	Scale Validation			Main Analysis		
	n_1	items ₁	α_1	n_2	items ₂	α_2
Trait Self-Control	10	10	.62	138	10	.71
State Self-Control	12	4	.88	151	4	.92
Performance	10	8	.81	128	8	.83
Low Stress	11	6	.30			
excluding						
ST-S-1 & ST-S-3	12	4	.52	150	4	.73
Health	11	8	.62	135	8	.66
Concrete Planning	12	6	.55	139	6	.68
Progress Monitoring	12	9	.40			
excluding						
RM-A-1 & RM-M-0	12	7	.59	148	7	.54
Short Iterations	12	5	.54	139	5	.39
Process Improvements	12	5	.79	153	5	.79
Construal Level Switch	12	6	.37			
excluding						
CL-P-2	12	5	.58	131	5	.47
Social Desirability ^a	12	2	.12	149	2	.45
Team Autonomy	12	7	.84	150	7	.82

Note. Cronbach's alpha values were calculated for scale validation (α_1) with a random subset of the survey data (Cronbach, 1951). Number of items per scale (items₁) and sample sizes (n_1) for the calculation are reported. During scale validation some items were excluded. The main analyses were performed with the remaining items and remaining data sets, for which the Cronbach's alpha values are also depicted (α_2). Only complete cases were used for the calculation, thus, if any of the items in a scale was missing the whole case was excluded.

^aReliability of the two-item social desirability scale was calculated in addition with the Spearman-Brown formula, which showed identical results to Cronbach's alpha values with $\rho_1 = .12$ and $\rho_2 = .45$, respectively (Eisinga, te Grotenhuis, & Pelzer, 2013).

Cronbach's alpha from $\alpha = .37$ to $\alpha = .58$. From the stress scale two items were removed that increased Cronbach's alpha from $\alpha = .30$ to $\alpha = .52$.

The social desirability scale showed an extremely low Cronbach's alpha value of $\alpha = .12$. For two-item scales the Spearman-Brown formula to calculate the scales reliability is more appropriate than Cronbach's alpha (Eisinga et al., 2013), but also this reliability estimate matched the Cronbach's alpha with $\rho = .12$. It was decided to include the scale regardless, as the removal of one item could not be justified rationally. The analysis of the actual reliability in the main data set later revealed an improved, but still unacceptable reliability ($\alpha = .45$ and $\rho = .45$). Calculating the main analysis of trait self-control again with the two social desirability items included individually did not structurally change the result of the regression analysis.

3.2.2 Data Preparation and Regression Analyses. The remaining data for the main analyses consisted of 71 raw items answered by 159 participants. The raw data contained a low ratio of missing values of overall 3.2%. The data set was screened for outliers. No univariate outliers were found ($z \geq 3.29$; Tabachnick & Fidell, 2007).

Scale variables were calculated as arithmetic mean of the corresponding raw items. Missing values were omitted on mean calculation. If a participant did not answer any item of a scale the value was marked as missing data. One participant skipped all raw items of three scales, two participants skipped all raw items of two, and seven participants skipped all raw items of one scale. The most skipped scale was the social desirability scale (5 times), followed by the state self-control scale (3) and the trait self-control scale (2). Furthermore, scales that were skipped only once include the low stress scale, the health scale, the process improvements scale, and the team autonomy scale.

The distributions of all scales were analyzed. The process improvements scale showed the largest and significant skew and kurtosis ($S = -1.44, p < .001$; $K = 3.55, p < .001$). That said, a visual inspection of the histogram revealed a sufficient normal distribution of the scale. This was the same for the histograms of other scales with lower but still significant skew values (social desirability, team performance, concrete planning, state self-control, and progress monitoring).

Two participants were removed as multivariate outliers based on Mahalanobis distance ($p < .001$; Tabachnick & Fidell, 2007). Thus, 157 data sets of in total 22 Development Teams were included into the main analyses.

Overall, the data set consisted of 12 scales answered by 157 participants and contained 14 missing mean values (0.74%). The distribution of the missing values led to a typical exclusion of seven participants in the main analyses (4.46% of participants). The histograms of the data of these participants were visually compared to the histograms of the remaining data. No relevant differences were found. Due to this low ratio of missing values no imputation of missing values, but a case-wise exclusion of the respective participants was done (Graham, 2009; Tabachnick & Fidell, 2007). Items and scales were aligned so that a higher number depicted a "more" of the respective scale. The stress

scale was inverted, thus, depicting "lower stress" with higher values. Consequently, all criterion variables showed higher numbers for more beneficial outcomes (self-control, performance, low stress, and good health).

Bivariate correlations between the predictors showed medium to high, but no very high correlations (see Table 2) ranging from $r = .07$ (scales team autonomy and trait self-control; $t(155) = 0.701$, $p = .482$) to $r = .60$ (scales progress monitoring and process improvements; $t(155) = 9.575$, $p < .001$). Multicollinearity issues are expected for correlations from $r = .70$ upwards (Tabachnick & Fidell, 2007). Bivariate correlations of criteria variables ranged from $r = .15$ (scales team performance and health; $t(155) = 1.310$, $p = .192$) to $r = .46$ (scales state self-control and health; $t(155) = 6.237$, $p < .001$).

The comments from the open-ended question in the questionnaire were screened but did not lead to any exclusion of participants.

After data preparation was finished, regression analyses were performed. The hierarchical structure of the data required the calculation of multilevel regression analyses: Development Team members on the first level were nested in Development Teams on the second level. The regression analyses permitted random intercepts between the Development Teams to take the influence of team structure into account. No second-level predictors were included, while first-level predictors were. The unequal team sizes were neglected as multilevel regressions do not require equal group sizes (Tabachnick & Fidell, 2007).

3.2.3 Scrum Supports High Self-Control. The 157 data sets were subjected to two multilevel regression analyses³ with team as grouping factor⁴. Predictors were centered on the scales grand mean but not standardized (Baron & Kenny, 1986; Hox, 2010; Tabachnick & Fidell, 2007; Whisman & McClelland, 2005).

³All regression analyses were performed with *R* module *nlme* (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2014; R Core Team, 2014). Module *nlme* does not provide standard error estimates for random effects as variance estimates in general linear mixed models are strongly asymmetric and regarded as poor indicators of uncertainty (Bates, 2010).

⁴This was analogous to the other regression analyses for performance, low stress, and health, though the intraclass correlation coefficient of trait self-control showed a minor relevance of the grouping factor ($\rho < .01$).

Table 2
Descriptive Statistics and Scale Intercorrelations (Study 1)

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Trait Self-Control	3.51	0.51	1											
2. State Self-Control	3.46	0.84	.34***	1										
3. Performance	3.56	0.67	.15	.14	1									
4. Health ^a	3.33	0.76	.27***	.46***	.15	1								
5. Stress	3.51	0.82	.20*	.39***	.17*	.34***	1							
6. Concrete Planning	3.86	0.57	.18*	.13	.46***	.10	.23**	1						
7. Progress Monitoring	3.76	0.50	.25**	.22**	.48***	.02	.19*	.41***	1					
8. Short Iterations	3.14	0.50	.11	.09	.56***	.02	.14	.53***	.46***	1				
9. Process Improvements	4.36	0.58	.12	.06	.45***	-.06	.25**	.45***	.60***	.41***	1			
10. Construal Level Switch	3.15	0.75	.06	.13	.42***	.08	.02	.31***	.37***	.37***	.36***	1		
11. Social Desirability	4.13	0.70	.20*	.08	.10	-.11	-.03	.13	.13	.13	.17*	.19*	1	
12. Team Autonomy	3.54	0.69	.07	.22**	.53***	.11	.32***	.48***	.47***	.51***	.52***	.35***	.07	1

Note. Potential range of all scales is 1–5. Only pairwise complete cases were included in correlation calculation. Participants $N \geq 149$ and $N \leq 157$. Teams $N = 22$.

^aRaw items with six-point Likert type scale (HT-H-2-6) were scaled down from range 1–6 to range 1–5 before scale calculation.
 * $p < .05$. ** $p < .01$. *** $p < .001$. All t -tests are two-tailed.

Table 3
Trait Self-Control Regression Results (Study 1)

	B	SE
Fixed effects		
Intercept	3.48***	0.04
Social Desirability	0.11*	0.05
Concrete Planning	0.14	0.09
Concrete Planning × Team Autonomy	0.26*	0.04
Progress Monitoring	0.31**	0.11
Progress Monitoring × Team Autonomy	-0.05	0.12
Short Iterations	-0.06	0.11
Process Improvements	-0.06	0.11
Process Improvements × Team Autonomy	-0.06	0.12
Construal Level Switch	-0.02	0.06
Team Autonomy	-0.06	0.08
Random effects		
$\sigma_{u_0}^2$	0.00	
σ_e^2	0.47	
ρ	0.00	

Note. The trait self-control scale was regressed on the scales depicted in the table. Values are raw, centered, and unstandardized regression coefficients of a multilevel regression with 22 teams on the second level with a total of 150 team members on the first level (Hox, 2010). The model significantly explains the overall variance compared to a model with only the covariate social desirability included ($\chi^2_{(9, N=150)} = 16.893, p = .050$).

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

The correlation between self-control trait and state measures was significant but low indicating a certain dependency but also the structural independency of trait and state self-control ($r = .34, t(150) = 4.431, p < .001$). Trait self-control was expected to be influenced long-term by concrete planning, progress monitoring, and process improvements. Since these depend on team autonomy, they were included into the regression along with their interactions with team autonomy. Additionally, short iterations and construal level switch were included as predictors. The used trait self-control scale is known to highly correlate with social desirability (Tangney et al., 2004). To control for this influence the social desirability scale was included in the regression. The raw regression coefficient of the trait self-control regression are summarized in Table 3.

The trait self-control regression partly showed the expected pattern of results. The results point toward a gain of trait self-control by concrete planning and regular monitoring. Short iterations, process improvements, and construal level switch did not show the expected influence. A detailed discussion will be given further down together with the results of the state self-control regression. For the state self-control regression it was assumed that people with high trait self-control should also show a high state self-control. They will have higher self-control capacity or habits and automated behaviors that help to avoid ego depletion (Ent, Baumeister, & Tice, 2015; Neal, Wood, & Drolet, 2013; Schroder et al., 2013). Trait self-control was included into the regression to control for this influence. Concrete planning, progress monitoring, and process improvements depend on high team autonomy. Therefore, concrete planning, progress monitoring, and process improvements together with their interactions with team autonomy were included into the regression. Additionally, team autonomy, short iterations, and construal level switch were included into the regression. The regression results are summarized in Table 4.

The state self-control regression ($\rho = .07$) result revealed a pattern of lowered state self-control through concrete planning and progress monitoring. Process improvements increased state self-control. All of these relationships depended on high team autonomy, as only the interaction effects of these with team autonomy reached significance. Short iterations and construal level switch did not show any significant influence. Only correlations could be revealed by the present study, as neither an experimental manipulation nor a repeated measurement was done. No empirical evidence for a causal relationship could be revealed. Still, the found relationships will be interpreted in the expected direction as suggested by the literature reviewed earlier. However, the question of the causal direction will be revisited later. First, the results of trait and state self-control regressions will be discussed in more detail in the next chapters.

Table 4
State Self-Control Regression Results (Study 1)

	B	SE
Fixed effects		
Intercept	3.46***	0.07
Trait Self-Control	0.58***	0.12
Concrete Planning	0.04	0.14
Concrete Planning × Team Autonomy	-0.33 [†]	0.20
Progress Monitoring	0.12	0.17
Progress Monitoring × Team Autonomy	-0.38*	0.18
Short Iterations	-0.06	0.16
Process Improvements	0.00	0.16
Process Improvements × Team Autonomy	0.66***	0.19
Construal Level Switch	0.13	0.09
Team Autonomy	0.13	0.12
Random effects		
$\sigma_{u_0}^2$	0.05	
σ_e^2	0.69	
ρ	0.07	

Note. The state self-control scale was regressed on the scales depicted in the table. Values are raw, centered, and unstandardized regression coefficients of a multilevel regression with 22 teams on the second level with a total of 150 team members on the first level. The model significantly explains the overall variance compared to the intercept-only model ($\chi^2_{(10, N=150)} = 50.869$, $p < .001$).

[†] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

3.2.3.1 Concrete Planning and Progress Monitoring. Taken together, the trait and state self-control regression analyses results support the hypothesis that concrete planning and progress monitoring long-term increase trait self-control, while short-term state self-control is decreased (see Table 3 and Table 4).

Increased trait self-control was related to increased concrete planning ($B = 0.26$) and increased progress monitoring ($B = 0.31$). Predictors of the multilevel regression had been centered before calculation. Consequently, a significant regression coefficient implies that the independent variable significantly predicts the dependent variable given all other independent variables are at their average value (Whisman & McClelland, 2005). The effect of concrete planning depended on high team autonomy, as only the interaction of concrete planning and team autonomy reached significance and not the independent variable concrete planning alone. That is, with average team

autonomy, concrete planning did not significantly predict trait self-control. However, due to the significant interaction term, with increasing team autonomy, the relation between concrete planning and trait self-control became significantly stronger. Thus, the influence of concrete planning on trait self-control depended on high team autonomy. Unexpectedly, the effect of progress monitoring on trait self-control did not depend on high team autonomy. The regression coefficient of the interaction between team autonomy and progress monitoring stayed insignificant and close to zero. Apparently, team autonomy is not as important in the execution phase of the Sprint, that is, in the Daily Scrum Meetings, as it is in the planning phase in the Sprint Planning Meeting. A re-planning can be done in the Daily Scrum Meeting during the execution phase of the Sprint. Still, this re-planning seemed not to depend on high team autonomy. Perhaps this is because the re-planning is rather a further refinement of the overall plan created in the Sprint Planning Meeting. That is, the overall scope of the Sprint is not changed in the re-planning. Perhaps it is especially the scope selection that requires high team autonomy; and team autonomy is not required for the breakdown of Sprint Backlog Items to the task level.

State self-control was marginally significant decreased by concrete planning ($B = -0.33$) and significantly by progress monitoring ($B = -0.38$), both in interaction with high team autonomy. A negative effect on state self-control at the beginning of the Scrum implementation had been predicted, with a reduction of this negative effect due to habituation. In the survey data a clear negative relationship between concrete planning as well as progress monitoring and state self-control was found. Apparently, a negative influence on state self-control by concrete planning and progress monitoring was present also after the initial implementation phase. The implementation phase of the teams could not be controlled for. Consequently, the simplest explanation for the results of the present study is that with high team autonomy concrete planning and progress monitoring have an ego depleting effect in the initial implementation phase and after the initial implementation phase of a Scrum implementation. Concrete planning and progress monitoring, thus, always seemed to have an ego depleting effect.

Concrete planning and regular monitoring had different effects on state and trait self-control. In the state self-control regression the effect of trait self-control was controlled for. High trait self-control significantly predicted high state self-control ($B = 0.58$). That means, reduced state self-control by concrete planning and progress monitoring is present for persons with high as well as with low trait self-control. However, persons with high trait self-control reported higher state self-control. Reduced state self-control by concrete planning and progress monitoring should, thus, affect persons less that have higher state self-control, which is supported by higher trait self-control. Trait self-control in turn was improved by concrete planning and progress monitoring. Overall, the empirical results show a positive pattern of improving trait self-control of the Development Team members by concrete planning and progress monitoring with high team autonomy, though with the cost of reduced state self-control in the short-term.

Process improvements from the Sprint Retrospective Meetings had a significant positive effect on team members' state self-control, but again only with high team autonomy ($B = 0.66$). Sprint Retrospective Meetings probably helped to improve and smooth processes in a way that reduced ego depletion. This effect seemed to be effective short-term, but no positive effect was found on trait self-control in the long-run.

In summary, initial support for the hypothesis that concrete planning and active progress monitoring may have led to long-term gains in trait self-control has been found. Short-term, state self-control was reduced by concrete planning and active progress monitoring. Effective process improvements increased state self-control. All effects on trait and state self-control required high team autonomy. With low team autonomy only active progress monitoring was significantly related to trait self-control.

3.2.3.2 Short Iterations. The expected relations between short iterations and trait as well as state self-control were not found. Regression coefficients in both regressions failed to reach significance. Thus, meeting the Sprint end deadlines and trying hard to finish the Sprint Backlog Items by then apparently did neither systematically reduce state self-control nor did it improve trait self-control.

After a second, closer investigation of the experiment by Oaten and Cheng (2006a), it became apparent that the early deadlines in the experiment were likely not directly

improving self-control, but supported the creation of a concrete plan. The early deadlines in the experiment helped to create achievable and concrete goals, which in turn probably supported self-control improvement.

In the present study, high trait self-control was significantly predicted by concrete planning with high team autonomy. Short iterations might have supported this effect by supporting concrete planning. However, a statistical mediation effect was not found for this post-hoc hypothesis (Baron & Kenny, 1986). Upon regressing the dependent variable trait self-control on the independent variable short iterations in a multilevel regression with team as grouping factor, no significant relation was found ($F < 2$, $p > .15$). Hence, statistically no evidence for the mediation of the relationship between short iterations and trait self-control by concrete planning was found. Concerning state self-control also no direct relationship between dependent variable state self-control and independent variable short iterations existed in a second multilevel regression with team as grouping factor ($F < 1.5$, $p > .25$). Therefore, a mediation effect could not be found for trait or state self-control. Short iterations seem not to have supported concrete planning that in turn improved trait as well as state self-control in the present study.

In sum, no direct relation between short iterations and trait or state self-control was found in the trait and state self-control regressions. The plausible explanation that short iterations may lead to more concrete planning and this in turn supports trait and state self-control, did not get any empirical support.

3.2.3.3 Process Improvements. The interaction of process improvements from the Sprint Retrospective Meetings with high team autonomy significantly predicted improved state self-control ($B = 0.66$). With average team autonomy, process improvements did not significantly influence state self-control. The regression coefficient of process improvements predicting state self-control was literally zero ($B = 0.00$). This pattern is in line with the expectation that the positive effect of process improvements depends on high team autonomy. Concerning trait self-control, unexpectedly, no significant relation with process improvements was found.

The results for trait self-control did not support the hypothesis that behavioral changes agreed upon in the Sprint Retrospective Meetings lead to a self-control improvement

training that increases trait self-control in the long-term. Nevertheless, empirical indications were found that Sprint Retrospective Meetings help to reduce ego depletion in the day-to-day work environment of the teams. Agreed process improvements may help to improve effectiveness and efficiency of team-internal processes. Perhaps the main improvement stems from solving interpersonal conflicts in the teams. Sprint Retrospective Meetings are said to be very emotional at times. It seems plausible that the social relationships inside the teams are improved by the Sprint Retrospective Meetings. These improvements of social relationships may successively reduce self-control demands in social interactions, that is, they may reduce ego depletion (Baumeister & Alquist, 2009b; Baumeister et al., 2007). The study's results support the hypothesis that high team autonomy is a prerequisite of this process. No significant effect of process improvements on state self-control was found, only the interaction of process improvements with team autonomy was significantly predicting state self-control.

In summary, a positive relation between process improvements and Development Team members' state self-control was found. Presumably, process improvements led to more effective and efficient team internal processes and improved team internal social relationships, which helped to reduce self-control demands in day-to-day work. Although plausible, only empirical indications for this relationship were found and further investigations are needed. However, no empirical support was found for the hypothesis that process improvements from the Sprint Retrospective Meetings support trait self-control improvements of the Development Team members.

3.2.3.4 Construal Level Switch. Unexpectedly, a high construal level in the Sprint Planning Meeting or throughout the Sprint was not significantly related to trait or state self-control in any of the regression analyses.

Construal level influences might be too subtle as to have an impact on self-control in an applied work setting. This could perhaps explain why no effect of construal level switch on trait or state self-control was found. Construal level research seems to be largely based on laboratory experiments, in which manipulations of participants' construal level are rather lasting minutes than hours⁵. In a complex organizational work environment, such as the one in which the present study was conducted, too many other influences might have affected the Development Team members' construal level. Hence, a clear effect could not be found or perhaps the effect is too subtle in this applied setting.

Moreover, the scale used in the present study to measure construal level switch had a low reliability (Cronbach's $\alpha = .47$). The low reliability of the scale may have undermined the detection of a self-control supporting effect of high construal level in the Development Team.

In sum, no relation between construal level switch and trait or state self-control was found in the present study. This could be explained by the low reliability of the used scale or because construal level influences might have been too subtle to be detected in the complex work environment.

3.2.3.5 Team Autonomy. As expected, no significant effect of high team autonomy on trait self-control was found. The mere increase of team autonomy alone was not expected to improve trait self-control, but only when Scrum principles were implemented with high team autonomy. State self-control was expected to be increased with mere increased team autonomy, since individual's high autonomy can reduce ego depletion on self-control exertion (Moller et al., 2006; Muraven, 2008; Muraven et al., 2008). Unexpectedly, this relation did not reach significance, though descriptively the effect pointed in the expected direction ($B = 0.13$, $F(1, 118) = 1.316$, $p = .254$). Still, team and team members' autonomy needs to be distinguished. Higher state self-

⁵A search in PsycINFO for quantitative studies in academic journals containing *construal level* or *psychological distance* returned 344 results. Within these results only two articles were classified as *field study* and only seven articles contain the search term *employee*.

control probably depends on team members' autonomy and less on the overall team's autonomy. High team autonomy might correlate with low team members' autonomy and vice versa (Langfred, 2000, 2005). Consequently, high team autonomy implicated low team members' autonomy, which in turn should not improve team members' state self-control. Taking this into account, even a negative relation between team autonomy and state self-control could have been expected. However, the present study does not provide data concerning team members' autonomy. Hence, this ad-hoc hypothesis could not be investigated further.

The present study's results support the hypothesis that high team autonomy is a prerequisite of the relationship between Scrum principles and self-control. Trait self-control was improved by concrete planning, but only with high team autonomy. Reduced state self-control by concrete planning and progress monitoring as well as increased state self-control by process improvements were present only in interaction with high team autonomy. Only trait self-control improvement by progress monitoring did not depend on high team autonomy.

In sum, empirical indications of the importance of high team autonomy for the implementation of Scrum in a way that supports self-control were found. The potential self-control improvement through concrete planning and progress monitoring were only effective with high team autonomy.

3.2.3.6 Summary. Empirical indications of a trait self-control improvement by Scrum's planning and progress monitoring were found in the present study. State self-control was decreased by concrete planning and progress monitoring. These effects depended on high team autonomy. One notable exception to this was the positive influence of progress monitoring on trait self-control, which did not depend on high team autonomy. State self-control tended to be decreased by concrete planning and progress monitoring for team members with high and low trait self-control. Still, high state self-control was predicted by high trait self-control. All in all, the pattern of results found indicates the existence of a cycle of self-control improvement with decreased state self-control in the short-term that leads to increased trait self-control in the long-term.

Present study's results support a buffering hypothesis of the relationship between state and trait self-control. Trait self-control might act as a buffer against ego depletion. Contrary to this, the experiments by Imhoff et al. (2014) revealed an ironic effect of people with high trait self-control showing higher ego depletion compared to people with low trait self-control on identical tasks. However, the present study is situated in an applied work setting. People with high trait self-control were not forced to face ego depleting situations and cope with these using their state self-control capacity. People with high trait self-control could have used proactive tactics to avoid facing ego depleting situations. Overall, the present study may add some empirical insight to the large and yet unclear relationship between state and trait self-control.

Short iterations by the short Sprints, which end with the Sprint Review Meeting, were neither related to trait nor to state self-control. Furthermore, no empirical support was found that trying to meet the short iteration deadlines led to a more concrete planning that in turn improved self-control.

Process improvements from the Sprint Retrospective Meetings did not influence trait self-control. Still, state self-control was significantly increased by process improvements. Probably, process improvements from the Sprint Retrospective Meetings led to reduced self-control demands in the day-to-day work of the Development Team members. The main support for state self-control may stem from reduced self-control demands in social interactions in the team due to solved conflicts and better social relationships.

Unexpectedly, construal level switching was not related to trait or state self-control. Possibly, the used scale was not suitable for measuring the changes due to its low reliability; or the construal level effect was too subtle to be revealed in the complex working environment.

Empirical indications were provided that high team autonomy is important for implementing Scrum in a way that supports Development Team members' self-control. Development Team members' self-control was mostly influenced by concrete planning and progress monitoring. However, influences on trait and state self-control were found only in interactions with team autonomy. The influence of progress monitoring on trait self-control was the only exception that did not depend on high team autonomy. Further, a state self-control increasing effect was found by process improvements from the Sprint Retrospective Meetings. Again, this depended on high team autonomy. High team autonomy hence appears to be crucial for the positive effects on self-control by Scrum.

The state self-control scale used in the questionnaire of the present study might be subject to criticism. The scale was derived from an experiment by Sonnentag and Jelden (2009), who had successfully used a similar scale. However, contrary to this research, in the present study the questionnaire was not used in a repeated measures design. A baseline for the individual Development Team member could not be calculated and the results are not based on intra-individual differences, but on inter-individual differences in reported state self-control. The scale focuses on exhaustion. If it is a valid measure of ego depletion still needs to be confirmed. In the meantime, the state self-control capacity scale was proposed (Bertrams, Unger, & Dickhäuser, 2011; Twenge, Muraven, & Tice, 2004). It measures ego depletion more comprehensively. Still, also this scale lacks proven validity and reliability, as it has not been officially published yet.

3.2.4 Effects of High Self-Control. It was predicted that high self-control increases team performance, reduces experienced stress, and supports good health. In addition, direct influences of the Scrum principles with similar effects might support the positive outcomes.

Table 5
Performance Regression Results (Study 1)

Variable	B	SE
Fixed effects		
Intercept	3.58***	0.04
Trait Self-Control	0.06	0.09
State Self-Control	0.02	0.05
Concrete Planning	0.02	0.09
Progress Monitoring	0.10	0.11
Short Iterations	0.37***	0.11
Process Improvements	0.15	0.10
Construal Level Switch	0.12*	0.06
Team Autonomy	0.19**	0.08
Random effects		
$\sigma_{u_0}^2$	0.09	
σ_e^2	0.47	
ρ	0.16	

Note. The team performance scale was regressed on the scales depicted in the table. Values are raw, centered, and unstandardized regression coefficients of a multilevel regression with 22 teams on the second level with a total of 150 team members on the first level. The model significantly explains the variance compared to the intercept-only model ($\chi^2_{(8, N=150)} = 80.423$, $p < .001$).

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

3.2.4.1 Increased Team Performance. Performance was predicted with a multi-level regression with team as grouping factor ($\rho = .16$). Predictors were trait and state self-control, concrete planning, progress monitoring, short iterations, process improvements, construal level switch, and team autonomy. Interaction terms of team autonomy with other variables were not included into the regression due to a lack of theoretical plausibility.

Results of the regression analysis are depicted in Table 5. Short iterations and team autonomy significantly predicted high team performance ($B = 0.37$ and $B = 0.19$, respectively). Additionally, construal level switch significantly predicted high team performance ($B = 0.12$).

Unexpectedly, team members' trait and state self-control were not related to team performance. Generally, for individuals high self-control is related to high performance (de Ridder et al., 2012; Duckworth & Seligman, 2005; Tangney et al., 2004). However, team performance is not simply the sum of the team members' performance. The degree of how good the team members' efforts are coordinated is relevant for the team

performance. In addition, the interdependency of the team members' tasks is relevant (Kozlowski & Bell, 2003; Langfred, 2005; Stewart & Barrick, 2000). In highly interdependent tasks, the individual performance of the team members will less likely sum up to the overall team performance compared to tasks with low interdependency. Hence, high team members' self-control does not necessarily lead to high team performance.

Concrete planning and progress monitoring were not significantly related to team performance either. Team performance might be highest with moderate concrete planning. Performance might decline with a more or less concrete planning. The relation of concreteness of planning and team performance would, thus, not be linear but curvilinear with a flipped u-shaped form. A linear regression could not reveal this non-linear relationship. However, in the present study no empirical support for a flipped u-shaped relationship was found. Checking the scatter-plots of team performance predicted by concrete planning or by progress monitoring individually showed a linear relationship with a positive slope for both predictors.

The significant relation between short iterations and team performance might stem from the operationalization of the two scales. The short iterations scale measured aspects of commitment to the Sprint Goal, effort to achieve it, getting feedback for achievements (which should in turn increase commitment), and acceptance of the Sprint length. This scale should cover whether the team members actually try to achieve the Sprint Goal or not. On the opposite side, the items of the performance scale asked the team members to compare their current team with other teams they know. They rated their current team on the dimensions efficiency, amount of work accomplished, meeting deadlines, and quality and speed of work. One additional item measured the subjective impression of an increased productivity of the team through Scrum. Comparing this scale to the short iterations scale reveals some similarity between some items of both scales. Especially the item from the short iterations scale assessing the proportion of finished Sprint Backlog Items during an ordinary Sprint (ED-C-4, see in the Appendix, *Items per Scale (Study 1)*) is similar to the evaluation of the team's capability to meet its deadlines (PF-F-3) and to meet the Sprint Goal (PF-F-5). Additionally, the question about acceptance of the Sprint length (ED-C-1) might be closely related to the

evaluation whether Scrum made the team more productive (PF-R-1). Both questions might be strongly related to a general acceptance of Scrum.

Checking the correlation of the items of the two scales confirmed this suspicion. The highest and third highest correlation coefficients existed between the proportion of finished Sprint Backlog Items per Sprint (ED-C-4) and the team's capability to meet the Sprint Goal (PF-F-5; $r = .47$, $t(155) = 6.558$, $p < .001$) as well as the capability to meet deadlines (PF-F-3; $r = .36$, $t(155) = 4.785$, $p < .001$). The second highest correlation existed between the Sprint length acceptance (ED-C-1) and the rating of Scrum made the team more productive (PF-R-1; $r = .40$, $t(155) = 5.483$, $p < .001$). Still, the correlations between items of the two scales were only moderate with a maximum of $r = .47$. In addition, a recalculation of the performance regression with the overlapping items removed from the performance scale (PF-F-3, PF-F-5, PF-R-1) showed that the relation between performance scale and short iterations scale remained significant ($B = 0.26$, $F(1, 127) = 6.752$, $p = .011$). Therefore, the relation between short iterations and team performance cannot simply be attributed to an item overlap of the two scales.

Short iterations, that is, having short Sprints that are accepted by the team members, getting feedback in the Sprint Review Meeting, and trying hard to finish the Sprint Backlog were related to high team performance. It is not surprising that working hard and accepting the deadlines is related to high performance. This seems plausible and the results of the present study support this hypothesis.

High team autonomy significantly predicted high team performance as well. Although in this study the validity of the performance measurement can be discussed due to the self-evaluation by the team members, other research already demonstrated a positive influence of high team autonomy on team performance with less subjective measurements of performance (Lee & Xia, 2010). The present study's results support the hypothesis that high team autonomy supports team performance.

Construal level switch significantly predicted high team performance. Supporting high construal levels in the team, that is, *why* a task is done, was related to high team performance. Low construal levels of *how* a task is done are assumedly evoked in daily work anyway, simply, as working on a task requires dealing with the details of that

task. Consequently, reminding team members of the high level objective results in a construal level switch. Additionally, team performance might have been supported through better alignment of the team members' efforts. An alternative explanation that construal level switch might increase team members' self-control and thereby improve team performance was not supported by the results of the trait and state self-control regressions. Construal level switch was not significantly related to trait or state self-control. Furthermore, no influence of trait or state self-control on team performance was found in the performance regression. So even if construal level switch had improved trait or state self-control, this would probably not have improved team performance. The construal level switch scale needs to be thoroughly revised, as it had a low reliability ($r = .47$). Hence, the construal level results are only initial empirical indication that high construal level might support team performance. However, the influence of high construal level on self-control that in turn supports team performance in a complex work setting could not be supported empirically.

In summary, team performance was supported by Scrum's short iterations. Working hard with high commitment to achieve the Sprint Goal probably led to higher performance of the Development Teams. It could be ruled out that the result stems from an item overlap of the performance and the short iterations scales. High team autonomy showed, as predicted, a positive influence on team performance as well. Emphasizing high construal levels, or distal goals, was also related positively to high team performance. No empirical evidence was found that high team performance was supported by trait or state self-control. Furthermore, the Scrum principles that were related to self-control, concrete planning, progress monitoring, and process improvements were not significantly related to team performance either.

Table 6
Stress Regression Results (Study 1)

	B	SE
Fixed effects		
Intercept	3.50***	0.07
Trait Self-Control	0.09	0.13
State Self-Control	0.36***	0.08
Concrete Planning	0.05	0.14
Progress Monitoring	-0.11	0.16
Short Iterations	-0.14	0.16
Process Improvements	0.21	0.14
Team Autonomy	0.23*	0.12
Random effects		
$\sigma_{u_0}^2$	0.16	
σ_e^2	0.69	
ρ	0.19	

Note. The low stress scale was regressed on the scales depicted in the table. Higher values of the low stress scale indicate lower experienced stress levels. Values are raw, not centered or standardized regression coefficients of a multilevel regression with 22 teams on the second level with a total of 150 team members on the first level. The model significantly explains the variance compared to the intercept-only model ($\chi^2_{(7, N=150)} = 40.141, p < .001$).

† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

3.2.4.2 Lower Stress Level. The low stress criterion was subjected to a multilevel regression with team as grouping factor ($\rho = .19$). Predictors were trait and state self-control, concrete planning, progress monitoring, short iterations, process improvements, and team autonomy. Team autonomy interactions with other variables were again not included due to a lack of theoretical plausibility. Construal level switch was not included for the same reason. High state self-control significantly predicted low experienced stress ($B = 0.36$; see Table 6). Additionally, high team autonomy significantly predicted low experienced stress ($B = 0.23$). All other regression coefficients were insignificant.

The item sequence in the questionnaire might have led to an assimilation effect between stress and state self-control scale. The items of the stress scale were followed by the items of the state self-control scale. It cannot be completely ruled out that this sequence influenced the results. However, the correlation of the scales is only moderate ($r = .39, t(152) = 5.190, p < .001$), and analyzing the correlations between all items of the two scales, the maximum correlation found is also only moderate ($r = .45, t(152) = 6.243, p < .001$; correlation of ST-S-2 with SC-S-4). Additionally, the state self-control item that was probably influenced the most as being the first item after the stress items (ST-

S-1) was not included into the main regression analyses. This item had already been removed in the scale validation to improve reliability of the low stress scale. Overall, spurious results due to the influence of the item sequence seem unlikely.

As expected, high state self-control was related to low experienced stress. This relation may result from different processes. For now we leave aside the processes of cognitive appraisal that translate external stressors to internal experienced stress of individuals. On one side, team members that are confronted with less stressors than other team members probably reported lower perceived stress and would also have been less depleted. On the other side, hypothetically being confronted with identical stressors, team members with higher state self-control capacity would have reported a higher current state self-control. In this situation, state self-control would have acted as a buffer against these stressors. Overall, the positive relation of high state self-control with lower experienced stress could, thus, be caused by confounding external stressors or by the buffering effect of state self-control for perceived stress.

Surprisingly, trait self-control was not significantly related to experienced stress. It was expected that high trait self-control acted as buffer against stress and with that reduced experienced stress (Schmidt et al., 2012). Perhaps high trait self-control increased state self-control, which in turn reduced experienced stress. In fact, a post-hoc mediation analysis (Baron & Kenny, 1986) with a sequence of three multilevel regressions with team as grouping factor revealed that state self-control mediated the relation between trait self-control and experienced stress. In two regression analyses, the independent variable trait self-control significantly predicted the mediator state self-control ($B = 0.56$, $F(1, 129) = 19.983$, $p < .001$) as well as the dependent variable low stress ($B = 0.33$, $F(1, 129) = 7.109$, $p = .009$). In a third multilevel regression, the independent variable trait self-control did not significantly predict the dependent variable low stress any more ($B = 0.14$, $F(1, 128) = 1.367$, $p = .245$), while the mediator state self-control still significantly predicted the dependent variable low stress ($B = 0.33$, $F(1, 128) = 19.698$, $p < .001$; model comparison to intercept-only model $\chi^2_{(2, N=152)} = 25.439$, $p < .001$). Apparently, high trait self-control was related to lower experienced stress. This could have been caused, for example, by self-control relieving habits (Ent et al., 2015;

Neal et al., 2013; Schroder et al., 2013). Yet, high trait self-control did not reduce experienced stress directly, but might have reduced experienced stress by improving state self-control. Again, only an empirical indication for this mediation can be provided by the present study. More research is required to investigate this ad-hoc finding.

High team autonomy was related to lower experienced stress. High team autonomy seemed to have provided the required control to the team that helped the team to reduce the stress level. Also, teams with high team autonomy may have used their autonomy to reject Sprint Backlog Items that they expected not to finish until the Sprint Review Meeting. In that way, workload and stress level could have been reduced by the Development Teams. In addition, high team autonomy may have implied reduced team-external interventions in team processes, which in turn may have increased team members' feeling of control and thereby reduce team members' experienced stress (S. Cohen et al., 1983).

No direct relationship between any of the Scrum principles and experienced stress was found. This is particularly surprising for concrete planning. The concrete planning scale included two items assessing high predictability of the Sprints (CP-P-1 and CP-P-2, see in the Appendix, *Items per Scale (Study 1)*). Unpredictability is one of the core dimensions of perceived stress (S. Cohen et al., 1983). Eventually, planning concretely and thereby reducing uncertainty should help to reduce experienced stress. Nevertheless, a significant relationship between concrete planning and low stress was only found in a multilevel regression with team as grouping factor leaving out all other predictors ($B = 0.30$, $F(1, 133) = 6.697$, $p = .011$). As soon as other predictors were included into the regression, as in the low stress regression (see Table 6), concrete planning was not significantly predicting low stress any longer. Concrete planning seems to have a subtle or implicit influence on experienced stress. It seems not to exert a direct influence on experienced stress. At least in the present study, no relevant influence of concrete planning was found on low experienced stress.

In sum, high state self-control and high team autonomy are related to lower experienced stress. In a post-hoc analysis, high trait self-control supported high state self-control that in turn was related to low experienced stress. State self-control might, thus, act

Table 7
Health Regression Results (Study 1)

	B	SE
Fixed effects		
Intercept	1.91**	0.58
Trait Self-Control	0.22 [†]	0.12
State Self-Control	0.39***	0.08
Concrete Planning	0.09	0.13
Progress Monitoring	-0.18	0.15
Short Iterations	-0.07	0.15
Process Improvements	-0.12	0.13
Team Autonomy	0.10	0.11
Random effects		
$\sigma_{u_0}^2$	0.00	
σ_e^2	0.66	
ρ	0.00	

Note. The health scale was regressed on the scales depicted in the table. Values are raw, not centered or standardized regression coefficients of a multilevel regression with 22 teams on the second level with a total of 150 team members on the first level. The model significantly explains the variance compared to the intercept-only model ($\chi^2_{(7, N=150)} = 43.955, p < .001$).

[†] $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

as buffer against stressful events. No empirical support was found that the Scrum principles reduced perceived stress, except for high team autonomy.

3.2.4.3 Improved Health. The health criterion was predicted by the same variables as the low stress criterion in a multilevel regression with team as grouping factor ($\rho < .01$). The regression results are summarized in Table 7.

The regression results show that health is significantly predicted by state self-control ($B = 0.39, F(1, 121) = 28.861, p < .001$), as well as marginally significant by trait self-control ($B = 0.22, F(1, 121) = 3.568, p = .061$).

One possible explanation that needs to be ruled out for the relationship between state self-control and health is a striking similarity of some of the items of the two scales. Especially the item asking participants if they feel full of energy (HT-H-5) resembles the item from the state self-control scale (cf. SC-S-1: "In the last 24h I feel active"⁶). Checking the correlations between the items of the two scales, this item does indeed show the highest correlation coefficient with the state self-control scale items ranging from $r = .42$ ($t(150) = 5.680, p < .001$; SC-S-1) to $r = .53$ ($t(150) = 7.617, p < .001$;

⁶Rough translation, original item in German, see in the Appendix, *Items per Scale (Study 1)*.

SC-S-3). Still, these correlations are only moderate and hence the item overlap may not be responsible for the found relationship.

However, a question sequence effect could not be ruled out easily. In the questionnaire the items of the state self-control scale were followed by the items of the health scale. The correlations of the first item of the health scale (HT-H-1) with the preceding state self-control scale items were relatively low, ranging from $r = .27$ ($t(139) = 3.271$, $p = .001$, SC-S-1) to $r = .38$ ($t(138) = 4.813$, $p < .001$, SC-S-2). Perhaps the sequence of the very specific questions may still have led to an assimilation effect for the successive general health question (HT-H-1), as these specific questions could be included into the same category of the general health question (Schwarz & Bless, 2007; Schwarz, Strack, & Mai, 1991).

To rule out spurious results due to this potential assimilation (HT-H-1) or the scale item similarity (HT-H-5), the two items were removed from the health scale (remaining items Cronbach's $\alpha = .58$). The recalculation of the regression showed significant relations between health and state self-control ($B = 0.36$, $F(1, 121) = 16.980$, $p < .001$) as well as between health and trait self-control ($B = 0.29$, $F(1, 121) = 4.339$, $p = .039$; model comparison to intercept-only model $\chi^2_{(7, N=150)} = 33.849$, $p < .001$). The regression results are, thus, not different from the results obtained when these two items were included. Consequently, the found relation between state self-control and health may not be explained by mere item overlap or an assimilation effect.

Unexpectedly, trait self-control predicted health only marginally significant. Perhaps state self-control mediated the influence of trait self-control on health. In that case high trait self-control supported high state self-control that in turn supported good health. A mediation analysis gave initial support to this ad-hoc hypothesis in a series of three multilevel regression analyses with team as grouping factor (Baron & Kenny, 1986). Firstly, the mediator state self-control was significantly predicted by the independent variable trait self-control ($B = 0.56$, $F(1, 129) = 19.983$, $p < .001$). Secondly, the dependent variable health was significantly predicted by the independent variable trait self-control ($B = 0.40$, $F(1, 129) = 12.035$, $p < .001$). Thirdly, the dependent variable health was regressed on the independent variable trait self-control again, including

the mediator state self-control. The prediction of health by trait self-control was only marginally significant and the coefficient reduced to $B = 0.19$ ($F(1, 128) = 2.904$, $p = .091$) from $B = 0.40$ without including the mediator state self-control. State self-control predicted health still significantly ($B = 0.38$, $F(1, 128) = 30.933$, $p < .001$; model comparison to intercept-only model $\chi^2_{(2, N=152)} = 39.570$, $p < .001$). The mediation analysis statistically demonstrated that state self-control may partially mediate the influence of trait self-control on health. The relationship between health and trait self-control was reduced, though not eliminated, by including the mediator state self-control into the regression of health on trait self-control. Although the statistical result alone without a sound theoretical background is not suitable for establishing a mediation relationship (Fiedler, Schott, & Meiser, 2011), also theoretically the mediation seems plausible. Still, only an empirical indication for this mediation can be provided by the present study's results. More research is required to explore this relationship.

Unexpectedly, no relation between any of the Scrum principles and health was found. It was assumed that Scrum, which emphasizes a controlled, self-monitoring work processes, supports health of the Development Team members similar to the demonstration in the experiment by Oaten and Cheng (2006a). These relations were not found. Possibly, the Scrum principles improve trait self-control, which in turn supported team members' health. Self-control was found to be improved by two Scrum principles in the trait self-control regression, namely by concrete planning interacting with high team autonomy and by progress monitoring. However, health was not significantly related to these two Scrum principles. No significant relation was found in the health regression; and even regressing health individually on concrete planning and progress monitoring in two multilevel regressions with team as grouping factor revealed no significant relation either (both F s < 1.5 , $p > .20$). Therefore, as no direct influence of neither concrete planning nor progress monitoring on health were found, these relationships cannot be mediated by state or trait self-control. The Scrum principles, thus, do neither influence team members' health directly nor indirectly by improving self-control.

Team autonomy was, unexpectedly, not significantly related to individual team members' health. Possibly, team members' autonomy as opposed to autonomy of the team

is of more relevance for team members' health (Mirowsky & Ross, 2007). However, this hypothesis cannot be further investigated in the present study.

In addition to the direct relationships of Scrum to team members' health, it was also predicted that poor health in the long-run could originate from a high stress level. To investigate this, the health regression was performed again including low stress as additional predictor. The results revealed that low stress significantly predicted better health ($B = 0.18$, $F(1, 120) = 6.001$, $p = .016$). State self-control and trait self-control relationships did not change fundamentally and were still predicting better health significantly and marginally significant ($B = 0.33$, $F(1, 120) = 18.316$, $p < .001$, and $B = 0.20$, $F(1, 120) = 3.109$, $p = .080$, respectively; model comparison to intercept only model $\chi^2_{(8, N=150)} = 49.838$, $p < .001$; $\rho < .01$). Low stress may hence support better health. This finding corroborates findings from literature that high stress probably has detrimental effects on health in the long-run.

Overall, the regression analysis showed a relation between better health and higher state as well as marginally significant higher trait self-control. High trait self-control might have supported high state self-control that in turn supported better health. Initial empirical indications supporting this ad-hoc hypothesis were found in a mediation analysis. However, no empirical support was found that the Scrum principles improved self-control, which in turn supported better health. Generally, the found relationships between self-control and health replicate previous findings that high self-control supports better health and health behavior (Schroder et al., 2013; Tangney et al., 2004; Wills et al., 2007). A possible item overlap of the health scale with the state self-control scale and a potential assimilation effect between these scales due to the item sequence could be ruled out.

3.2.5 Final Thoughts. The present study initially supports the hypothesis that Scrum improves Development Team members' self-control, lowers experienced stress, improves team members' health, and improves team performance. The core principles of Scrum are its teamwork with concrete planning (Sprint Planning Meeting), thorough progress monitoring (Daily Scrum Meeting), short iterations (Sprint Review Meeting), process improvements (Sprint Retrospective Meeting), its demand for

high Development Team autonomy, which is supported by the Scrum Master, and potentially by an immanent construal level switch. Concrete planning and progress monitoring, thoroughly performed, seemed to have trained and improve self-control of the Development Team members in the long-run. High team autonomy revealed to be highly important for this self-control training. At the same time, high team autonomy supported high team performance with simultaneously low perceived stress. In that way, Scrum may increase the Development Team's viability, that is, it enables a sustainable high team performance (Kozlowski & Bell, 2003; Schatz & Abdelshafi, 2006). High team performance was also related to meeting the frequent, short iteration deadlines with the Sprint Review Meetings. The Sprint Retrospective Meetings, finally, seemed to have supported state self-control, while not supporting trait self-control improvement as hypothesized.

The found positive effects of Scrum's Development Teams resemble the effects found for SMWTs. Similar to SMWTs, positive relations have been found between team self-organization with high team autonomy and high team performance as well as low experienced stress of the team members, while high team autonomy was of high importance for these findings. In addition to SMWTs, Scrum's roles and temporal structure introduce an overarching structure of how and when internal and external team collaboration takes place. For future research on SMWTs it might be worth including this perspective of team self-organization derived from Scrum, that is, to include the influence of performing a planning with progress monitoring, frequent deadlines, and team internal process improvements. These Scrum principles may possibly support positive effects of an installment of SMWTs.

The construal level switch scale needs to be further analyzed. Foremost, the scale revealed a low reliability in the main analyses (Cronbach's $\alpha = .47$). A significant relation of construal level switch to team performance was found, but not to trait or state self-control. An exploratory principle component analysis⁷ of the construal level switch scale with varimax rotation on the data of the main analyses revealed two components with eigenvalues larger than one. Results were confirmed by a parallels

⁷The principal component analysis was performed with *R* module *psych* (R Core Team, 2014; Revelle, 2014).

test, which compared the extracted principal components with principal components extracted from random data (Tabachnick & Fidell, 2007). The first principal component (variance proportion explained 53%) comprised of two items, CL-P-1 (standardized loading on first component .87, on second component .04, communality $h^2 = .76$) and CL-S-2 (.83, .09, $h^2 = .69$). This first principal component can be interpreted as depicting the clarity of the Product Backlog and its visibility throughout the Sprint. The second principal component (47%) consisted of the remaining three items, CL-S-1 (-.14, .71, $h^2 = .53$), CL-R-1 (.12, .74, $h^2 = .57$), CL-R-2 (.32, .57, $h^2 = .42$). This second principal component can be interpreted as depicting customer contact and reflection on the *why* of the daily tasks. Recalculating the performance regression with the construal level switch scale separated into these two principal components revealed that only the first principal component was significantly related to high team performance ($B = 0.11$, $F(1, 118) = 4.110$, $p = .045$), while the second principal component was not significantly related to team performance ($B = 0.06$, $F(1, 118) = 1.781$, $p = .185$; model comparison to intercept only model $\chi^2_{(9, N=149)} = 84.206$, $p < .001$). It seems that the clarity of the Product Backlog, that is, the clarity of the overall goal, and its visibility throughout the Sprint might have supported team performance, whereas customer interaction and reflecting on the *why* might not have supported team performance. Still, these results need to be verified in further analyses, as these results were obtained only in an exploratory post-hoc analysis.

In future research, the questionnaire used in this study could be improved. The construal level scale requires a refinement not only clarifying its factorial structure but also improving its validity and its applicability in the context of an applied work setting. In the questionnaire, the stress, the state self-control, and the health scales were placed too close together. In the present study, a relevant influence of the item sequence could be ruled out. Still, the item sequence might provoke item sequence effects, which could artificially increase the correlation between health as well as low stress and state self-control scale (Schwarz et al., 1991). The sequence of the items in the questionnaire should be changed. The used state self-control scale might be more suitable for repeated measure application (as applied by Sonnentag & Jelden, 2009). To measure state self-

control between-subject, the scale might better be replaced by a more comprehensive state self-control scale (see for instance Twenge et al., 2004). The team performance rating was done with self-assessment of the team by its team members. Although this approach probably leads to valid results, still, a second measurement by an external observer could add to the validity of the results. No validated questionnaire existed to measure the compliance to the Scrum processes or the fundamental principles of Scrum. The scales of the Scrum Questionnaire, which measured the Scrum principles, were capturing these principles with sufficient or even good reliability (concrete planning, process improvements, team autonomy; all Cronbach's $\alpha > .68$). Still, some of the scales need to be revised for future research (progress monitoring, short iterations; both Cronbach's $\alpha < .54$).

The study was conducted anonymously and voluntarily. This might limit the generalizability of the results. A self-selection bias cannot be ruled out. Team members favoring Scrum might have been more willing to support Scrum research. Team members that see Scrum negatively and do not willingly adopt the Scrum process might not have filled out the questionnaire. In that way, overall variance could have been reduced. This would have reduced the chance of finding the predicted relationships. The interpretation of the results will, thus, not be spuriously affected by this influence. However, if participation of team members disagreeing with Scrum could be increased, this would add to the power of the analyses.

What the scales in the questionnaire actually measured and what the research question as such was, was not obvious to participants. Hence, a bias due to intentionally wrong ratings of the self-control, low stress, or health scales is not probable. The used trait self-control scale is susceptible to social desirability (Tangney et al., 2004). To control for that influence a social desirability scale was included.

A limiting factor for the results is that these stem from only a single development organization. Influences and effects including interaction effects of organizational norms and processes may have biased the relationships found in this study. A confirmatory replication of the results in different organizations is, thus, needed to increase generalizability of the results.

Including control-groups could add to the generalizability of the results. Concerning the present study, the Scrum implementation was already ongoing in the organization. Hence, neither a pre-test nor the inclusion of control-groups could be realized. However, during the transition phase the progress of the Scrum implementation differed sufficiently between the Scrum Teams to discover the expected relationships in the questionnaire.

The number of teams analyzed ($N = 22$) was too low to investigate the predicted relationships on team level. The analyses were based on the individual level while taking the team level into account. The results are, thus, based on average team member's cognition and evaluation of the relationships but not on team comparisons. The level of analysis is important, though oftentimes neglected (Van Mierlo et al., 2005). For the present study mostly individual level variables were in the focus of interest, with self-control, low stress, and health. Hence, an analysis on individual level is reasonable. Additional analyses on team level could support the overall validity. For example, team level analyses might demonstrate that team members of Development Teams that follow the Scrum rules more strictly have higher self-control. However, such analyses require a large number of Development Teams and, still, the individual level analysis would be required to show that the overall effect is not limited only to the team level.

The cross-sectional design of the present study could limit the interpretation of present study's results. Causal relationships cannot be derived from found relationships, as the relationships are only correlative. Confounding variables influencing the dependent and independent variables cannot be ruled out. For example, the found relationship between high state self-control predicting low experienced stress could also be plausibly explained by high self-control demands, which on one side decrease state self-control, and on the other side increase experienced stress. One of such potential confounding variables might be the age of the team members, particularly, for relationships including self-control or health. Self-control and health probably vary with age. However, recalculating all five main regression analyses again—trait self-control, state self-control, team performance, team members' low experienced stress, and team members' health—

including age as covariate revealed fundamentally identical results. Age seemed not to be an underlying confounding variable for the found relationships, also, because age did not reach significance in any of the regressions. Still, in addition to confounding variables, a common method variance could have artificially increased found relationships, due to all results stemming from only one questionnaire (Sonnentag & Frese, 2003). This common method variance cannot be ruled out in the present study.

The present study revealed correlative relationships. However, the results are not suitable for deciding on the existence or direction of a causal influence. A longitudinal study with pre- and post-measurement of Development Teams could add argumentative power and insight into causal relationships.

Hence, the causal effect might be in the opposite direction than hypothesized. Trait self-control could be the cause of the found relations, if a high stability of trait self-control is assumed. In that case, high trait self-control might be supporting concrete planning and progress monitoring. Still, this reversal of the causal effect seems unlikely for state self-control. State self-control is of a fluctuating nature compared to the Scrum principles, which influence all team members and during a long time. As a result, state self-control is probably only affected by the more stable Scrum principles, but could not systematically influence the implementation of the Scrum principles.

Team performance might be causing the found relationship between team performance and short iterations. High team performance should help to meet the short iteration deadlines. This reversal of causal relation seems plausible. In addition, the found relation between high team performance and high team autonomy could also be the reverse. High team performance might increase team autonomy, because requiring only some team members to work on and finish stakeholder requests, other team members could choose to work on team internal initiatives. For construal level switch the reverse of the causal effect appears unlikely. If it was the reverse, high team performance would increase clarity and visibility of the Product Backlog throughout the Sprint. This does not seem to be plausible.

The reverse of the causal effect for team members' low experienced stress and better health appears possible. In case it was the reverse causal direction, high team members'

health would support team members' trait and state self-control, and low perceived stress would support high state self-control. The reverse of the causal effect of high team autonomy on low experienced stress might be explained by a confounding variable. Low experienced stress might not directly increase team autonomy. However, if low experienced stress stems from low pressure put on the Development Team by its stakeholders, this low pressure could also explain increased team autonomy. Team members could work on team internal initiatives.

In summary, it might be possible that the causal effect for the found relationships between Scrum principles and positive outcomes could be the reverse. However, the literature reviewed prior to present study supports the hypothesized causal directions. It does not suffice that the opposite causal direction seems possible, but empirical evidence would be needed to substantiate this objection. Eventually, most likely most of the relations are directly or indirectly mutual. In case of mutual relationships, the implementation of Scrum might give a positive spin to these interdependencies, supporting an overall heightened level of self-control, lower experienced stress, better health, and increased team performance.

3.2.6 Summary. In summary, the present study found empirical indications that Scrum is linked to higher self-control, lower experienced stress, better health, and higher team performance.

Self-Control, Stress, and Health. The present study's results initially support the hypothesis that Scrum is able to improve self-control of the Development Team members. Concrete planning in the Sprint Planning Meeting as well as active progress monitoring in the Daily Scrum Meetings were both related to reduced state self-control (controlled for trait self-control). At the same time, a positive relation between concrete planning as well as progress monitoring and trait self-control was found. It seems that a temporary reduction in state self-control could support the improvement of trait self-control in the long-run. Sprint Retrospective Meetings seemed to have only a short-term state self-control relieving effect, but were not related to trait self-control improvement. High team autonomy turned out to be of high importance for almost all found relations. With the only exception of progress monitoring, which was related to high trait self-

control irrespective of team autonomy, all other found relationships were significant only with high team autonomy. In summary, an empirical indication of the self-control training effect by Scrum was found with team autonomy being of high importance for this process.

No direct influence of the Scrum principles concrete planning, progress monitoring, short iterations, or process improvements on team members' experienced stress and on health was found in the study's results. However, high team autonomy revealed a positive association to low experienced stress. Additionally, high state self-control was related to Development Team members' low stress as well as better health. High trait self-control was marginally significant related to better team members' health. Still, it appears that high trait self-control indirectly reduced team members' experienced stress and supported team members' health by improving state self-control. Two mediation analyses revealed a statistical indication for a partial mediation of the relationship between trait self-control and health by state self-control, and a full mediation of the relationship between trait self-control and experienced stress by state self-control. Consequently, Scrum might support team members' health and low experienced stress by its demand for high team autonomy and by Scrum's potential to improve team members' self-control in the long-run, though no direct empirical support for these relationships could be provided by the present study.

Performance. Not surprisingly, trying to meet short Sprint deadlines with the Sprint Review Meetings was related to high team performance. In addition, a positive relation between high team autonomy and high team performance was found. Construal level switch, though not being related to self-control, was related to higher team performance.

Team performance was not predicted by Development Team members' state or trait self-control. Possibly, individual team members' high performance, supported by high state and trait self-control, does not translate into high team performance. Team internal dependencies and coordination effectiveness influences the team's performance as well (Langfred, 2005; Stewart & Barrick, 2000). It seems that the potency of team members' self-control in this relationship is lower than these effects on team level.

Overall, the study generally supports the hypothesized positive influence of Scrum on Development Team members' self-control and on Development Team's performance. In addition, positive relations between team autonomy as well as self-control and reduced stress as well as better health were found.

3.2.7 Post-hoc Analysis. Present study found a relationship between concrete planning as well as progress monitoring and self-control. High self-control in turn was related to low experience stress and better health. These particular relationships could be of practical relevance to improve team members' self-control and health. Thus, a post-hoc analysis of these relationships on individual item level was done. To focus on possible effects from team level on team member's self-control, the items of the concrete planning and progress monitoring scales were replaced by group mean values, whereas the items of the self-control scales were left unchanged.

A stepwise regression analysis based on Akaike Information Criterion of state self-control was performed and resulted in a model with only two items left (Venables & Ripley, 2002). One item asked how strongly team members agreed with the statement that the Development Team breaks down the Product Backlog Items into concrete tasks and estimates the efforts (item CP-C-1, see in the Appendix, *Items per Scale (Study 1)*). The other item asked to rate the average duration of the smallest planned tasks ("less than two hours" to "more than five days"; item CP-C-3; the item responses were inverted). However, the results were contradictory. On the one hand, a positive relation between high state self-control and breaking tasks down into subtasks was found (CP-C-1; $B = 0.51$, $F(1, 19) = 7.913$, $p = .011$). On the other hand, a negative relation between high state self-control and task duration was found (CP-C-3; $B = -0.51$, $F(1, 19) = 10.274$, $p = .005$; model comparison to intercept-only model $\chi^2_{(2, N=157)} = 10.267$, $p = .006$; $\rho < .01$). Hence, the first item suggested a positive relation between high state self-control and fine-grained, concrete planned tasks, whereas the second item suggested coarse-grained, abstract items.

A similar stepwise regression analysis of trait self-control confirmed the relevance and contradictory results for these two items found in the analysis of state self-control. This time the effects were only marginally significant. Besides the two items, the

breaking-down-into-tasks item (CP-C-1; $B = 0.31$, $F(1, 16) = 3.958$, $p = .064$) and the task-duration item ($B = -0.21$, $F(1, 16) = 3.461$, $p = .081$), additional three items remained in the final model (CP-C-2, CP-P-2, RM-S-2; model comparison to intercept-only model $\chi^2_{(5, N=157)} = 12.531$, $p = .028$; $\rho < .01$).

In summary, the post-hoc analysis of the study results uncovered a contradiction in deciding on the most beneficial concreteness level of planning in the Development Teams. One item favored a very concrete and detailed planning, whereas another item seemed to favor an abstract and general planning. These questions of optimal concreteness and causal direction were further investigated by two laboratory experiments. These will be described in the next chapter.

4 Plan Specificity and Self-Control

Study 1 revealed a correlation between Scrum and Development Team members' self-control. However, correlations are not suitable for deciding on the direction of an influence. Probably, Scrum supported Development Team members' self-control—but also the opposite influence is possible, that is, high Development Team members' self-control influenced the Scrum implementation. To investigate the direction of influence, one partial finding of Study 1 was investigated as a prototype in more detail in two laboratory experiments.

Study 1 on Scrum and self-control revealed a relation between the concreteness or specificity of the Development Team's Sprint Backlog created in the Sprint Planning Meeting and Development Team members' self-control. However, results of two questionnaire items were contradicting each other. Results of one item suggested high concreteness of the Sprint Backlog supported team members' self-control, while a second item suggested low concreteness of the Sprint Backlog supported team members' self-control.

These contradicting results from two questionnaire items of Study 1 can be resolved assuming an inverted u-shaped relationship between plan specificity and self-control. Having planned extremely fine-grained and specific tasks could be as detrimental to self-control as having too coarse-grained and abstract tasks. If tasks are too fine-grained and specific, ego depletion should be increased because of the monitoring effort. If

every single step needs to be controlled and aligned with a plan and perhaps even documented in a written plan, this high attentional control needed for working in this self-monitoring way may increase ego depletion (Baumeister et al., 2007; Muraven et al., 1998). Conversely, if planned tasks are too vague and abstract, then they lack clear guidance. They may therefore fail to direct behavior in a helpful manner. Abstract and low specific tasks may not have the supporting effect of having already sufficiently pre-structured task execution. Monitoring actual progress is impossible. Overall structuring and planning needs to be done during task execution. This, again, requires high attentional control and complex cognitive processes, which may again increase ego depletion during task execution. Taking this into consideration, a moderately specific plan might reduce ego depletion during task execution by shifting parts of the required structuring of that task to a planning phase. Compared to a moderately specific plan, the creation of a highly specific plan might be more ego depleting in the planning phase, as well as its execution might be more ego depleting in the execution phase. Compared to a moderately specific plan, the creation of a low specific plan might be less ego depleting in the planning phase, but execution might be more ego depleting. In sum, a moderately as opposed to a low or a highly specific plan should reduce ego depletion during execution of that plan.

In fact, previous findings corroborate the hypothesis that moderate plan specificity can support self-control. Kirschenbaum, Tomarken, and Ordman (1982) carried out an experiment with students. In a "Study Improvement Program" students were taught self-control techniques and in particular planning skills. Students were able to express their preference for doing a highly specific daily or a moderately specific monthly planning. One control group of students did not do any planning. Results indicated that experimental groups with moderately specific planning outperformed experimental groups with specific planning in regard to improvement of exam grades. If the planning mode, moderately or highly specific, met the students' preferences, they improved more compared to the non-planning control group. If their preference was not met, then students who preferred a moderately specific planning but were forced to do a highly specific planning showed a decline of grades below the level of the non-planning

control group. At the same time, students who preferred a highly specific planning but were forced to do only a moderately specific planning performed comparable to the non-planning control group. All in all, a pattern emerged that not planning as well as too specific planning had little or even a negative effect on self-controlled behavior. Moderately specific planning had a positive effect, even one year later in a follow-up study (Kirschenbaum, Malett, Humphrey, & Tomarken, 1982).

Similarly, in Scrum the specificity of Sprint Backlog Items might influence goal achievement and Development Team members' self-control. Thus, a moderately specific planning might support self-control of Development Team members. Sprint Backlog Items should, thus, be planned neither too concrete nor too abstract.

Two laboratory experiments were carried out to help to resolve the contradicting findings of two questionnaire items from Study 1. It was empirically investigated if a moderate plan specificity supports self-control. In addition, the experiments analyzed one partial finding of Study 1 experimentally to substantiate the claim that Scrum supports self-control of the Development Team members. These experiments are conducted as kind of prototype of experiments to clarify the influence of Scrum on self-control beyond simple correlations. The first experiment revealed empirical indications of a positive influence of moderate as opposed to low or high plan specificity on self-control. The second experiment failed to reproduce and extend these findings, probably because of its operationalization.

4.1 Experiment 1

To investigate the influence of planning specificity on self-control, Experiment 1 was carried out in a laboratory setting. Planning specificity was manipulated as between-subject factor with three levels. Participants were given a description of a text-formatting task. After that, participants had to plan the task with a moderate number of steps, or a high number of steps, or they did not have to plan at all. Participants then executed their self-generated plan. All participants executed an identical task of formatting a raw text. Dependent variable ego depletion was measured with the Stroop task before and after the text-formatting task (MacLeod, 1991).

Predictability was a second between-subject condition in the experiment. Planning requires predictability. Low predictability could, for instance, be caused by constant changes in the environment or by missing information about a task that has to be planned. In both cases a helpful and specific plan will be difficult to create. With low predictability, the positive influence of moderately specific planning on self-control should diminish. To investigate this influence empirically, predictability was additionally manipulated as between-subject factor. Half the participants received detailed information about the formatting task prior to planning it, the other half received only rough information. The rough information should make it more difficult to create an appropriate plan, as the concrete task was not yet clear.

4.1.1 Method.

4.1.1.1 Participants and Design. One-hundred-seventeen undergraduate students of the University of Heidelberg participated in the experiment to fulfill a study requirement or to obtain a small payment. The experiment was implemented as computer program in *Microsoft VB.net*. Participants were randomly assigned to one of six between-subject conditions. The design of the experiment was a 3 (plan specificity: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) design.

4.1.1.2 Materials and Procedures. Plan specificity was operationalized by different numbers of plan steps for the text-formatting task. Participants were to change the formatting of a raw text so that it would look like a given template by adding bold and italics formatting or adding newlines and spaces. After welcoming participants, the task was described. Participants had to plan the execution in advance in three steps (moderately specific planning), six steps (highly specific planning), or they did not have to plan it at all (no-planning). Participants in the moderately specific planning and highly specific planning condition entered their planned steps into three or six text boxes on the screen, respectively. The underlying assumption was that planning more steps for the identical goal should result in higher specificity of the planned steps. This procedure is similar to a mindset manipulation of abstractness of thinking, which asks participants to categorize items in a low or high number of categories (Burgoon, Henderson, &

Markman, 2013; Ülkümen, Chakravarti, & Morwitz, 2010). The predictability of the text-formatting task was operationalized by the amount of information provided to the participants. In the detailed information condition participants received a detailed description along with a screenshot of the task to be planned. In the rough information condition only a rough description of the task was given, increasing the difficulty of planning it as the real task was not predictable.

The main dependent variable was ego depletion. Ego depletion was measured via the Stroop task (MacLeod, 1991). The Stroop task is commonly used to measure the ego depletion state (cf. Gailliot, Baumeister, et al., 2007; Gailliot et al., 2012; Inzlicht, McKay, & Aronson, 2006; Richeson & Trawalter, 2005; Storbeck, 2012; Zelenski, Santoro, & Whelan, 2012). It shows a high sensitivity to ego depletion state, but has itself a relatively low ego depleting effect (Hagger et al., 2010). The used procedure was analogous to experiments performed by Inzlicht and Gutsell (2007): On the center of the screen a fixation cross was shown for 500 ms, then the color words *red* or *green* were shown for 200 ms. The actual color of the characters of the color words could be either red or green. Participant had to respond as fast as possible to the color of the characters by pressing the corresponding key on the computer keyboard for red or green. After the key press, or automatically after 1500 ms, the next trial started with the presentation of the fixation cross. In each trial one of four possible combinations of character color and word meaning could be shown. Two of these were congruent (*red* in red characters, *green* in green characters) and two were incongruent (*red* in green characters, *green* in red characters). The Stroop task was performed in blocks of 48 trials with 32 congruent and 16 incongruent trials presented in random order. One block was performed to familiarize participants with the procedure, then each three blocks were performed before and after the text-formatting task. In that way, the amount of ego depletion caused by the text-formatting task could be calculated. At the same time, differences in ego depletion could be controlled that were caused by the different planning procedures executed at the beginning of the experiment.

After the first three blocks of the Stroop task, the text-formatting task was executed (see screenshot of the task in Figure 3). The task was inspired by the procedure used

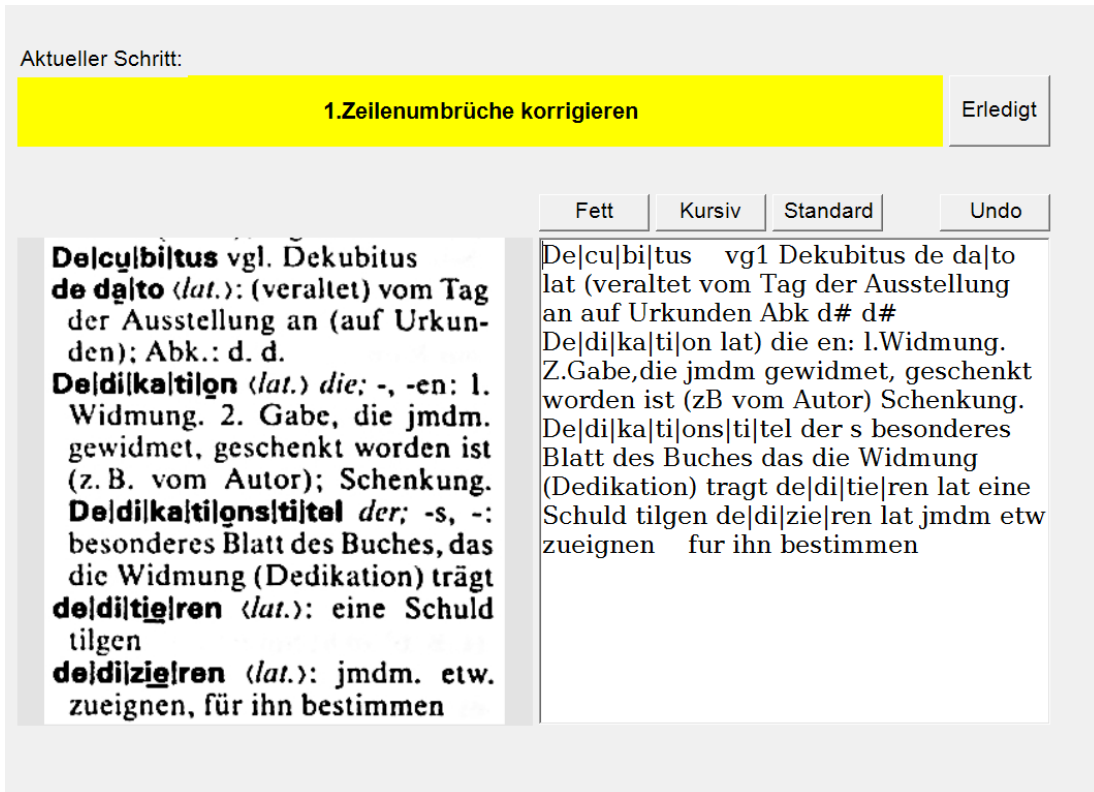


Figure 3. Text-Formatting Task (Experiment 1)

A screenshot of the text-formatting task used in Experiment 1 (in German). The highlighted bar on top displayed the current editing step ("1. Zeilenumbrüche korrigieren"; yellow background in original). The left part displayed the target formatting. The right part was a text editor in which participants could adapt and correct the raw text. Participants were instructed to press the button right to the editing step when they finished that editing step ("Erledigt"). Three buttons on top of the text editor changed the text formatting to bold, italics, or standard, respectively. The fourth button allowed to undo the last editing action.

by Kruger and Evans (2004, experiments 3 and 5). The previously planned three or six steps, which participants had entered into the text boxes at the beginning of the experiment, were shown in the upper part of the screen. Only one step was shown at a time. After finishing that step, participants clicked on a "done"-button. The next planned step was shown until the last step was finished. After that, participants had to agree to continue to the next part of the experiment, otherwise they were able to continue on the text-formatting task. There was no time limit. In the no-planning condition only one generic step was shown. Participants were asked to format the text in the text editor so that it would look like the text on the picture on the left part of the screen.

Adjacent followed the second three blocks of the Stroop task. Then, participants were asked to fill out the brief self-control scale. Again, the same three items as in Study 1 were left out (Tangney et al., 2004). Additional questions were asked concerning: participants' motivation to execute the text-formatting task, how autonomous they felt while executing that task, how difficult and straining the task was, how detailed the plan was, as well as how difficult the planning was; they were asked to speculate about the background of the experiment, and finally to provide demographic details. Participants were debriefed and thanked for their participation.

4.1.2 Results and Discussion.

4.1.2.1 Data Screening and Exclusions. The reformatted raw texts were compared to the target text for each participant based on the Levenshtein distance (Navarro, 2001). The Levenshtein distance measures how many simple edits, adding or removing a character, are needed to transfer a given text into a target text. In total 182 editing actions needed to be done for the optimal solution. Changing the formatting of a character to bold or italics was considered one editing action of the text. Based on this measure, four participants were excluded from the data set due to not having executed the text-formatting task sufficiently compared to the overall sample (they did less than nine editing actions compared to overall $M = 160$, $SD = 46$; $z \geq 3.29$). Another five participants were excluded due to a very high error rate in the Stroop task (error rates larger than 52%; $z \geq 3.29$). A screening of the free text field entries did not lead to any exclusion of participants. The remaining 108 participants (74 females, 34 males) were 18 to 60 years old ($M = 23.1$, $SD = 6.3$, $Mdn = 21$).

4.1.2.2 Manipulation Check. Plan specificity was manipulated between-subjects. Specificity and effectiveness for reaching the text formatting goal were rated by participants themselves and, in addition, the created steps were blindly rated by two independent raters concerning their specificity and effectiveness. A 2 (planning: moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) analysis of variance (ANOVA) indicated no significant difference for participants' rating of detailedness of the plans (all F s < 1.0 , p s $> .30$; $F(3, 70) = 1.109$, $p = .351$, $R_{adj}^2 = .004$). Specificity ratings of the

two raters showed a low interrater reliability (Cronbach's $\alpha = .27$, Spearman-Brown $\rho = .27$). A 2 (planning: moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA revealed no significant difference of rated plan specificity between the two planning condition ($F(1, 70) = 0.114, p = .736; F(3, 70) = 4.461, p = .006, R_{adj}^2 = .125$).

In addition, in a 2 (planning: moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on the effectiveness of the planned steps, both main effects were marginally significant. The steps planned in the moderately specific planning condition were rated marginally significant more effective compared to the highly specific planning condition ($F(1, 70) = 2.781, p = .100; F(3, 70) = 4.437, p = .007, R_{adj}^2 = .124$; effectiveness scale $\alpha = .79, \rho = .83$).

Predictability was as well manipulated between-subjects. Participants rated the difficulty of the planning task. It should be more difficult to plan with low predictability as opposed to high predictability. Still, a 2 (planning: moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA indicated no significant difference for the difficulty of planning (all $F_s < 1.1, p_s > .30; F(3, 70) = 0.360, p = .782, R_{adj}^2 = -.027$). However, in the two ANOVAs reported above, the steps planned in the detailed information condition were rated marginally significant more effective compared to the rough information condition ($F(1, 70) = 3.463, p = .067$). Furthermore, steps planned by participants with rough information were less specific than steps planned by participants with detailed information ($F(1, 70) = 2.325, p = .030$).

In summary, the plan specificity manipulation was perhaps not effective as the plan specificity did not differ between the levels of the plan condition from participants' perspective or in a blind rating by two independent raters. Still, the planned steps were blindly rated as being more effective in the moderately specific planning condition compared to the highly specific planning condition. The predictability manipulation was partly effective. The influence of the predictability manipulation was investigated indirectly. Participants did not report an expected difference in difficulty of performing

the planning. Yet, the detailed information in the high predictability condition led to the planning of more specific and effective steps compared to the rough information condition. Although the planning manipulation was apparently not fully effective as expected, the main analysis was performed.

4.1.2.3 Main Analyses. The Stroop task reaction times of the correctly answered trials were analyzed. A mixed-effects model predicting reaction time by time (pre- vs. post-text-formatting task) and congruence (congruent vs. incongruent trial) including participant as random factor indicated a marginally significant difference on the Stroop trial congruence ($F(1, 27793) = 3.293, p = .070$; comparison to intercept-only model $\chi^2_{(2, N=27902)} = 473.009, p < .001$). The global means showed a very small Stroop Interference of congruent trials being responded to by 1 ms faster (congruent trials $M = 390$ ms, $SD = 127$, $Mdn = 359$ ms, $n = 18611$ vs. incongruent trials $M = 391$ ms, $SD = 136$, $Mdn = 359$ ms, $n = 9291$). Despite the almost missing general Stroop reaction time difference, differences between the different conditions may still exist. Thus, the analysis of the Stroop Interference and ego depletion measure can still shed light on these relations.

The Stroop Interference was calculated by subtracting the mean reaction times of the correctly rated congruent trials from the correctly rated incongruent trials per participant. A measure of ego depletion was calculated by further subtracting the Stroop Interference of the pre-text-formatting task trials from the post-text-formatting task trials. The Stroop Interference and ego depletion measures were sufficiently normal distributed on visual investigation. Ego depletion is indicated by the Stroop Interference change from before the text-formatting task to after the text-formatting task. A higher value, thus, represents a higher post-Stroop Interference or a lower pre-Stroop Interference and hence indicates a higher ego depletion through the text-formatting task.

A 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on ego depletion failed to fit the data ($F(5, 102) = 1.086, p = .373$).

The explained variance by the predictability condition was very low with a very low F -value compared to the planning condition ($SS = 1.15$, $F(1, 102) = 0.001$ for predictability compared to $SS = 1314.95$, $F(2, 102) = 0.823$ for planning). Therefore, the data of the predictability condition was pooled. The model did not change significantly ($F(3, 105) = 0.172$, $p = .915$), but the remaining model was more parsimonious. Variance between the levels of the planning condition was homogeneous, which is a prerequisite for the ANOVA calculation, as indicated by a non-significant Levene's test ($F(2, 105) = 1.123$, $p = .330$; Boslaugh & Watters, 2008). However, the model fit was only marginally significant ($F(2, 105) = 2.516$, $p = .086$; $R_{adj}^2 = .028$).

Plan Specificity. Ego depletion, due to the execution of the text-formatting task, differed between the levels of the planning condition. The different ego depletion values are shown in Figure 4. Participants in the moderately specific planning condition showed, as expected, the lowest ego depletion ($M = -9.79$ s, $SD = 27.87$). The ego depletion difference between moderately specific planning condition and no-planning condition was significant in an a priori defined contrast with higher ego depletion in the no-planning condition ($M = 4.95$ s, $SD = 32.57$; $t(105) = 2.045$, $p = .043$). The moderately specific planning condition did not significantly differ in a second a priori contrast from the highly specific planning condition ($M = -4.00$ s, $SD = 22.79$; $t(105) = -0.277$, $p = .783$).

Other sources than plan specificity could perhaps explain the relatively low ego depletion in the moderately specific planning condition. The effect could be caused by the mere time taken for performing the text-formatting task, the editing actions done, or the editing actions left out as indirect indicator of the effort. To rule out these influences, these influences were further investigated.

A 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on the time taken for the text-formatting task indicated a significant main effect for planning ($F(2, 102) = 3.786$, $p = .026$; $F(5, 102) = 2.871$, $p = .018$, $R_{adj}^2 = .080$). Participants in the no-planning condition needed marginally significant less time to finish the text-formatting task ($M = 370$ s, $SD = 110$) than participants in the

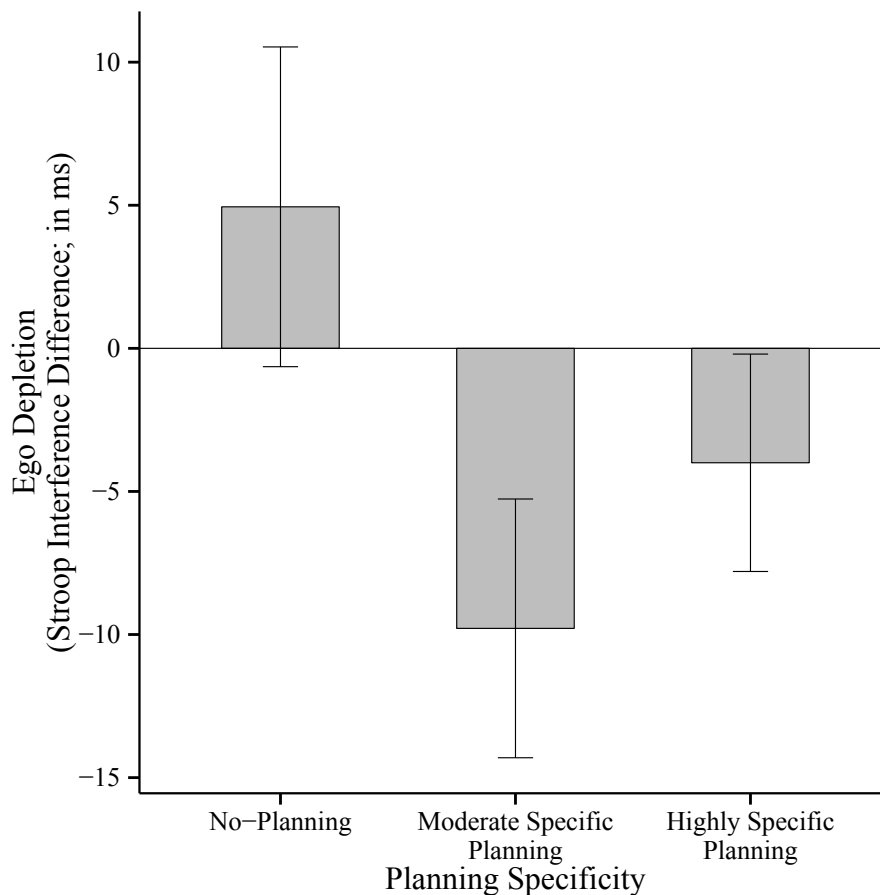


Figure 4. Ego Depletion by Planning Specificity (Experiment 1)

A measure of ego depletion was calculated by subtracting participants' Stroop Interference before executing a text-formatting task from participants' Stroop Interference after executing the text-formatting task. Lower values correspond to lower ego depletion. Participants either executed the text-formatting task without using a plan with defined steps (no-planning), or they used a plan with three steps (moderately specific planning), or six steps (highly specific planning). Participants in the moderately specific planning condition showed significantly lower ego depletion compared to participants in the no-planning condition. Ego depletion of participants in the highly specific planning condition did not significantly differ from participants in the moderately specific planning condition. Standard error as error bars.

moderately specific planning condition ($M = 447$ s, $SD = 165$; Tukey's test for post-hoc significance testing, $p = .067$; Hays, 1994). Participants in the no-planning condition also needed significantly less time compared to the highly specific planning condition ($M = 493$ s, $SD = 145$; $p = .002$). Time did not differ significantly between the moderate and highly specific planning conditions ($p = .351$). In sum, participants in the no-planning condition were faster in the editing task compared to the two other planning conditions. The lower ego depletion of participants in the moderately specific planning

condition may hence not originate from the mere time taken for the text-formatting task, as the no-planning condition took the least time for the text-formatting task and in the same time showed a higher ego depletion effect compared to the moderately specific planning condition.

The differences in ego depletion might be explained by the mere number of editing actions performed by participants in the text-formatting task. A more detailed analysis of the Levenshtein distance of participants' formatted text to the target text with a 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA showed a significant interaction effect ($F(2, 102) = 4.057, p = .020$) with both main effects being non-significant (planning $F(2, 102) = 0.993, p = .374$, predictability $F(1, 102) = 2.115, p = .150$) and an only marginal significant model fit ($F(5, 102) = 2.141, p = .066, R_{adj}^2 = .051$; Levene's test insignificance verified homogeneity of variances, $F(5, 102) = 1.499, p = .197$). Participants in the moderately specific planning condition with detailed information finished the text-formatting task with the highest remaining Levenshtein distance ($M = 69.28, SD = 46.03$). There had been still an average of 69 editing actions to finish the task. Other participants with detailed information in the no-planning condition ($M = 45.31, SD = 19.31$) and the highly specific planning condition ($M = 44.13, SD = 10.93$) finished the text-formatting task with the lowest Levenshtein distances of all cells of the 2×3 design. The missing editing actions of participants in the rough information condition fell between these end points (range: 47.20–59.44). Hence, the detailed information seemed to have supported the influence of the planning specificity, whereas the rough information did not lead to such a strong difference. Still, the differences are only tendencies, as a Tukey's test revealed no significant single difference ($\alpha < .05$) of any two Levenshtein distance values.

Analyzing the actual editing actions done, a different pattern emerges. Planning and predictability conditions did not differ in number of editing actions performed in the text-formatting task (the model failed to fit the data, $F(5, 102) = 0.587, p = .710, R_{adj}^2 = -.020$).

The analyses showed that the lower ego depletion of participants in the moderately specific planning condition could neither be explained by the mere time taken for the text-formatting task, nor by the number of performed or left-out editing actions. Surprisingly, a non-significant tendency was visible that participants in the moderately specific planning condition with detailed information missed to match the target text the most, while not performing significantly less editing actions than participants in the other conditions.

All participants performed a similar number of editing actions. Still, participants in the moderately specific planning condition showed the least ego depletion, but also left out the most required editing actions to match the target text when supplied with detailed information for the planning. Apparently, the editing actions performed by participants in the moderately specific planning condition with detailed information were less effective compared to the other two conditions. This is even more surprising as participants in the moderately specific planning condition took significantly more time for the text-formatting task as participants in the no-planning condition. Thus, participants in the moderately specific planning condition had had more time reflecting on their current editing actions and to try not to miss a required editing action.

Perhaps, the moderately specific planning was the appropriate level of specificity for the text-formatting task, which made participants in the moderately specific planning condition focus too strongly on their current editing action. Participants in the highly specific planning condition planned too detailed and were forced to ignore their plan partly on executing the text-formatting task. Participants in the no-planning condition did not have a plan to focus on. Perhaps, participants in the moderately specific planning condition were focused more on their current editing action than participants in the other two conditions. In the moderately specific planning condition three steps may have served as seemingly helpful guides to the text-formatting task. Conversely, participants in the no-planning condition were likely not focusing on working on single aspects in the whole text at a time due to the lack of a formal plan for their task execution. They rather have worked in a more dynamic way for updating the text formatting. Participants in the highly specific planning condition were likely not

that focused on the current step either. The steps planned by these participants were less effective, and, as will be reported further down, participants in the highly specific planning condition skipped significantly more of their planned steps without performing any editing actions. These highly specific plans were not effective. As a result, participants in the highly specific planning condition could not focus on their current planned step, as this was not supporting them solve the text-formatting task. Contrary to these, participants in the moderately specific planning condition may have been focused strongly on the current step. In case they missed an editing action in a prior step, like missing to insert some punctuation character, or they had erroneously done some change, they may not have recognized this in a later step due to their strong focus and, thus, not correct for it. Perhaps, this led to a relatively high number of left-over editing actions and erroneous changes in the moderately specific planning condition.

Compared to participants in the moderately specific planning condition, participants in the no-planning condition were free to change whatever missing editing action they saw whenever they saw it. They had only a generic plan with one step, which was not subdivided into any sub-steps. This may explain the lower number of missed edits. Also, they did not have to pay attention to any plan. Probably participants executed the text-formatting task faster, as they did not have a plan to follow.

However, participants from the no-planning condition showed a higher ego depletion compared to participants in the moderately specific planning condition. This might be due to the missing structure of executing even this simple task. The text-formatting task could be subdivided into useful aspects like (a) adapting paragraph and white-spaces, (b) correcting case of characters, correcting wrong characters and umlauts, and (c) adapting the formatting like bold and italics. Participants in the no-planning condition did not have a written plan. Hence, they had two different approaches they could use to fulfill the task.

Firstly, participants in the no-planning condition could edit the raw text only once from top to bottom correcting all aspects as described in (a) to (c). This approach is probably costly in terms of attention needed, as following a high number of targets simultaneously

is more effortful than following a low number of targets at once (A. Cohen, Jaudas, & Gollwitzer, 2008). The working memory load of this approach is likely high as all aspects have to be kept in mind at once and checked for in the raw text. A relation between working memory capacity and high self-control is well established (Hofmann et al., 2012; Schmeichel, Volokhov, & Demaree, 2008). Perhaps, high working memory load reduces state self-control.

Secondly, another approach that participants in the no-planning condition could use is to edit the raw text several times and focus on different aspects each time. This approach is perhaps used by participants in the moderate or highly specific planning condition. However, contrary to these, participants in the no-planning condition did not have a written plan on top of the screen, which might allow to free memory resources. They had to keep the aspects they already finished in mind together with the aspects they still had to do. This may have increased working memory load. Additionally, participants in the no-planning condition most likely did not experience a relieving effect by freed cognitive capacity through creation of a plan (Masicampo & Baumeister, 2011). Instead, they had to decide multiple times what the next aspect is to work on after finishing the last aspect. While taking care of a specific aspect they saw missing editing actions from other aspects. They had to decide if they perform this editing action or stick to correcting the aspect they were focusing on. These numerous decisions that participants in the no-planning condition may have had to make may have led to an increased ego depletion (Baumeister et al., 2007; Vohs et al., 2008). Lastly, if participants in the no-planning condition did not focus on the three broad aspects described above, but on a higher number of very specific and smaller aspects, they were likely confronted with impulses to adapt simple changes from other aspects they currently did not focus on. Overriding these impulses can lead to ego depletion (Baumeister et al., 1998).

Taken together, participants in the no-planning condition might have suffered from higher working memory demands during task execution. In whatever way they were working on the text-formatting task, it may have increased working memory demands,

which could perhaps explain the increased ego depletion effect compared to the moderately specific planning condition.

In the highly specific planning condition, six steps may have already been too many steps for the text-formatting task. Planning is a resource intensive task. Hence, planning of very simple tasks is not useful and may not have been performed thoroughly by the participants (Mumford et al., 2001). The text-formatting task was perhaps too simple for planning it in six steps. A 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on the number of skipped steps (steps with zero editing steps) revealed a significant main effect for planning ($F(2, 102) = 41.227, p < .001$; $F(5, 102) = 24.850, p < .001, R_{adj}^2 = .527$). A higher number of steps was skipped in the highly specific planning condition ($M = 2.53, SD = 1.50$) compared to the moderately specific planning condition ($M = 0.63, SD = 0.82$) or the no-planning condition⁸ ($M = 0.06, SD = 0.24$; all pairwise comparisons were significant in a Tukey's test, $\alpha < .05$). It had already been shown in the analysis of the specificity and effectiveness of the planned steps that planned steps in the highly specific planning condition were significantly less effective and not more specific compared to planned steps in the moderately specific planning condition. Overall, it appears that participants with highly specific planning created additional unnecessary steps that they then had to skip during execution of the text-formatting task.

In sum, moderately specific planning led to the lowest ego depletion. Ego depletion was significantly lower in the moderately specific planning condition compared to the no-planning condition. Comparing the moderately specific planning condition to the highly specific planning condition no significant difference was found, but a tendency in the expected direction existed. Still, the found relations are partly untrustworthy due to the marginal significant model fit. The ego depletion differences could not be explained by the mere time taken for the text-formatting task, or the editing actions performed, or the editing actions left out. The specificity of the plan with three steps

⁸On finishing the text-formatting task also participants in the no-planning condition were able to selected not to continue. In that way participants were able to perform more steps than the condition originally planned for (one vs. three vs. six steps).

seemed to be appropriate for this particular text-formatting task. Participants in the no-planning condition may have suffered from higher working memory demands when executing the text-formatting task. This may have led to an increased ego depletion effect. Participants in the highly specific planning condition had planned additional unnecessary steps. As a result, these probably supported the text-formatting task execution less compared to the moderately specific planning condition.

Predictability. As already described before, ego depletion did not differ significantly between participants in the rough information condition compared to the detailed information condition. Participants with detailed information did not need significantly more time for reading the instructions and planning the steps. A 3 (plan: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on the time taken for reading the instructions with rough or detailed information and planning the steps indicated no significant effect for predictability ($F(1, 102) = 0.094$, $p = .760$; $F(5, 102) = 21.120$, $p < .001$; $R_{adj}^2 = .485$). However, detailed information led participants to create marginally significant more specific and more effective plans, as reported above (see Chapter 4.1.2.2 *Manipulation Check*).

In addition, participants with detailed information rated the text-formatting task more difficult and straining to perform. A significant difference was found ($F(1, 102) = 4.472$, $p = .037$) in a 3 (plan: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on difficulty and strain, though with only marginally significant model fit ($F(5, 102) = 1.995$, $p = .086$, $R_{adj}^2 = .044$). The two-item scale was sufficiently reliable (Cronbach's $\alpha = .69$, Spearman-Brown $\rho = .70$). Participants in the rough information condition rated the task as easier and themselves as less strained ($M = 2.79$, $SD = 1.21$, $Mdn = 3.0$) than participants in the detailed information condition ($M = 3.42$, $SD = 1.38$, $Mdn = 3.5$). The difference in difficulty may be due to the effort needed for reading the additional information and the creation of comparably more specific and effective plans. Apparently, participants planned more thoroughly. This could explain the reported higher difficulty.

The detailed information about the task to be planned led to a higher specificity and effectiveness of the created plans. Still, ego depletion through execution of the plan in the text-formatting task did not differ. The text-formatting task was probably too simple that participants benefited from planning. Yet, participants in the detailed information condition rated the text-formatting task more difficult and straining to perform. Presumably, more specific and effective plans could be of higher importance in the execution of larger projects, which do not need only minutes to be executed and which need a collaborative execution. Ego depletion might be affected differently by differences in predictability in these contexts.

4.1.2.4 Additional Analyses. To gain more insight into the experiment's results, additional calculations were performed. These were further analyses of the found negative ego depletion values, which would be a surprising ego replenishment, alternative explanations for the findings, and alternative measures of self-control.

Ostensible Ego Replenishment. Surprisingly, measured ego depletion values were oftentimes negative (all conditions $M = -3.22$ ms, $SD = 28.33$, $n = 108$, $Mdn = -1.16$ ms, range: -93.12 ms– 64.88 ms; $t(107) = -1.181$, $p = .240$; 95% confidence interval: -8.62 ms– 2.18 ms). Negative ego depletion values indicate that participants were replenishing or building up self-control strength during the text-formatting task. This seems unlikely. Instead, participants might still have improved their Stroop task performance by practicing the Stroop task. In fact, participants showed significantly faster reaction times in the post-text-formatting Stroop tasks compared to the pre-text-formatting Stroop tasks (pre-text-formatting: $M = 403$ ms, $SD = 84.17$; post-text-formatting: $M = 375$ ms, $SD = 67.29$; $t(107) = 6.856$, $p < .001$).

Probably, two opposing processes influenced the Stroop Interference measurement. Firstly, the ego depletion effect increased the Stroop Interference from the pre- to the post-Stroop trials due to a decreased self-control capacity and thereby decreased attentional control. Secondly, opposing this process, a practicing process of the Stroop task itself should decrease the Stroop Interference from the pre- to the post-text-formatting task Stroop trials as participants were practicing and improving their Stroop performance throughout the Stroop trials. Practicing the Stroop task probably im-

proves Stroop reaction times as well as Stroop Interference (cf. Dulaney & Rogers, 1994). However, the improvement by practicing did not significantly differ between the planning conditions. An ANOVA with reaction time improvement between pre- and post-text-formatting task Stroop trials as dependent variable and planning condition as between-subject factor revealed no significant difference between the planning conditions ($F(2, 105) = 0.604, p = .549$). Taking the reaction time improvements as an indicator of the Stroop improvement by practicing, this Stroop improvement process may be neglected.

In sum, the negative ego depletion effects found could be explained by an ongoing Stroop task practicing throughout all Stroop trials before and after the text-formatting task. However, this practicing effect was distributed evenly between the planning conditions and may not have systematically influenced the ego depletion process.

Alternative Explanations. To check for alternative explanations, the main ANOVA of planning (no-planning vs. moderately specific planning vs. highly specific planning) on ego depletion was extended to an analysis of covariance (ANCOVA) by including different covariates, which could alternatively explain the found relationship. A series of eight exploratory ANCOVA analyses was performed including individually age, difficulty of the text-formatting task, motivation, autonomy, trait self-control, text-formatting task time, editing actions performed, and missing editing actions to the target. However, with two notable exceptions the ANCOVA models failed to fit the data ($p > .10$). The exceptions were, firstly, including the covariate difficulty and strain of the text-formatting task revealed a marginal significant model fit ($F(3, 104) = 2.193, p = .093; R_{adj}^2 = .032$). Still, covariate difficulty and strain did not reach significance ($F(1, 104) = 1.521, p = .220$) while the between-subject factor planning was still marginally significant related to ego depletion ($F(2, 104) = 2.561, p = .082$).

Secondly, including covariate age, both age and planning were marginally significant related to ego depletion (age, $F(1, 104) = 3.088, p = .082$; planning, $F(2, 104) = 2.430, p = .093; F(3, 104) = 2.740, p = .047, R_{adj}^2 = .047$). To test the ANCOVA precondition of equal influence of the age covariate in the planning conditions, the interaction of planning and age was included (Tabachnick & Fidell, 2007). The interaction term was

not significant, the covariate age was, thus, not violating this precondition ($F(2, 102) = 0.118, p = .889; F(5, 102) = 1.663, p = .150, R_{adj}^2 = .030$). In addition, ego depletion was regressed on age and factor planning (no-planning vs. moderately specific planning vs. highly specific planning). The regression revealed a marginal significant negative regression weight of age ($B = -0.76, t(106) = -1.757, p = .082$). Older participants tended to show a lower ego depletion effect. This effect may be explained by differences in learning the Stroop task between younger and older participants (Dulaney & Rogers, 1994). The learning curve of younger participants was probably steeper compared to older participants. Assuming a learning process with large improvements at the beginning that are decreasing over time, younger participants might have improved their Stroop performance already to a large extent in the Stroop trials before the text-formatting task. When starting with the Stroop trials after the text-formatting task, young participants were probably improving only slightly. Conversely, older participants' learning curve might be flatter overall and, particularly, in the beginning phase. Probably, older participants had achieved less improvements in the Stroop trials before the text-formatting task and were still in the steeper part of their learning curve when the Stroop trials after the text-formatting task started. Consequently, older participants had improved their Stroop performance to a larger extent still in the Stroop trials after the text-formatting task. As a result, the Stroop practicing process counteracted the ego depletion effect still more for older participants compared to younger participants. This could explain the decreased ego depletion effect found for older participants.

The covariate age could not explain the relationship between the dependent variable ego depletion and the between-subject condition planning. Also, the relationship cannot be explained by any other of the included covariates, difficulty of the text-formatting task, motivation, autonomy, trait self-control, text-formatting task time, editing actions performed, or missing editing actions to the target as individual ANCOVAs did not indicate any significant relationship.

Two additional analyses of participants' rating of motivation and autonomy when executing the text-formatting task revealed no significant difference between planning

or predictability conditions. No difference was found in a 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on motivation (all F s $<$.70, p s $>$.50; $F(5, 102) = 1.004$, $p = .419$, $R_{adj}^2 = .000$). A similar ANOVA on autonomy did not show any significant result either (all F s $<$ 1.20, p s $>$.30; $F(5, 102) = 0.502$, $p = .774$, $R_{adj}^2 = -.024$).

In summary, the found ego depletion differences between moderately specific planning and no-planning condition could not be explained by the covariates age, difficulty of the text-formatting task, motivation, autonomy, trait self-control, text-formatting task time, editing actions performed, and missing editing actions to the target. Age revealed a marginal significant negative relation to ego depletion, which could be explained by a flatter learning curve of older participants when practicing the Stroop task. Motivation and felt autonomy while executing the text-formatting task did also not differ significantly between any of the conditions.

Alternative Self-Control Measures. In addition to the main self-control measurement by the Stroop Interference change, self-control could be inferred by two more measures in the present experiment. Still, these did not show any significant difference. The Stroop task error rate, that is, the number of erroneous classifications of the Stroop task character color can indicate the ego depletion state and, secondly, participants filled out the trait self-control scale at the end of the experiment.

Investigating the Stroop task error rate, no significant difference was found between the conditions in three 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVAs testing pre- and post-text-formatting task Stroop trials (all F s $<$.20, p s $>$.70) and the difference of pre- and post-text-formatting task Stroop trials (all F s $<$ 1.30, p s $>$.25).

Reported trait self-control did not significantly differ between planning or predictability conditions either. No significant difference was found in a 3 (planning: no-planning vs. moderately specific planning vs. highly specific planning) \times 2 (predictability: rough information vs. detailed information) ANOVA on trait self-control (all F s $<$ 0.80,

$ps > .40$; $F(5, 102) = 1.139$, $p = .345$). Trait self-control did not correlate significantly with the Stroop Interference of the pre-text-formatting trials ($r = .15$, $t(106) = 1.519$, $p = .132$), with the post-text-formatting trials ($r = .01$, $t(106) = 0.111$, $p = .912$), or with ego depletion ($r = -.13$, $t(106) = -1.333$, $p = .185$). However, trait self-control is a relatively stable feature of a person's character. It should not have differed between the planning conditions in this experiment, as participants had been randomly assigned to the different conditions.

In sum, the Stroop task error rate did not corroborate the findings of the Stroop Interference difference between moderately specific planning and no-planning condition. No significant difference between any of these conditions was found for Stroop task error rate. Trait self-control did, expectedly, not differ between the planning or predictability conditions either.

4.1.2.5 Limitations. One limitation to the findings is that the statistical analysis lacked solid and indisputable effects. The main analysis of ego depletion by planning specificity (no-planning vs. moderately specific planning vs. highly specific planning) \times predictability (rough information vs. detailed information) failed to fit the data. The predictability conditions were thus pooled together, as predictability explained only a low portion of the overall variance. The resulting ANOVA of ego depletion comparing only planning specificity conditions fit the data marginally significant. The explained variance of the ANOVA was low ($R_{adj}^2 = .028$). The statistical findings can hence give only limited empirical support to the hypothesis that moderate plan specificity supports ego depletion.

The experiment could be improved by more strictly isolating the planning phase from the execution phase. The influence of the execution phase was isolated from influences of the planning phase by measuring ego depletion state directly before and after the text-formatting task. Additionally, the specificity manipulation depended on the steps planned by participants in the experiment. As it turned out, manipulating the number of steps to be planned did not let participants create plans with highly specific or low specific steps, but participants in the highly specific planning condition created additional unnecessary steps instead of additional highly specific steps. Considering

this, providing prepared plans with high or low specificity to participants instead of asking participants to plan should be preferred for future experiments, which thereby also isolate the execution phase from the planning phase.

4.1.2.6 Summary. Ego depletion due to the text-formatting task was significantly higher in the no-planning compared to the moderately specific planning condition. Participants in the no-planning condition did not do any planning and saw only one step in the text-formatting task, which described the overall goal without any specific steps to perform. Generally, a single step plan has a lower specificity than a plan with defined sub-steps. Found ego depletion advantage of the moderately specific planning condition over the no-planning condition initially supports the main hypothesis that planning specificity matters for the ego depleting effect. Executing a moderately specific plan apparently depleted the ego less compared to a low specific plan when trying to achieve an identical overall goal. The difference in ego depletion could not be explained by the number of steps done or left out in the text-formatting task, time taken for the text-formatting task, differences in motivation or autonomy, age of the participants, or the difficulty and strain participants reported for the text-formatting task.

Planning specificity did not differ between moderate and highly specific planning condition as indicated by the manipulation check. Still, ego depletion differed non-significantly between these two conditions in the expected direction. There was a tendency that ego depletion due to the text-formatting task was lower in the moderately specific planning condition compared to the highly specific planning condition. Yet, one source of influence could also be that participants in the highly specific planning condition planned additional unnecessary steps, which they had to skip during the text-formatting task execution. Hence, the differences between the moderately specific planning condition and the highly specific planning condition are difficult to interpret.

No influence was found of predictability during task planning on ego depletion during task execution. Participants only rated the text-formatting task more difficult and straining with higher predictability. High predictability led to the creation of more specific and effective steps compared to low predictability. This difference in specificity of the created plans did not lead to significant differences in ego depletion through the

text-formatting task. However, plan specificity was not manipulated directly, but by asking participants to plan three or six steps. This manipulation was insufficient. The plan specificity manipulation should be done directly in future experiments.

In summary, initial empirical support was found for the influence of a plan's specificity on ego depletion during execution of that plan. In particular, moderately specific planning could decrease the ego depletion effect compared to a low specific planning, such as when no plan is available. However, the manipulation check of the plan specificity manipulation failed. Additionally, the only marginally significant results limit the applicability of the findings further. The influence of predictability during planning on ego depletion during task execution could not be demonstrated.

4.2 Experiment 2

To further isolate the effect of plan specificity on self-control during the execution of a plan, Experiment 2 was carried out. In this experiment the task execution was performed without prior planning by participants to rule out influences from the planning phase and to ensure that plan specificity differs as expected between the plan conditions. Participants received a moderately specific plan, a highly specific plan, or they did not receive a plan but only the overall goal. The moderately specific plan should support self-control best and lead to the least ego depletion compared to the low or highly specific plan.

4.2.1 Method.

4.2.1.1 Participants and Design. Eighty-seven undergraduate students of the University of Heidelberg participated in the experiment to fulfill a study requirement or to obtain a small payment. Participants were randomly assigned to three between-subject conditions. In the no-plan condition participants did not get a plan of the main task. In the moderately specific plan condition a plan was given containing the major steps of the task. In the highly specific plan condition a comprehensive step-by-step plan was given with all single steps of the task.

4.2.1.2 Materials and Procedures. The experiment was conducted computer-based similar to Experiment 1. Participants were welcomed on the first screen. They were told that two independent studies and two questionnaires will follow. Next, the Stroop task, which was already used in Experiment 1, was introduced and a total of 48 test trials were performed (one block of a random sequence of 32 congruent and 16 incongruent trials). The initial block of Stroop trials served the purpose of familiarizing participants with the task. Contrary to Experiment 1 only a post-measurement of the Stroop Interference after the main task was performed. With an additional measurement of the Stroop Interference before the main task, the Stroop Interference change between pre- and post-measurement could have been calculated. However, due to pragmatic reasons an extension of the overall duration of the experiment was not possible. As a result, the pre-measurement was omitted in favor of an extension of the post-measurement, which possibly increased the reliability of the post-measurement.

Successive to the Stroop task the *Towers of Hanoi* (TOH) task was introduced and performed. In this task six discs have to be moved from one peg on the left to another peg on the right while adhering to some simple rules. The TOH task is commonly used as experimental task to study problem-solving and planning behavior (cf. Mataix-Cols & Bartrés-Faz, 2002; Noyes & Garland, 2003; Ward & Allport, 1997; Welsh, Cicerello, Cuneo, & Brennan, 1995). The optimal solution of this task needs exactly thirty-one moves. In the no-plan condition participants were asked to move the discs from the left to the right peg while adhering to the rules but they were not given any further move description. In the highly specific plan condition a plan with all thirty-one single disc moves was presented to participants during task execution. The next move was highlighted all the time. In the moderately specific plan condition only five important intermediate positions were presented, with the state to be achieved next highlighted all the time. Participants were automatically moved on to the next part of the experiment when they finished the TOH task, or after reaching a time limit of fifteen minutes. Participants were allowed to quit the TOH task, but not before executing it at least for two and a half minutes.

Successive to the TOH task the real trials of the Stoop task followed. The procedure was described again, then four blocks of Stroop tasks were performed with a total of 192 trials (four blocks of 32 congruent and 16 incongruent trials).

Next, a computer adaptation of the *Behavior Identification Form* questionnaire (BIF; Vallacher & Wegner, 1989) was filled out to measure participants' construal level, which might serve as manipulation check. Participant's construal level may be influenced by plan specificity. Highly specific plans may evoke low construal levels, whereas low specific plans may evoke high construal levels (for an introduction to construal level theory, see Chapter 2.1.5 *Construal Level Switch*). Compared to low specific plans, steps of highly specific plans are concrete and fine-grained. Potentially, this high specificity of the steps influences the participants' mental model of the task to be more concrete and specific, which corresponds to a low construal level. Conversely, the opposite effect might occur for low specific plans, which might evoke a high construal level.

The experiment ended with the ten item short version of the *State Self-Control Capacity Scale* (SSCCS; Bertrams et al., 2011; Twenge et al., 2004), and additionally, a sequence of twelve questions concerning motivation, autonomy, ratings of the TOH task, and prior knowledge of the TOH task; participants were asked to speculate about the background of the experiment, and finally to provide demographic details. Participants were debriefed and thanked for their participation.

4.2.2 Results and Discussion.

4.2.2.1 Data Screening and Exclusions. From the 87 participants, data of three participants was discarded as these participants did not finish the TOH task. Another nine participants were excluded as these were outliers on different variables according to the criterion of Tabachnick and Fidell (2007) of removing extreme values ($z \geq 3.29$, $p < .001$).

One participant in the highly specific plan condition was excluded due to taking extremely long for the TOH task (540.20 s, $z = 3.515$ compared to highly specific plan condition $M = 190.80$ s, $SD = 99.40$). One participant was excluded due to taking extremely long for an average move in the TOH task (7.04 s, $z = 3.713$ compared to

no-plan condition $M = 3.16$ s, $SD = 1.04$). One participant was excluded due to an extremely high number of moves in the TOH task (104 moves, $z = 3.290$ compared to highly specific plan condition $M = 40.52$, $SD = 19.29$). One participant was excluded due to an extremely high number of tried illegal moves in the TOH task (15 trials, $z = 3.362$ compared to no-plan condition $M = 2.85$, $SD = 3.61$).

Three participants were excluded due to a very high number of wrong categorized Stroop trials compared to all participants ($z \geq 3.29$; that is, $x \geq 67$ wrong congruent trials compared to $M = 14.78$, $SD = 16.04$, and $x \geq 34$ wrong incongruent trials compared to $M = 7.60$, $SD = 7.87$).

A screening of the free text field did not lead to any further exclusion of participants.

The remaining 75 participants were 18 to 37 years old ($M = 22.2$, $SD = 3.4$, $Mdn = 21$; 54 females, 21 males). Participants' age was distributed evenly between the plan conditions. An ANOVA with age as dependent variable and plan condition (no-plan vs. moderately specific plan vs. highly specific plan) as between-subject factor revealed no significant difference ($F(2, 72) = 0.561$, $p = .573$, $R_{adj}^2 = -.012$). Participants sex was marginally significant unevenly distributed between the plan conditions ($\chi^2_{(2, N=75)} = 5.119$, $p = .077$). Most male participants participated in the highly specific plan condition (24 compared to 21 in the moderately specific plan condition and 17 in the no-plan condition), while the least female participants participated in the highly specific plan condition (3 compared to 8 and 12, respectively). However, an ANOVA with participants' sex as factor and dependent variable Stroop Interference, which is the main dependent variable of the present experiment, revealed no significant difference between female and male participants ($F(1, 73) = 0.555$, $p = .459$, $R_{adj}^2 = -.006$). Thus, participants' sex was ignored in further analyses.

4.2.2.2 Manipulation Check. An ANOVA with plan condition (no-plan vs. moderately specific plan vs. highly specific plan) as between-subject factor and rating of the detailedness of the TOH task plan as dependent variable showed a significant main effect ($F(2, 72) = 4.988$, $p = .009$). An a priori defined contrast revealed that participants rated the plan in the moderately specific plan condition ($M = 4.44$, $SD = 1.48$, $Mdn = 4$) significantly more detailed than participants in the no-plan

condition ($M = 4.00$, $SD = 1.18$, $Mdn = 4$; $t(72) = 2.360$, $p = .021$). A second a priori contrast revealed that participants rated the plan in the moderately specific plan condition significantly less detailed than participants in the highly specific plan condition ($M = 5.42$, $SD = 2.02$, $Mdn = 7$, $t(72) = 3.029$, $p = .003$). The plan specificity differed as expected between the plan specificity conditions.

Participants' construal level as measured with the BIF showed no significant difference. The BIF scale was sufficiently reliable (Cronbach's $\alpha = .78$). However, in an ANOVA with construal level as dependent variable and between-subject factor plan condition (no-plan vs. moderately specific plan vs. highly specific plan) no significant differences of participants' construal level between plan conditions was found ($F(2, 72) = 0.246$, $p = .783$). The execution of the TOH task with specific as opposed to abstract move descriptions had no detectable influence on participants' construal level.

However, the construal level was not influenced by the TOH task execution either. Irrespective of the plan specificity, all participants executed the identical TOH task. Apparently, the mere manipulation of the plan's specificity did not suffice to influence participants' construal level. All participants had to think about and execute the moves of the TOH task concretely and not abstractly. Thus, all participants might be influenced in direction of a low construal level. Still, the empirical findings do not support this ad-hoc hypothesis either. The mean construal level rating of all participants was at the middle point of the construal level scale, that is, the experiment overall did not systematically influence participants' construal level in any direction ($M = 0.50$, $SD = 0.19$, scale range: 0–1). Participants' mean construal level did not significantly differ from this middle point of the construal level scale ($t(74) = 0.124$, $p = .902$).

The manipulation check showed that participants rated the plan specificity significantly different between the plan specificity conditions. An alternative check by analyzing participants' construal level failed to show a difference between the plan specificity conditions. The applicability of the BIF as manipulation check for the present experiment needs to be analyzed further.

4.2.2.3 Main Analyses. A 3 (plan: no-plan vs. moderately specific plan vs. highly specific plan) \times 2 (congruency: congruent vs. incongruent trials) ANOVA on the Stroop reaction times of correctly answered trials with repeated measures on the second factor indicated a significant effect of the Stroop trial congruency ($\chi^2_{(1,N=150)} = 8.668$, $p = .003$; model compared to intercept-only model $\chi^2_{(3,N=150)} = 8.534$, $p = .036$). As expected, participants reacted faster to congruent trials ($M = 380$ ms, $SD = 54.53$) than to incongruent trials ($M = 386$ ms, $SD = 62.57$).

The Stroop Interference was calculated per participant as described in Experiment 1. Unexpectedly, the Stroop Interference did not differ significantly between the plan conditions as shown in an ANOVA of Stroop Interference as dependent variable with plan condition (no-plan vs. moderately specific plan vs. highly specific plan) as between-subject factor ($F(2, 72) = 0.837$, $p = .437$; see also Figure 5). Exploratory ANCOVAs to check for potential suppressor effects did not reveal any result either. The plan specificity condition did not significantly predict Stroop Interference on including covariates age, time of TOH task, moves done in the TOH task, average time taken per move in the TOH task, and prior knowledge or experience of the TOH task. No significant relation was found when the covariates were included individually, or when all covariates were included simultaneously (all F 's < 2 , $ps > .18$). No significant difference was found in two additional exploratory ANOVAs of the Stroop Interference on the plan condition separating red and green target color trials. In sum, no significant difference of the Stroop Interferences between the plan conditions was found even in comprehensive post-hoc analyses.

No significant difference of the Stroop task error rate between the plan conditions was found either. A mixed-effects model regressing Stroop task error rate on the factor plan condition (no-plan vs. moderately specific plan vs. highly specific plan), the factor Stroop task trial congruency (congruent vs. incongruent), the interaction of the two factors, and including participant as random factor failed to fit the data (model comparison to intercept-only model $\chi^2_{(5,N=74)} = 3.991$, $p = .551$). No significant difference between the Stroop task error rate between the plan conditions or between congruent and incongruent Stroop trials could be identified.

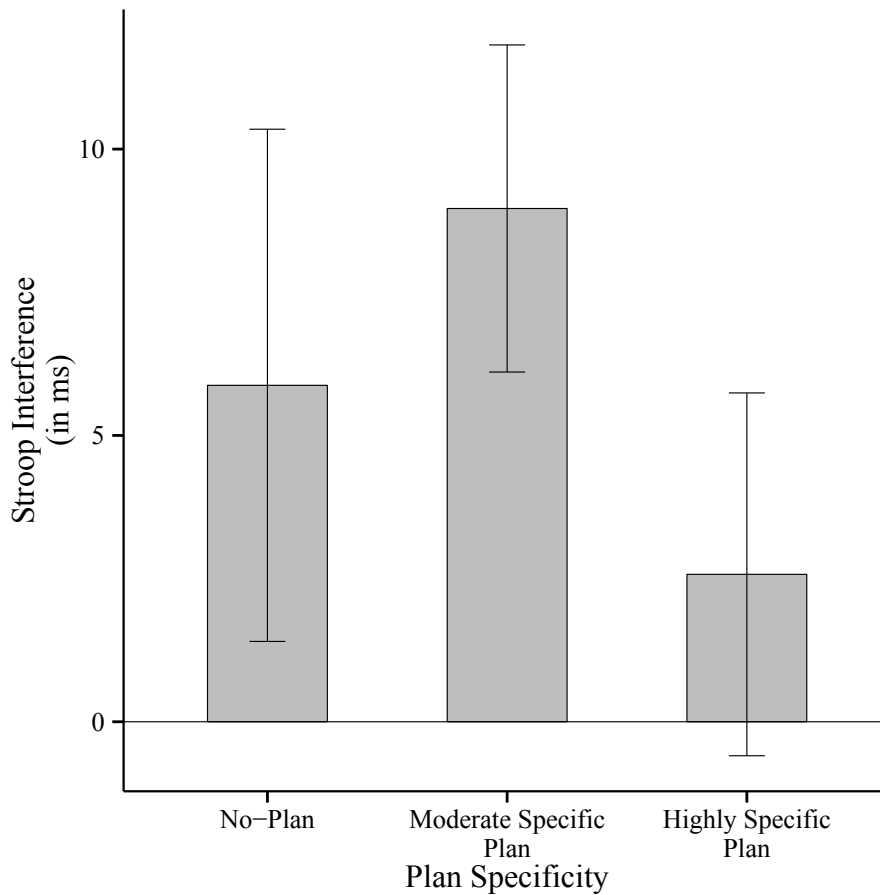


Figure 5. Stroop Interference by Plan Specificity (Experiment 2)

No significant difference of Stroop Interferences was found between participants processing the Tower of Hanoi (TOH) task without a supplied plan (no-plan), with a moderately specific plan, or with a highly specific plan. In the highly specific plan condition, participants were processing the TOH task with a move-by-move instruction of all thirty-one required moves. Participants in the no-plan condition did not receive any move description of the TOH task, but only a goal description to move all discs from the left to the right peg. Participants in the moderately specific plan condition received a plan with five intermediate positions needed to solve the TOH task. Stroop Interference was measured once after the TOH task. Standard error as error bars.

Participants' ego depletion state did not differ between plan conditions as measured with the SSCCS. The SSCCS showed a sufficient reliability (Cronbach's $\alpha = .85$). However, it did neither show any significant difference between the plan conditions ($F(2, 72) = 0.129, p = .879, R_{adj}^2 = -.024$), nor did it correlate significantly with the Stroop Interference ($r = -.02, t(73) = -0.180, p = .857$).

In summary, only overall shorter reaction times in the Stroop task for congruent trials compared to incongruent trials were found. Ego depletion did not differ between the

plan conditions as measured by the Stroop Interference, Stroop task error rate, or the SSCCS. Participants' construal level did not differ depending on the plans specificity. Following, additional analyses were performed to get a more comprehensive impression of the experiment's results.

4.2.2.4 Additional Analyses. The TOH time was separated into a planning part, the time until the first move was performed, and the execution part, the remaining time until the TOH task was solved. An ANOVA with dependent variable planning time and between-subject factor plan condition (no-plan vs. moderately specific plan vs. highly specific plan) did not reveal any significant difference ($F(2, 72) = 2.093, p = .131$). This is remarkable because participants in the highly specific plan condition did not have to plan at all. However, providing the plan to these participants did not significantly affect the time they needed for "planning". Likewise, a second ANOVA with execution time as dependent variable and the between-subject factor plan specificity (no-plan vs. moderately specific plan vs. highly specific plan) revealed that participants with highly specific plan took marginally significant less time for the execution ($M = 166.82$ s, $SD = 71.70$) compared to participants with moderately specific plan ($M = 229.41$ s, $SD = 126.90$; Tukey's test $p = .074$; $F(2, 72) = 2.513, p = .088, R_{adj}^2 = .039$). Participant in the no-plan condition did not need significantly more or less time compared to the other two conditions ($M = 206.76$ s, $SD = 90.14$; compared to moderately specific plan $p = .701$, compared to highly specific plan $p = .357$).

An ANOVA with the number of moves as dependent variable and the between-subject factor plan condition (no-plan vs. moderately specific plan vs. highly specific plan) revealed a significant difference between the plan conditions ($F(2, 72) = 10.647, p < .001$). Participants in the highly specific plan condition needed the least moves ($M = 38.67, SD = 15.30$). In a Tukey's test this was significantly less compared to the average number of moves in the moderately specific plan condition ($M = 62.22, SD = 28.11$; $p = .002$) and the no-plan condition ($M = 69.13, SD = 26.18$; $p < .001$).

An ANOVA with between-subject factor plan (no-plan vs. moderately specific plan vs. highly specific plan) and dependent variable number of illegal moves indicated a significant main effect ($F(2, 72) = 4.310, p = .017, R_{adj}^2 = .082$). The moderately

specific plan condition showed a significantly increased number of illegal moves ($M = 4.59$, $SD = 5.94$) compared to the highly specific plan condition ($M = 1.33$, $SD = 1.97$, Tukey's test $p = .015$). The moderately specific plan condition did not differ significantly from the no-plan condition; still, descriptively, in the no-plan condition participants tried fewer illegal moves ($M = 2.42$, $SD = 2.78$, $p = .142$).

It appears that participants with moderately specific plan were not as expected supported by the provided plan and were struggling to get the TOH task solved compared to participants in the highly specific plan condition. Possibly, the moderately specific plan misled participants to move the discs directly to the positions described in the plan while ignoring the rules of the TOH task. It can be assumed that the plan could not be executed as easily as the fully specified plan in the highly specific plan condition. The plan execution needed to be monitored. Compared to that, participants in the no-plan condition did not have to perform any monitoring. The supportive effect of the moderately specific plan appears further questionable, as participants in the moderately specific plan condition did not outperform participants in the no-plan condition, neither concerning time required, nor concerning moves required. The moderately specific plan had not been pre-tested for clarity and it was not created by the participants themselves. A lack of understanding of the moderately specific plan may have hindered the effective execution of the plan.

The missing Stroop Interference differences between the plan conditions may be explained by the possible confusion caused by the moderately specific plan used in the present experiment. The additional analyses suggest that the moderately specific plan was rather hindering than supporting plan execution. Obviously, if the moderately specific plan confused participants, the plan could not support self-control effectively as hypothesized. In that way, a possible self-control advantage between the moderately specific plan condition and the low specific as well as the highly specific plan condition were probably missed. In future research, thus, the different specific plans need to be evaluated thoroughly.

In sum, additional analyses revealed that the moderately specific plan supplied to participants was not effective. Participants in the moderately specific plan condition tried

the most illegal moves and did not outperform participants in the no-plan condition, neither did they need less time for the TOH task, nor did they need less moves. The moderately specific plan used in the experiment might be the reason for the missing self-control differences between the plan conditions. Planning time of the TOH task did not differ between plan conditions. Participants in the highly specific plan condition needed less time executing the TOH task compared to participants in the moderately specific plan condition. Participants in the highly specific plan condition needed significantly less steps to finish the TOH task compared to participants in the moderately specific plan condition and no-plan condition.

4.2.2.5 Summary. The experimental manipulation of the plan specificity by providing different specific plans of the TOH task to participants was effective as rated by participants. However, the plan given to the participants in the moderately specific plan condition did not support participants effectively, but probably confused participants. This might explain the missing difference in state self-control between the plan conditions. The expected influence of plan specificity (no-plan vs. moderately specific plan vs. highly specific plan) on state self-control was not found as measured by the Stroop task or the SSCCS (Bertrams et al., 2011; MacLeod, 1991; Twenge et al., 2004). The expected influence of plan specificity (no-plan vs. moderately specific plan vs. highly specific plan) on participants' construal level was not found either.

4.3 Discussion

Experiment 1 and Experiment 2 were conducted to investigate the potential causal influence of differences in specificity of a plan on state self-control during execution of that plan. Results of the experiments will be discussed next. Successively, the appropriateness of the Stroop task to measure self-control and self-regulation will be discussed.

4.3.1 Plan Specificity and Self-Control. Experiment 1 found initial empirical support for the hypothesis that a moderately specific plan may support self-control better than a plan with very high or low specificity. A moderately specific plan led to significantly lower ego depletion compared to a low specific plan, though the

manipulation check failed to verify the successful manipulation of plan specificity. Experiment 2 did not show any difference in state self-control through using plans with different specificity, though plan specificity was successfully manipulated as rated by participants. The result could be explained by an inappropriate moderately specific plan used in the experiment.

More complex experimental tasks to be planned and executed are required to demonstrate more solidly the advantage of a moderate as opposed to a low or highly specific plan. The empirical findings of Experiment 1 initially support the hypothesis of an influence of a plan's specificity on ego depletion during execution of that plan. Still, the hypothesized relationship could not be empirically demonstrated without doubt. A highly specific planning should increase ego depletion because of the increased attentional control needed for monitoring progress during task execution (Baumeister et al., 2007; Muraven et al., 1998). Conversely, having a low specific or having no plan requires that structuring and planning is done in parallel to task execution. This requires high attentional control and complex cognitive processes, which may increase ego depletion during task execution. In the execution phase, thus, ego depletion should be low with a moderately specific plan as opposed to a highly specific or a low specific plan. Processes pointed out here require that the task is complex enough so the execution of that task benefits from a pre-structuring of that task. In the present experiments this complexity of the tasks was not given. The text-formatting task in Experiment 1 could still be easily executed without planning and there was no restriction concerning the sequence in which the steps could be executed. Conversely, in the TOH task in Experiment 2 every single move depended on all moves before, but all moves being qualitatively similar in that only a disc needed to be moved from one peg to another. The TOH task execution required problem solving and mental simulation operations. However, comparing this to real-world projects, planning in such projects will be much more complex and tasks will be very heterogeneous. Future research should, thus, consider investigating more complex and applied tasks.

Experiment 1 and Experiment 2 investigated a partial aspect of the findings of Kirschenbaum, Malett, et al. (1982), who successfully demonstrated a moderate plan specificity ad-

vantage (see also Kirschenbaum, 1985; Kirschenbaum, Humphrey, & Malett, 1981). The experiments by Kirschenbaum, Malett, et al. focused on long-term self-regulation of learning behavior. The experiments were conducted in an applied setting with plan specificity manipulated experimentally. In contrast to that, present experiments focused on self-control during short-term task execution in a laboratory setting. Nevertheless, results obtained by Experiment 1 and results reported by Kirschenbaum, Malett, et al. point in a similar direction. Supporting self-control short-term probably supports successful self-regulation long-term. Self-regulation depends on self-control and other aspects like motivation, self-efficacy, or shared goal striving (Baumeister & Vohs, 2007; Hofmann et al., 2012; Klassen et al., 2009). These aspects may be needed for successful self-regulation even with high self-control. High self-control is necessary but not sufficient for high self-regulation capability. From that perspective, as the present research focuses on self-control, partial aspects of the findings by Kirschenbaum, Malett, et al. are supported by the findings of Experiment 1.

The operationalization of plan specificity needs to be revisited. In the present experiments it was assumed that if fewer steps are planned for an identical goal to achieve, these steps are less specific, or more abstract. In Experiment 1 this assumption was rejected, as participants in the highly specific planning condition did not create steps with higher specificity, but created additional unnecessary steps. This issue of the failing plan specificity manipulation was solved in Experiment 2. Participants rated the plan specificity differently as expected. However, participants in the moderately specific plan condition tried more illegal moves than participants in the highly specific plan condition and, non-significantly, in the no-plan condition. It seems that the moderately specific plan confused participants instead of being an effective support for task execution. Participants in the moderately specific plan condition did not outperform participants in the no-plan condition, neither concerning required moves, nor concerning required time. This corroborates the notion that the moderately specific plan was not supporting participants. Probably, no meaningful plans with significantly differing plan specificity can be created for tasks with comparably low complexity as the TOH task. The TOH task is difficult to solve, but all steps are uniform and simple. Potentially, with a

more complex task, a hierarchical plan could be created. The lower level of this plan contained the individual, concrete steps, whereas the higher level of that plan contained summarizing headings of multiple lower level steps. This would be in line with typical instructional descriptions of procedures as for example how-to guides or tutorials. Plan specificity could then be manipulated by providing only low-level steps, only high-level headings, or low-level and high-level together to participants. However, participants' expertise may differ for different tasks. Typically, for experts high-level steps will suffice to execute a procedure. They might be even confused by low-level steps interfering with low-level steps they remember. Conversely, novices might require low-level steps to be able to execute a new procedure at all. High-level steps can provide a clustering of steps in semantically meaningful categories. This probably supports effective execution of the plan. With hierarchical plans, plan specificity or abstractness would differ between high- and low-level in a meaningful way, but expertise of the planned task during plan execution needed to be considered.

The missing construal level effect as measured with the BIF in Experiment 2 can probably be explained by a weak direct influence on participants' mindset. Amongst other measures, Experiment 2 used the BIF, a widely used measure of construal level (Burgoon et al., 2013). The results of Experiment 2 did not indicate a difference of participants' construal level between the plan specificity conditions. Seemingly, the plan specificity manipulation was not effective. However, Experiment 2 was not using a mindset manipulation of participants' construal level, but manipulated only the focal task's plan specificity (Burgoon et al., 2013). This is probably the reason why a transfer effect of construal level from the main task to subsequent tasks, as the BIF, was not found. However, for future research a mindset manipulation seems not appropriate for the analysis of the relationship between plan specificity and self-control. It is particularly the specificity of the focal task's plan that is in focus of present research. Insofar, future experiments should rely on varying only plan specificity of the focal task. Despite the seeming similarity of the two topics, perhaps only indirect relations between present research on the influence of plan specificity on self-control and construal level differences might exist.

Goal specificity needs to be distinguished from plan specificity. Best performance in terms of personal savings had been reported from participants of a study that tended to have a high construal level trying to achieve specific goals and from participants that tended to have a low construal level trying to achieve unspecific goals (Ülkümen & Cheema, 2011). Participants with high construal level, who tended to think about why they should save money, saw specific goals as more important, supporting their saving efforts. Participants with low construal level, who tended to think about how they could save money, saw specific goals as more difficult to achieve, hindering their saving efforts. Ülkümen and Cheema hypothesized a positive effect of higher plan specificity to higher performance, but they did not expect an interaction effect of construal level with plan specificity. Present research adds to this that with increasing plan specificity the effect could be reversed at some point, and further increasing plan specificity could exert an increasingly negative influence on self-control and performance.

Overall, results of Experiment 1 initially support the hypothesis that plan specificity influences self-control. Yet, the opposite causal direction was not ruled out. This could be investigated by experimentally manipulating ego depletion with successive plan creation. If the specificity of the created plan depends on ego depletion state, an influence of ego depletion on plan specificity is also probable. It has been shown that ego depleted individuals show reduced planning activity (Ginis & Bray, 2010). If ego depletion also influences plan specificity needs to be investigated still.

Empirical indications have been found that a plan's specificity may influence ego depletion during execution of that plan. Future experiments should use more complex tasks. The definition of plan specificity needs to be refined further. If the Stroop task can be considered an appropriate measure of self-control will be discussed next.

4.3.2 Self-Control and the Stroop Task. The Stroop task is, amongst others, a task that is used to measure self-control. Before having a closer look at the relation between the Stroop task and self-control, it is necessary to broadly overlook the domain of self-control measures. It will be discussed whether the Stroop task is an appropriate measure of self-control in general and of ego depletion in particular.

4.3.2.1 Self-Control Measures and the Stroop Task. Classifying the Stroop task within available self-control measures needs to distinguish between self-control and self-regulation first. Self-regulation is conceptually broader and refers to any goal-oriented behavior. In contrast, self-control refers merely to the act of overcoming spontaneous impulses or urges to keep progressing toward a goal (Hofmann et al., 2012). Overcoming impulses requires some internal strength or internal resource that gets depleted. A state of depleted self-control is called ego depletion (Baumeister, 2002).

A multitude of measures of self-control and self-regulation exists that can be categorized into three categories: Delay of Gratification measures, questionnaires, and executive functions (EFs) measures (Duckworth & Kern, 2011).

Delay of Gratification. In the delay of gratification paradigm a real or hypothetical discounting of a long-term versus a short-term reward is measured. Participants typically have to choose between a short-term reward with lower value and a long-term reward with higher value (Duckworth & Kern, 2011). People differ in respect to these preferences and in their ability to wait for a higher value reward in the future while being tempted by a lower value reward available immediately (Laran, 2010; Metcalfe & Mischel, 1999; Mischel et al., 1989). The ability to delay a gratifications is a relatively stable personal property (Mischel et al., 1988). Still, the ability can be strengthened by applying different strategies and the ability may depend on situational influences (Mischel & Baker, 1975).

Questionnaires. Self-control can be measured by questionnaires based on self-rating or on rating by others (Duckworth & Kern, 2011). Amongst others, the self-control scale assessing trait self-control and the SSCCS assessing state self-control can be named here (Tangney et al., 2004; Twenge et al., 2004).

Executive Functions. Self-control is operationalized, thirdly, by measuring EFs, which are closely related to or partly underlying self-control processes. EFs are higher order cognitive processes that support successful goal-directed behavior involving reasoning, planning, problem-solving, and behavior execution. They establish the basis for processes like self-control, emotion regulation, or attentional control (Williams & Thayer,

2009). A close relation between EFs and self-control has already been demonstrated, as for example training EFs can improve self-control (Hofmann et al., 2012). Also, the convergent validity of EFs and self-control measures has been shown (Duckworth & Kern, 2011). Consequently, the convergence of EFs research and self-control research approaches has been proposed (Hofmann, Friese, Schmeichel, & Baddeley, 2011; Hofmann et al., 2012). Three EFs are commonly distinguished: Inhibition, memory updating and maintenance, and task switching (Miyake, Friedman, Emerson, Witzki, & Howerter, 2000; Shimamura, 2000).

Within these three categories of self-control measures, delay of gratification measures, questionnaires, and EF measures, the Stroop task belongs to the category of EF measures. The Stroop task is one of twelve typical tasks used to measure EFs (Duckworth & Kern, 2011). It taps on two of the three main EFs.

Firstly, the Stroop Interference is related to inhibition performance. Word reading is probably a prepotent process that has to be inhibited in favor of the less automatic process of identifying and naming the characters' color (Dishon-Berkovits & Algom, 2000; Jurado & Rosselli, 2007; Lindsay & Jacoby, 1994; MacLeod, 1991). Hence, the Stroop task eventually measures inhibition performance.

Secondly, the Stroop Interference is related to working memory performance. Stroop Interferences are lower for individuals with high working memory capacity (WMC) compared to individuals with low WMC (Long & Prat, 2002). More generally, the differences between the theoretical constructs working memory and attentional control have continuously decreased. A substantial overlap of the two constructs appears to exist (Awh, Vogel, & Oh, 2006; Gazzaley & Nobre, 2012; Postle, 2006; Schmeichel & Hofmann, 2011; Soutschek, Strobach, & Schubert, 2013). The relation of the Stroop task to WMC is supported by the interpretation of Stroop Interference as selective attention task. The Stroop task requires focusing attention selectively to one dimension in question, typically color of the characters, while ignoring a distracting dimension, typically meaning of the color words (Chajut & Algom, 2003; Melara & Algom, 2003). As a result, the Stroop task performance is probably also closely related to working memory performance.

In sum, self-control can be measured by delay of gratification tasks, questionnaires, and EF measures. The Stroop task itself is an EF measure. Stroop Interference is related to the EFs inhibition and to working memory processes. It is one of twelve common types of tasks to measure EFs in general. How the Stroop task can be used to measure ego depletion is described next.

4.3.2.2 *Measuring Ego Depletion with the Stroop Task.* The Stroop task has already been used many times to assess ego depletion (Gailliot, Baumeister, et al., 2007; Gailliot et al., 2012; Inzlicht et al., 2006; Richeson & Trawalter, 2005; Storbeck, 2012; Zelenski et al., 2012). The Stroop task is depending on two EFs, inhibition and working memory. Working memory, a major EFs, can be effectively trained; and training effects generalize to other tasks depending on EFs (Salminen, Strobach, & Schubert, 2012). EFs and self-control are probably closely related. Training and improving of EFs can improve actual self-control in unrelated tasks (Frieze et al., 2011). Even a closer relationship is possible, which is visible in a similar effect found for EFs and for state self-control. The capacity of EFs is temporarily reduced after tasks were executed that depended highly on EFs. It has been hypothesized that this process is the process underlying ego depletion. Ego depletion is the state of temporarily reduced self-control capacity after tasks were executed that depended highly on self-control (Baddeley, 2003; Schmeichel, 2007). The Stroop task would, thus, directly measure the processes underlying ego depletion and, consequently, would be a very appropriate measure of ego depletion. However, some dependencies have to be taken into account for the usage of the Stroop task.

Firstly, the hypothesis that ego depletion can be explained by temporarily reduced EF capacity is plausible, but not many empirical results corroborate this hypothesis yet. Empirical findings show that the effect of reduced EF capacity does not generalize as it would be expected from ego depletion research (Healey, Hasher, & Danilova, 2011). EF capacity reduction is not identical to state self-control capacity reduction. Identical characteristics of these two effects will probably be found only within well-defined boundary conditions. Research on this relationship is required.

Secondly, it only seems that the Stroop task is simple to conduct. Often, neglected context conditions are in fact the source of the Stroop effect; context conditions can completely remove the Stroop effect, or context conditions can even reverse the Stroop effect (Chajut & Algom, 2003). The discriminability of the word and color dimensions needs to be controlled, requiring a baseline measurement of both dimensions. Not only the target dimension of naming the character color should be measured, as it is typically done, but also the word reading should be measured for comparison. Additionally, the practice of using correlated word and color dimensions can be criticized (Chajut & Algom, 2003). If color and word dimension are not balanced, which is a common practice, words are predictive for colors (Dishon-Berkovits & Algom, 2000; cf. Compton et al., 2008; Inzlicht & Gutsell, 2007; Long & Prat, 2002; Storbeck, 2012; Zelenski et al., 2012). For example, if congruent trials (character color matching word meaning) are presented more often than incongruent trials, this renders word meaning a valuable cue for the correct response in the majority of cases. Consequently, participants read the word at least partially. In the incongruent condition, reading the word needs to be inhibited, but because of the positive correlation it is not reasonable to generally ignore the word meaning. With partial reading, the incongruent trials are reacted to slower, though this is not due to a failure of selective attention. In that way an ostensible Stroop Interference is generated. Even the classical findings of the Stroop effect may stem from these particular correlations (Algom, Dekel, & Pansky, 1996; Dishon-Berkovits & Algom, 2000; Sabri, Melara, & Algom, 2001; Shakuf & Algom, 2013).

The Stroop task results of Experiment 1 and Experiment 2 were re-analyzed. One additional finding was that a large portion of the measured Stroop Interferences was actually negative. Negative Interferences were present for 50% of all measured Stroop Interferences in Experiment 1 ($M = 0$ ms, $SD = 23.06$, $n = 216$, range: -55 ms– 99 ms) and for 43% of all measured Stroop Interferences in Experiment 2 ($M = 5$ ms, $SD = 17.56$, $n = 75$, range: -22 ms– 80 ms). Participants with negative interferences responded faster to incongruent trials (for instance, the word *red* in green character color) than to congruent trials (the word *red* in red character color). This effect is also

theoretically possible. However, negative Stroop Interferences are normally explained by a negative correlation of color and word dimension, which means there are more incongruent trials than congruent trials in the task (Lindsay & Jacoby, 1994; MacLeod, 1998; Melara & Algom, 2003; Sabri et al., 2001). In that situation, the incongruent word serves as cue for the correct response ("if the word *green* is written, I have to press *r*"), leading to a delay of congruent trials to override this response tendency. In the present experiments this negative correlation was not given, but the opposite was true with two-third congruent and one-third incongruent trials. The negative Stroop Interference may, thus, not be explained by a negative color and word correlation. For future experiments a balanced procedure would increase validity by measuring not only color reaction times but also word reaction times and additionally base rates for discriminability of the two dimensions. The high ratio of negative Stroop Inferences might indicate deficits of the particular Stroop task used in the present experiments and requires further investigation.

A third dependency to take into account when using the Stroop task is that selective attention might not be indicative for the current ego depletion state. For example, selective attention might be improved under cognitive load (Park, Kim, & Chun, 2007). As a result, Stroop task performance would be improved under cognitive load, which indicated low ego depletion. Conversely, actual ego depletion was probably higher due to the high cognitive demand of cognitive load tasks (Baumeister et al., 2007). Still, high cognitive load might also reduce ego depletion by increasing selective attention, which prevents perceiving tempting stimuli right from the beginning (Alberts, Martijn, Nievelstein, Jansen, & de Vries, 2008; Van Dillen, Papies, & Hofmann, 2013). In that situation, Stroop task performance would be high, indicating low ego depletion, and ego depletion would actually be low. Besides cognitive load, stress in general can influence selective attention and thereby invalidate Stroop task measurements of ego depletion. High stress, which can be induced, for instance, by time pressure, task difficulty, or threads to the ego can lead to an increased selectivity or narrowed attention, which might increase Stroop task performance (Chajut & Algom, 2003). A Stroop task would hence indicate low ego depletion in high stress situations. Contrary to that,

actual ego depletion will probably be high with high stress (Oaten & Cheng, 2005). Taken together, Stroop task performance could diverge from actual ego depletion state under cognitive load or stress. These limiting conditions need to be considered when measuring ego depletion with the Stroop task. The existence of other limiting conditions needs to be investigated still.

In summary, the Stroop task is, on first sight, an appropriate measure of ego depletion. This impression is supported by the ongoing convergence of EF and self-control research. Although the Stroop task has been widely used, the Stroop task is only seemingly simple to conduct. The relation between the measured EFs, the Stroop task, and ego depletion needs to be clarified further. Valid usage scenarios of the Stroop task and their boundary conditions need to be analyzed, as for example, under cognitive load the Stroop task performance might not reliably indicate actual ego depletion. The Stroop task should be complemented by other measures of ego depletion to increase reliability. Further broadening the perspective to self-regulation, measuring self-regulation with the Stroop task would be less precise. Measurements by the Stroop task may partly predict overall self-regulation capability of a person. For self-regulation diverse conceptualizations exist. A multi-method approach to measure self-regulation ability is proposed (Duckworth & Kern, 2011). Strong empirical evidence would be obtained, if convergent results were found from questionnaires, EF tasks, and delay of gratification measures. In the present experiments this convergent validity was not found. The Stroop Interference did neither correlate with the trait self-control scale in Experiment 1, nor with the SSCCS in Experiment 2 (Bertrams et al., 2011; Tangney et al., 2004; Twenge et al., 2004). However, these missing relationships might be due to the particular Stroop task used in the present experiments, as indicated by the negative Stroop Interferences in both experiments. Still, further clarification is needed.

4.3.3 Summary. In two experiments it was tried to further analyze the ambiguous finding from Study 1 that simultaneously high and low specificity of Sprint Backlog Items were related to higher self-control of the Scrum Team members in two items of the Scrum questionnaire.

Experiment 1 found empirical indications of a supportive effect of moderate as opposed to low or high plan specificity on ego depletion during plan execution. However, the statistical results do not corroborate the hypothesis without doubt, and the effectiveness of the plan specificity manipulation could not be verified by the manipulation check. Experiment 2 successfully manipulated plan specificity as rated by participants, but probably due to an inappropriate moderately specific plan given to the participants, no ego depletion difference between the groups with low, moderately, and highly specific plans was found. The concept of specificity should be further refined. In addition, analyzing more complex plans is indicated by present research results. More complex plans would increase generalizability of the results and it would improve the applicability of findings to Development Teams, which are in focus of present research.

Experiment 1 found empirical indications that an influence of plan specificity on ego depletion exists. Whether a reverse influence of ego depletion on plan specificity exists, is not yet clear. Present research was primarily interested in the influence of the specificity of a Development Team's Sprint Backlog on the Development Team members' self-control. Identifying an influence of plan specificity on self-control is sufficient for the application of the results to Scrum. The relationship is probably mutual. Team members with high trait self-control may tend to create a Sprint Backlog with moderate specificity. In turn, a moderate specific Sprint Backlog may support Development Team members' state self-control in their day-to-day work.

In Experiment 2 participants' construal level was not influenced by the execution of a plan with different plan specificity. Present research focused on differences in specificity or abstractness of a focal task, but did not try to influence participants' construal level directly. Relationships between present research and construal level research might be only indirect, as differences of a plan's specificity probably do not manifest in changed mindsets in direction of a high-level or a low-level construal.

Post-hoc the appropriateness of the Stroop task for measuring ego depletion was analyzed. On the one hand, based on the ongoing convergence of self-control and EF research with converging concepts of ego depletion, EFs, and working memory, the Stroop task appears to be a valid measure of ego depletion. On the other hand, the Stroop task is only seemingly easy to conduct and, for example, under cognitive load ego depletion as measured by the Stroop task and actual ego depletion may diverge to a large extent. Other boundary conditions of a valid application of the Stroop task to measure ego depletion need to be clarified still.

In sum, empirical indications have been found that plan specificity influences self-control. The empirical basis of the findings still needs to be broadened. Yet, refining the concept of plan specificity and analyzing more complex plans with varying specificity appear to be promising for future research.

5 Conclusion

Present research argued theoretically and found initial empirical support that and in which way Scrum can support and potentially improve self-control of Development Team members. Results were obtained from a questionnaire in Study 1, which was conducted in an international software company. According to present research, Scrum's core principles can be described as, firstly, performing a concrete planning in the Sprint Planning Meeting at the beginning of a Sprint, that is at the beginning of a development cycle; secondly, actively monitoring progress throughout a Sprint in Daily Scrum Meetings; thirdly, working in an iterative process with short Sprints ending with Sprint Review Meetings; fourthly, improving the Development Team processes team-internally in Sprint Retrospective Meetings; and fifthly, working in teams with high team autonomy similar to SMWTs. Results revealed a positive relationship between Scrum principles and Development Team members' self-control as well as the Development Team's performance. No direct influence of Scrum principles on health or experienced stress was found, but Development Team members' health and low experienced stress correlated with team members' high self-control. Results were complemented by two laboratory experiments. Experiment 1 found empirical indica-

tions that moderately as opposed to low or highly specific Sprint Backlog Items may better support self-control during task execution. Experiment 2 failed to reproduce and extend the findings, probably due to an inappropriate moderately specific plan used in the experiment. The findings will be discussed in more detail in the next paragraphs. After that, practical implications will be derived.

5.1 Scrum and Development Team Members' Self-Control

Study 1 revealed correlations between the Scrum principles and Development Team members' self-control. Concrete planning together with active progress monitoring were found to potentially improved Development Team members' self-control. Concrete planning and progress monitoring correlated positively with trait self-control and negatively with state self-control. This pattern of findings could indicate that self-control improvement was taking place. Short-term ego depletion leads to long-term self-control improvement, similar to training a muscle leads to short-term exhaustion but long-term gains in strength. Team autonomy appeared to be an essential aspect of the found self-control improvement process. Except for the positive correlation between progress monitoring and trait self-control, all other relations between concrete planning and trait as well as state self-control and between progress monitoring and state self-control depended on high team autonomy. Process improvements from the Sprint Retrospective Meetings related to increased state self-control, but not to changed trait self-control. Process improvements potentially reduced self-control demands short-term by improving team-internal social interactions, but did not support long-term self-control improvement. In summary, several theoretically derived relationships between Scrum principles and Development Team members' self-control have been empirically demonstrated by the present study.

Experiment 1 added empirical indications that plan specificity influenced state self-control during execution of that plan. Leaving aside the manipulation check, which failed to verify the manipulation of plan specificity, plans should be created with moderately specific steps as opposed to highly or low specific steps. Moderately specific plans supported state self-control best. However, due to the failed manipulation

check, the findings of Experiment 1 are vague, as it is not clear if found differences in state self-control stemmed from plan specificity differences or from other influences. Therefore, only empirical indications are provided by Experiment 1. Experiment 2 did not reproduce the results of Experiment 1, potentially because of an inappropriate operationalization of plan specificity. The relation between plan specificity and self-control was one partial aspect of the relation between Scrum and Development Team members' self-control revealed in Study 1. Arguably, if the plan specificity influence on self-control could be demonstrated in general, this would suggest that the Sprint Backlog Items' specificity influences Development Team members' self-control. Still, this particular influence in an applied Scrum setting needs to be substantiated by further research. Besides the potential influence of Sprint Backlog Item specificity, other influences of Scrum principles on Development Team members' self-control had been revealed in Study 1. Present research suggests theoretically that self-control differences of Development Team members' are contingent on Scrum principles and their concrete implementation. Still, further empirical investigation is required.

However, the found pattern could either indicate a long-term gain in trait self-control due to working in a Scrum Development Team or this pattern could indicate that high trait self-control of Development Team members caused the Development Teams to plan more concretely and monitor the progress more actively. This concrete planning and active progress monitoring, in turn, could have decreased state self-control of Development Team members. With findings of Study 1 being only correlative, it is not definite, which of these two explanations is true. To demonstrate self-control improvements and a possible causal effect of Scrum principles on self-control, a longitudinal experimental study could provide compelling evidence.

In general it is not fully understood yet, which tasks lead to long-term self-control improvement, and which do not (Mann et al., 2013). Furthermore, some research shows that the ego depletion effect might be less general than originally posited (Dang et al., 2013; Dewitte et al., 2009; Xiao, Dang, Mao, & Liljedahl, 2014). Hence, the self-control improvement effect needs further empirical investigations pointing out the concrete circumstances of self-control improvements. Insights gained from these investigations

may further help to refine how Scrum should be implemented to improve Development Team members' self-control.

In summary, present research found empirical indications that Scrum can help to improve Development Team members' self-control. Correlations between Scrum principles and Development Team members' self-control were found in Study 1. Experiment 1 investigated one finding of Study 1 experimentally: The influence of a plan's specificity on self-control during execution of that plan. Results indicated an influence of plan specificity on self-control. The correlative pattern from Study 1 suggests that Scrum helped to improve Development Team members' self-control. However, no empirical evidence for the direction of the influence could be provided by present research, but reviewed literature suggests the existence of an influence of Scrum principles on self-control. A longitudinal experimental study is required to proof that Scrum actually influences self-control.

5.2 Practical Implications

Overall, present research initially supports the hypothesis that a particular implementation of Scrum can positively influence self-control of the Development Team members. In organizations, a controversy can arise about the right implementation of Scrum (Deemer et al., 2012; West et al., 2010). One common standpoint is that "textbook" Scrum should be implemented, that is, the implementation should be done in an ideal-typical way exactly as described in Scrum literature. The opposing standpoint is typically that Scrum should be implemented in a custom and adapted way to accommodate the Scrum processes to peculiarities of existing software development processes and the organizational setting. Typical adaptations observed by me include performing Sprint Retrospective Meetings only twice a year, performing Daily Scrum Meetings only twice a week, performing Sprint Review Meetings by only discussing the current progress instead of handing over finished Sprint Backlog Items to the Product Owner, not separating the roles of Scrum Master and Product Owner, or in other ways not granting the Development Team the required autonomy. In regard to this controversy, present findings encourage a textbook Scrum implementation. Study 1

found that implementing Scrum processes in a rather ideal-typical way was related to positive outcomes, such as increased team performance, Development Team members' lower experienced stress, and potentially improved self-control, which in turn could support Development Team members' health.

In sum, present findings suggest that autonomous Development Teams should plan and monitor their work by creating a Sprint Backlog with moderately specific Sprint Backlog Items, and performing an active progress monitoring in Daily Scrum Meetings. Development Teams should take the Sprints seriously by meeting the Sprint deadlines of the Sprint Review Meetings and by finishing committed Sprint Backlog Items by then. Process improvements should be fostered by performing frequent Sprint Retrospective Meetings, and lastly, the organization in which the Development Teams work should accept and support the Development Teams' autonomy. These topics will be discussed in more detail in the following paragraphs.

5.2.1 Plan and Monitor. Scrum literature states that Development Teams should create a Sprint Backlog in the Sprint Planning Meeting that is fully specified for at least the first days of the Sprint. This should enable Development Teams to start working on the Sprint Backlog right after the Sprint Planning Meeting. The Sprint Backlog is to be kept up-to-date at all times by all Development Team members, which requires a thorough monitoring of actual progress throughout the Sprint (Schwaber, 2004).

Present research findings suggest beneficial effects of creating moderately specific Sprint Backlogs as opposed to creating Sprint Backlogs with very high or low specificity. In Study 1, Product Backlogs with high specificity were related to high trait self-control. Results of a more detailed post-hoc analysis suggested that moderate specific Sprint Backlogs best support self-control. This hypothesis received initial empirical support by findings of Experiment 1.

In addition, the creation of a moderate specific Sprint Backlog in Study 1 and the active monitoring of progress throughout the Sprint were related to high trait self-control and low state self-control of Development Team members. This pattern of high trait self-control and low state self-control might indicate a self-control training process. Concrete planning and active progress monitoring might thus help to improve

trait self-control in the long-run, at the expense of reducing state self-control in the short-run.

Scrum Teams should create moderately concrete Sprint Backlogs and subsequently stick to this Sprint Backlog and actively monitor the progress, as the long-term advantages of a self-control training will most probably outweigh the short-term disadvantages. In case it turns out during a running Sprint that the Development Team cannot finish the Sprint Backlog, the Sprint Backlog should be adapted accordingly as soon as possible. The Sprint Backlog should always be an up-to-date list of tasks still to be finished until the end of the Sprint. The whole process requires that Daily Scrum Meetings are team-internal steering meetings in autonomous Development Teams. Daily Scrum Meetings should not be status reporting meetings. Daily Scrum Meetings should help to align the team members' efforts to achieve the Sprint Goal.

5.2.2 Take Sprints Seriously. Scrum literature emphasizes that the commitment to finishing selected Sprint Backlog Items until the Sprint Review Meeting should be taken seriously (Schwaber, 2004). Finished Sprint Backlog Items should be demonstrated in the Sprint Review Meeting. In case it becomes apparent during the Sprint that not all committed Sprint Backlog Items can be finished due to, for instance, technical problems or unanticipated complexity, the Development Team should consult the Product Owner to discuss and adapt the Sprint Backlog. That means, committed Sprint Backlog Items should not be adapted silently or just be briefly mentioned in the Sprint Review Meeting, but not fulfilling the commitment should be addressed explicitly. In that way, Scrum puts emphasize on fulfilling the committed Sprint Backlog Items by the Development Team.

In Study 1, meeting Sprint deadlines by finishing committed Sprint Backlog Items was related positively to increased team performance. Interestingly, meeting the Sprint deadline by working hard to do so was not significantly related to Development Team members' health or experienced stress.

It appears advisable that Development Teams should commit to finishing the Sprint Backlog by the end of the Sprint. Development Teams should, in the long-run, improve predictions what they can actually finish within a Sprint and therefore increase reliabil-

ity of their planning. Urging Development Teams to finish the Sprint Backlog requires that Development Teams are autonomous in their Sprint Planning Meeting. In this meeting, the Development Team members discuss and decide on how many Backlog Items they commit to in the next Sprint. The commitment should be taken seriously and it should be followed up on in the Sprint Review Meeting at the end of the Sprint.

Urging Development Teams to fulfill their commitment from the Sprint Planning Meeting could support improving reliability of the teams' planning. Improved reliability of planning single Sprint Backlogs will increase reliability of the overall product release planning, which spans multiple Sprints and potentially multiple Development Teams.

Finishing committed Sprint Backlog Items by the end of a Sprint should be emphasized. Results of Study 1 support this demand. Deviating from the committed scope should be handled explicitly. To increase reliability of the software development process, Development Teams should be rather urged to fulfill their commitment than to commit to a high number of Sprint Backlog Items. High Development Team autonomy is a prerequisite of this process to increase reliability.

5.2.3 Foster Process Improvements. Sprint Retrospective Meetings are at the core of Scrum. Sprint Retrospective Meetings enable Development Teams' learning on team level. Sprint Retrospective Meetings enable Development Teams to adapt to changes of the organizational environment, to improve social interactions within the team, and to improve team internal processes (Schwaber & Sutherland, 2011).

However, to harness the potential of Sprint Retrospective Meetings, Development Teams need to have high team autonomy to effectively make decisions. This is empirically supported by Study 1. Study 1 revealed a marginal significant positive relationship between state self-control and effective Sprint Retrospective Meetings depending on high Development Team autonomy. It appeared that in Study 1, in autonomous teams, effective Sprint Retrospective Meetings helped to reduce the strain of day-to-day work by supporting Development Team members' state self-control. Perhaps this effect stems from improved Development Team internal social relationships, which might have reduced self-control demands in social interactions.

In Study 1, no significant positive influence of Sprint Retrospective Meetings on Development Team performance was found. Yet, effective Sprint Retrospective Meetings were related positively to Development Team members' self-control and possibly helped to improve social interactions in the Development Teams. Consequently, the Sprint Retrospective Meetings should not be neglected, as it often occurs in organizations (McHugh, Conboy, & Lang, 2012), but should be taken seriously and should be an integral part of all Sprints.

5.2.4 Support Team Autonomy. Scrum literature explicitly states that Development Teams should have a high level of team autonomy (Moe, Dingsøy, & Dybå, 2009; Schwaber, 2004; Schwaber & Sutherland, 2011). Especially the decision of how many Product Backlog Items the Development Team commits to in the Sprint Planning Meeting should be an autonomous decision by the Development Team only. High autonomy enables the Development Team to decide only based on feasibility, instead of deciding on wishful-thinking of what would be desirable to achieve by the next Sprint. Also other external influences that could lead to over-planning, such as high pressure due to customer requests, can be reduced. Ultimately, even if customers require features urgently, if finishing the feature in the next Sprint is not feasible, committing to that Product Backlog Item is futile.

Present research supports this demand theoretically and empirically. High team autonomy was related to high team performance and low Development Team members' experienced stress. High team autonomy turned out to support and to be essential for other relationships. Especially processes comprising the potential self-control improvement training depended mostly on high Development Team autonomy.

It appears advisable that Development Teams should have high team autonomy. Positive effects of high team autonomy have been found elsewhere (Haas, 2010; Hoegl & Parboteeah, 2006; Janz et al., 1997). Still, high team autonomy might elicit effects that need to be considered. For instance, high team autonomy may increase team efficiency but may also reduce extensiveness, that is, teams use less resources but also feel less bound to fulfilling customer requests (Lee & Xia, 2010). Thus, increasing Development Team autonomy seems advisable, but potential side effects might have to be controlled.

5.2.5 Core Principles of Scrum. In summary, present research supports the notion that Scrum should be implemented rather as textbook Scrum (that is, ideal-typical) than in a customized manner. Put differently, Scrum implementations might be adapted to fit the organizational environment and the existing software development processes, as long as the core principles of Scrum are still adhered to. According to findings from present research, these core principles are:

- The Development Team should start a Sprint by planning a moderately concrete Sprint Backlog in the Sprint Planning Meeting. The Development Team should be autonomous in performing their planning and the team alone decides how many Sprint Backlog Items it commits to.
- The Development Team should perform an active team-internal progress monitoring in the Daily Scrum Meetings. In case of larger deviations from the planned Sprint Backlog, the Development Team should adapt the Sprint Backlog together with the Product Owner. The Sprint Backlog should always be an up-to-date representation of the tasks still to be done until the end of a Sprint.
- The Development Team should try to finish committed Sprint Backlog Items by the end of the Sprint. If possible, finished Sprint Backlog Items should be demonstrated and handed over to the Product Owner in the Sprint Review Meeting. It needs to be emphasized that it is more important that the Development Team finishes committed Sprint Backlog Items, than committing to a high number of Sprint Backlog Items. In that way, reliability of the software development process may be increased.
- The autonomy of the Development Team regarding the number of Sprint Backlog Items needs to be accepted. It should not be interfered in team-internal processes from outside of the Development Team. In Study 1, high team autonomy was related to high team performance and low Development Team members' experienced stress. In addition, high team autonomy turned out to be essential for the possible self-control improvement process of the Development Team members.
- Sprint Retrospective Meetings should be performed in every Sprint. In Study 1, effective Sprint Retrospective Meetings were related to higher state self-control of

Development Team members. This relationship possibly resulted from improved social interactions and improved processes within the Development Team.

These core principles had been theoretically derived with the help of psychological research. Empirical indications of the relevancy of these core principles for Development Team members' self-control, health, low experienced stress, and for performance of the overall Development Team have been found in Study 1. These core principles are also emphasized in Scrum literature, though not derived from psychological research. Present research supports adhering to these principles by empirical results and by theoretical considerations mainly derived from psychological self-control research.

5.3 Summary

Scrum is an agile software development method based on close collaboration within autonomous Development Teams. It is part of the agile software development movement that has existed for more than a decade and is still evolving (Dingsøy et al., 2012; Fowler & Highsmith, 2001). Almost simultaneously self-control came into the focus of social-psychological research (Baumeister et al., 1998, 1994; Muraven et al., 1998). The fundamental importance of high self-control for many life domains has been demonstrated (Hagger et al., 2010; Tangney et al., 2004). Moreover, processes that might improve self-control have been described (Muraven, 2010a; Muraven et al., 1999). Adding to self-control research, present research shows that the process framework suggested by Scrum might be implemented in a way that would support and improve Development Team members' self-control, with beneficial outcomes for the individual team members and the overall organization.

Present findings in general are in line with the recommendations from Scrum literature. Yet, to add to these recommendations, present findings corroborate the expected positive effects of adhering to these recommendations from Scrum literature with empirical results from an international software company. In particular, present findings reveal a potential self-control improvement process supported by moderately concrete planning in the Sprint Planning Meeting, and thorough progress monitoring in the Daily Scrum Meetings. Effective Sprint Retrospective Meetings were related

to a self-control relieving effect, which might stem from reduced self-control demands in Development Team's day-to-day work. High as opposed to low team autonomy was required for the potential self-control improvement process as well as for the self-control relieving effect. Moreover, high team autonomy was related to high team performance and simultaneously to low stress of Development Team members. High team performance was additionally related to trying to complete committed Sprint Backlog Items by the time of the Sprint Review Meeting. Low stress and good health were mainly related to high self-control of Development Team members. In sum, all Scrum meetings and high Development Team autonomy yielded beneficial outcomes.

Present findings are also in line with those of SMWT research, showing positive outcomes for employees collaborating closely in small autonomous teams completing whole and identifiable pieces of work. Present research demonstrates that Scrum's Development Teams can be understood as SMWTs. Contrary to generic SMWTs, Scrum adds an overarching structure with clear roles, defined interactions, and a fixed temporal flow of the teams' internal and external collaborations to facilitate effective product development.

Finally, present results demonstrate that self-control research findings can be applied to Scrum. Self-control research findings may help to improve Scrum further, in a way that also improves overall team performance while benefiting Development Team members in the areas of self-control, lower stress, and arguably better health. More generally, present research demonstrates that psychological research can help analyze and improve applied process frameworks such as Scrum empirically by examining psychological processes that are often neglected.

References

- Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *Health Psychology, 27*(3), 379–387.
- Agrawal, N., & Wan, E. W. (2009). Regulating risk or risking regulation? Construal levels and depletion effects in the processing of health messages. *Journal of Consumer Research, 36*(3), 448–462.
- Alberts, H. J. E. M., Martijn, C., & de Vries, N. K. (2011). Fighting self-control failure: Overcoming ego depletion by increasing self-awareness. *Journal of Experimental Social Psychology, 47*(1), 58–62.
- Alberts, H. J. E. M., Martijn, C., Nievelstein, F., Jansen, A., & de Vries, N. K. (2008). Distracting the self: Shifting attention prevents ego depletion. *Self and Identity, 7*(3), 322–334.
- Algom, D., Dekel, A., & Pansky, A. (1996). The perception of number from the separability of the stimulus: The Stroop effect revisited. *Memory & Cognition, 24*(5), 557–572.
- Ambler, S. (2007). *The discipline of agile*. Retrieved from <http://www.drdoobbs.com/article/print?articleId=201804241&siteSectionName=architecture-and-design>
- Ambler, S. (2009). *Disciplined agile delivery*. Retrieved from https://www.ibm.com/developerworks/community/blogs/ambler/entry/disciplined_agile_delivery?lang=en
- Antoni, C. H. (1996). *Teilautonome Arbeitsgruppen : Ein Königsweg zu mehr Produktivität und einer menschengerechten Arbeit?* Universität Bielefeld; Fakultät für Psychologie und Sportwissenschaft; Arbeits- und Organisationspsychologie (Germany): Psychologie Verlags Union.
- Ariely, D., & Wertenbroch, K. (2002). Procrastination, deadlines, and performance: Self-control by precommitment. *Psychological Science, 13*(3), 219–224.
- Attaran, M., & Nguyen, T. T. (1999). Design and implementation of self-directed process teams. *Management Decision, 37*(7), 553–560.
- Austin, J. T., & Vancouver, J. B. (1996). Goal constructs in psychology: Structure, process, and content. *Psychological Bulletin, 120*(3), 338–375.

- Awh, E., Vogel, E., & Oh, S.-H. (2006). Interactions between attention and working memory. *Neuroscience*, *139*(1), 201–208.
- Baddeley, A. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience*, *4*(10), 829–839.
- Bandura, A., & Schunk, D. H. (1981). Cultivating competence, self-efficacy, and intrinsic interest through proximal self-motivation. *Journal of Personality and Social Psychology*, *41*(3), 586–598.
- Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182.
- Baskerville, R., & Pries-Heje, J. (2001). A multiple-theory analysis of a diffusion of information technology case. *Information Systems Journal*, *11*(3), 181–212.
- Bates, D. M. (2010). *lme4: Mixed-effects modeling with R*. Springer. Retrieved from <http://lme4.r-forge.r-project.org/book>
- Bauer, I. M., & Baumeister, R. F. (2011). Self-regulatory strength. In *Handbook of self-regulation: Research, theory, and applications (2nd ed.)*. (pp. 64–82). New York, NY US: Guilford Press.
- Baumeister, R. F. (2002). Yielding to temptation: Self-control failure, impulsive purchasing, and consumer behavior. *Journal of Consumer Research*, *28*(4), 670–676.
- Baumeister, R. F., & Alquist, J. L. (2009a). Is there a downside to good self-control?. *Self and Identity*, *8*(2-3), 115–130.
- Baumeister, R. F., & Alquist, J. L. (2009b). Self-regulation as a limited resource: Strength model of control and depletion. In *Psychology of self-regulation: Cognitive, affective, and motivational processes* (pp. 21–33). Psychology Press.
- Baumeister, R. F., Bratslavsky, E., Muraven, M., & Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *Journal of Personality and Social Psychology*, *74*(5), 1252–1265.
- Baumeister, R. F., Gailliot, M., DeWall, C. N., & Oaten, M. (2006). Self-regulation and personality: How interventions increase regulatory success, and how depletion

- moderates the effects of traits on behavior. *Journal of Personality*, 74(6), 1773–1801.
- Baumeister, R. F., & Heatherton, T. F. (1996). Self-regulation failure: An overview. *Psychological Inquiry*, 7(1), 1–15.
- Baumeister, R. F., Heatherton, T. F., & Tice, D. M. (1994). *Losing control: How and why people fail at self-regulation*. San Diego, CA, US: Academic Press.
- Baumeister, R. F., & Vohs, K. D. (2004). *Handbook of self-regulation: Research, theory, and applications*. New York, NY US: Guilford Press.
- Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass*, 1(1), 115–128.
- Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, 16(6), 351–355.
- Bertrams, A., & Dickhäuser, O. (2009). Messung dispositioneller Selbstkontroll-Kapazität Eine deutsche Adaptation der Kurzform der Self-Control Scale (SCS-K-D). *Diagnostica*, 55(1), 2–10.
- Bertrams, A., Unger, A., & Dickhäuser, O. (2011). Momentan verfügbare Selbstkontrollkraft - Vorstellung eines Messinstruments und erste Befunde aus pädagogisch-psychologischen Kontexten. *Zeitschrift für Pädagogische Psychologie*, 25(3), 185–196.
- Bonestroo, W. J., & de Jong, T. (2012). Effects of planning on task load, knowledge, and tool preference: A comparison of two tools. *Interactive Learning Environments*, 20(2), 141–153.
- Boslaugh, S., & Watters, P. (2008). *Statistics in a nutshell: A desktop quick reference*. O'Reilly Media, Inc., illustrated edition ed.
- Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology*, 81(5), 946–960.
- Bullinger, M., Heinisch, M., Ludwig, M., & Geier, S. (1990). Skalen zur Erfassung des Wohlbefindens: Psychometrische Analysen zum 'Profile of Mood States' (POMS) und zum 'Psychological General Well-Being Index' (PGWI). *Zeitschrift für Differentielle und Diagnostische Psychologie*, 11(1), 53–61.

- Bullinger, M., & Kirchberger, I. (1998). *SF-36 Fragebogen zum Gesundheitszustand* [Manual]. Göttingen: Hogrefe.
- Burgoon, E. M., Henderson, M. D., & Markman, A. B. (2013). There are many ways to see the forest for the trees: A tour guide for abstraction. *Perspectives on Psychological Science, 8*(5), 501–520.
- Carver, C. S. (2004). Self-regulation of action and affect. In *Handbook of self-regulation: Research, theory, and applications* (pp. 13–39). Guilford Press.
- Carver, C. S. (2005). Impulse and constraint: Perspectives from personality psychology, convergence with theory in other areas, and potential for integration. *Personality and Social Psychology Review, 9*(4), 312–333.
- Carver, C. S., & Scheier, M. F. (1982). Control theory: A useful conceptual framework for personality–social, clinical, and health psychology. *Psychological Bulletin, 92*(1), 111–135.
- Carver, C. S., & Scheier, M. F. (2012). Cybernetic control processes and the self-regulation of behavior. In *Oxford library of psychology* (pp. 28–42). New York, NY US: Oxford University Press.
- Chajut, E., & Algom, D. (2003). Selective attention improves under stress: Implications for theories of social cognition. *Journal of Personality and Social Psychology, 85*(2), 231–248.
- Chiou, W., Wu, W., & Chang, M. (2013). Think abstractly, smoke less: A brief construal-level intervention can promote self-control, leading to reduced cigarette consumption among current smokers. *Addiction, 108*(5), 985–992.
- Cohen, A., Jaudas, A., & Gollwitzer, P. (2008). Number of cues influences the cost of remembering to remember. *Memory & Cognition, 36*(1), 149–156.
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior, 24*(4), 385–396.
- Compton, R. J., Robinson, M. D., Ode, S., Quandt, L. C., Fineman, S. L., & Carp, J. (2008). Error-monitoring ability predicts daily stress regulation. *Psychological Science, 19*(7), 702–708.
- Cox, E. P. (1980). The optimal number of response alternatives for a scale: A review. *Journal of Marketing Research, 17*(4), 407–422.

- Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.
- Dang, J., Dewitte, S., Mao, L., Xiao, S., & Shi, Y. (2013). Adapting to an initial self-regulatory task cancels the ego depletion effect. *Consciousness and Cognition: An International Journal*, *22*(3), 816–821.
- Davies, S. P. (2003). Initial and concurrent planning in solutions to well-structured problems. *Quarterly Journal of Experimental Psychology: Section A*, *56*(7), 1147–1164.
- Deci, E. L., Connell, J. P., & Ryan, R. M. (1989). Self-determination in a work organization. *Journal of Applied Psychology*, *74*(4), 580–590.
- Deemer, P., Benefield, G., Larman, C., & Vodde, B. (2012). *Scrum primer 2.0*. Retrieved from <http://scrumfoundation.com/library>
- de Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2012). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review*, *16*(1), 76–99.
- de Vet, E., Oenema, A., & Brug, J. (2011). More or better: Do the number and specificity of implementation intentions matter in increasing physical activity? *Psychology of Sport and Exercise*, *12*(4), 471–477.
- Dewitte, S., Bruyneel, S., & Geyskens, K. (2009). Self-regulating enhances self-regulation in subsequent consumer decisions involving similar response conflicts. *Journal of Consumer Research*, *36*(3), 394–405.
- Dingsøy, T., Nerur, S., Balijepally, V., & Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development. *Journal of Systems and Software*, *85*(6), 1213–1221.
- Dishon-Berkovits, M., & Algom, D. (2000). The Stroop effect: It is not the robust phenomenon that you have thought it to be. *Memory & Cognition*, *28*(8), 1437–1449.
- Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality*, *45*(3), 259–268.

- Duckworth, A. L., & Seligman, M. E. P. (2005). Self-discipline outdoes IQ in predicting academic performance of adolescents. *Psychological Science, 16*(12), 939–944.
- Dulaney, C. L., & Rogers, W. A. (1994). Mechanisms underlying reduction in Stroop interference with practice for young and old adults. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(2), 470–484.
- Dybå, T. (2000). Improvisation in small software organizations. *Software, IEEE, 17*(5), 82–87.
- Dybå, T., & Dingsøy, T. (2008). Empirical studies of agile software development: A systematic review. *Information and Software Technology, 50*(9–10), 833–859.
- Eisinga, R., te Grotenhuis, M., & Pelzer, B. (2013). The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown? *International Journal of Public Health, 58*(4), 637–642.
- Elmuti, D. (1996). The perceived impact of team-based management systems on organizational effectiveness. *International Journal of Manpower, 17*(8), 4–17.
- Emery, M.-P. (2004). *KDQOL 1.2*. Retrieved from http://www.rand.org/health/surveys_tools.html
- Engling, J. (2010). *Fragen zum Thema STRESS*. Retrieved from http://www.psy.cmu.edu/~scohen/PSS_4_German.doc
- Ent, M. R., Baumeister, R. F., & Tice, D. M. (2015). Trait self-control and the avoidance of temptation. *Personality & Individual Differences, 74*, 12–15.
- Fiedler, K., Jung, J., Wänke, M., & Alexopoulos, T. (2012). On the relations between distinct aspects of psychological distance: An ecological basis of construal-level theory. *Journal of Experimental Social Psychology*.
- Fiedler, K., Schott, M., & Meiser, T. (2011). What mediation analysis can (not) do. *Journal of Experimental Social Psychology, 47*(6), 1231–1236.
- Fishbach, A., & Trope, Y. (2005). The substitutability of external control and self-control. *Journal of Experimental Social Psychology, 41*(3), 256–270.
- Fitzsimons, G. M., & Finkel, E. J. (2011). Outsourcing self-regulation. *Psychological Science, 22*(3), 369–375.
- Fowler, M., & Highsmith, J. (2001). The agile manifesto. *Software Development, 9*(8), 28–35.

- Friese, M., Hofmann, W., & Wiers, R. W. (2011). On taming horses and strengthening riders: Recent developments in research on interventions to improve self-control in health behaviors. *Self and Identity, 10*(3), 336–351.
- Friese, M., Wänke, M., & Hofmann, W. (2009). Unscrambling self-regulatory behavior determination: The interplay of impulse strength, reflective processes, and control resources. In *Psychology of self-regulation: Cognitive, affective, and motivational processes* (pp. 53–71). Psychology Press.
- Fujita, K. (2011). On conceptualizing self-control as more than the effortful inhibition of impulses. *Personality and Social Psychology Review, 15*(4), 352–366.
- Fujita, K., & Roberts, J. C. (2010). Promoting prospective self-control through abstraction. *Journal of Experimental Social Psychology, 46*(6), 1049–1054.
- Fujita, K., Trope, Y., & Liberman, N. (2010). Seeing the big picture: A construal level analysis of self-control. In *Self control in society, mind, and brain* (pp. 408–427). Oxford University Press.
- Fujita, K., Trope, Y., Liberman, N., & Levin-Sagi, M. (2006). Construal levels and self-control. *Journal of Personality and Social Psychology, 90*(3), 351–367.
- Fulton, L. V., Ivanitskaya, L. V., Bastian, N. D., Erofeev, D. A., & Mendez, F. A. (2013). Frequent deadlines: Evaluating the effect of learner control on healthcare executives' performance in online learning. *Learning and Instruction, 23*, 24–32.
- Förster, J., & Jostmann, N. B. (2012). What is automatic self-regulation? *Zeitschrift für Psychologie, 220*(3), 147–156.
- Gailliot, M. T., Baumeister, R. F., DeWall, C. N., Maner, J. K., Plant, E. A., Tice, D. M., . . . Schmeichel, B. J. (2007). Self-control relies on glucose as a limited energy source: Willpower is more than a metaphor. *Journal of Personality and Social Psychology, 92*(2), 325–336.
- Gailliot, M. T., Gitter, S. A., Baker, M. D., & Baumeister, R. F. (2012). Breaking the rules: Low trait or state self-control increases social norm violations. *Psychology, 3*(12), 1074–1083.
- Gailliot, M. T., Plant, E. A., Butz, D. A., & Baumeister, R. F. (2007). Increasing self-regulatory strength can reduce the depleting effect of suppressing stereotypes. *Personality and Social Psychology Bulletin, 33*(2), 281–294.

- Gazzaley, A., & Nobre, A. C. (2012). Top-down modulation: Bridging selective attention and working memory. *Trends in Cognitive Sciences*, *16*(2), 129–135.
- Gevers, J. M. P., Rutte, C. G., & van Eerde, W. (2006). Meeting deadlines in work groups: Implicit and explicit mechanisms. *Applied Psychology: An International Review*, *55*(1), 52–72.
- Gevers, J. M. P., van Eerde, W., & Rutte, C. G. (2009). Team self-regulation and meeting deadlines in project teams: Antecedents and effects of temporal consensus. *European Journal of Work and Organizational Psychology*, *18*(3), 295–321.
- Ginis, K. A. M., & Bray, S. R. (2010). Application of the limited strength model of self-regulation to understanding exercise effort, planning and adherence. *Psychology & Health*, *25*(10), 1147–1160.
- Gollwitzer, P. M., Fujita, K., & Oettingen, G. (2004). Planning and the implementation of goals. In *Handbook of self-regulation: Research, theory, and applications* (pp. 211–228). Guilford Press.
- Gollwitzer, P. M., & Sheeran, P. (2006). Implementation intentions and goal achievement: A meta-analysis of effects and processes. In *Advances in experimental social psychology* (Vol. 38, pp. 69–119). Elsevier Academic Press.
- Graham, J. W. (2009). Missing data analysis: Making it work in the real world. *Annual review of psychology*, *60*, 549–576.
- Greiner, J. M., & Karoly, P. (1976). Effects of self-control training on study activity and academic performance: An analysis of self-monitoring, self-reward, and systematic-planning components. *Journal of Counseling Psychology*, *23*(6), 495–502.
- Haas, M. R. (2010). The double-edged swords of autonomy and external knowledge: Analyzing team effectiveness in a multinational organization. *Academy of Management Journal*, *53*(5), 989–1008.
- Hackman, J. R. (1983). *A normative model of work team effectiveness* (Tech. Rep. No. 2). Yale School of Organization and Management.

- Hagger, M. S., Wood, C., Stiff, C., & Chatzisarantis, N. L. D. (2010). Ego depletion and the strength model of self-control: A meta-analysis. *Psychological Bulletin*, *136*(4), 495–525.
- Hays, W. L. (1994). *Statistics (5th ed.)*. Orlando, FL, US: Harcourt Brace College Publishers.
- Healey, M. K., Hasher, L., & Danilova, E. (2011). The stability of working memory: Do previous tasks influence complex span? *Journal of Experimental Psychology: General*, *140*(4), 573–585.
- Helms, J. E., Henze, K. T., Sass, T. L., & Mifsud, V. A. (2006). Treating Cronbach's alpha reliability coefficients as data in counseling research. *The Counseling Psychologist*, *34*(5), 630–660.
- Henderson, J. C., & Soonchul, L. (1992). Managing I/S design teams: A control theories perspective. *Management Science*, *38*(6), 757–777.
- Herweg, F., & Müller, D. (2011). Performance of procrastinators: On the value of deadlines. *Theory and Decision*, *70*(3), 329–366.
- Hoegl, M., & Parboteeah, P. (2006). Autonomy and teamwork in innovative projects. *Human Resource Management*, *45*(1), 67–79.
- Hofmann, W., Baumeister, R. F., Förster, G., & Vohs, K. D. (2011). Everyday temptations: An experience sampling study of desire, conflict, and self-control. *Journal of Personality and Social Psychology*. doi: 10.1037/a0026545
- Hofmann, W., Friese, M., Schmeichel, B. J., & Baddeley, A. D. (2011). Working memory and self-regulation. In *Handbook of self-regulation: Research, theory, and applications (2nd ed.)*. (pp. 204–225). New York, NY US: Guilford Press.
- Hofmann, W., Schmeichel, B. J., & Baddeley, A. D. (2012). Executive functions and self-regulation. *Trends in Cognitive Sciences*, *16*(3), 174–180.
- Houghton, J. D., & Neck, C. P. (2002). The revised self-leadership questionnaire: Testing a hierarchical factor structure for self-leadership. *Journal of Managerial Psychology*, *17*(8), 672–691.
- Hox, J. J. (2010). *Multilevel analysis (2nd ed.)*. New York, NY: Routledge.

- Imhoff, R., Schmidt, A. F., & Gerstenberg, F. (2014). Exploring the interplay of trait self-control and ego depletion: Empirical evidence for ironic effects. *European Journal of Personality, 28*(5), 413–424.
- Inzlicht, M., & Gutsell, J. N. (2007). Running on empty: Neural signals for self-control failure. *Psychological Science, 18*(11), 933–937.
- Inzlicht, M., McKay, L., & Aronson, J. (2006). Stigma as ego depletion: How being the target of prejudice affects self-control. *Psychological Science, 17*(3), 262–269.
- Janz, B. D., Colquitt, J. A., & Noe, R. A. (1997). Knowledge worker team effectiveness: The role of autonomy, interdependence, team development, and contextual support variables. *Personnel Psychology, 50*(4), 877–904.
- Jurado, M. B., & Rosselli, M. (2007). The elusive nature of executive functions: A review of our current understanding. *Neuropsychology Review, 17*(3), 213–233.
- Just, D. R., & Wansink, B. (2009). Smarter lunchrooms: Using behavioral economics to improve meal selection. *Choices, 24*(3).
- Keith, T. Z. (1982). Time spent on homework and high school grades: A large-sample path analysis. *Journal of Educational Psychology, 74*(2), 248–253.
- Kim, D. (2013). *The state of Scrum: Benchmarks and guidelines*. Retrieved from http://www.scrumalliance.org/scrum/media/ScrumAllianceMedia/Files%20and%20PDFs/State%20of%20Scrum/2013-State-of-Scrum-Report_062713_final.pdf
- Kirschenbaum, D. S. (1985). Proximity and specificity of planning: A position paper. *Cognitive Therapy and Research, 9*(5), 489–506.
- Kirschenbaum, D. S., Humphrey, L. L., & Malett, S. D. (1981). Specificity of planning in adult self-control: An applied investigation. *Journal of Personality and Social Psychology, 40*(5), 941–950.
- Kirschenbaum, D. S., Malett, S. D., Humphrey, L. L., & Tomarken, A. J. (1982). Specificity of planning and the maintenance of self-control: 1 year follow-up of a study improvement program. *Behavior Therapy, 13*(2), 232–240.
- Kirschenbaum, D. S., Tomarken, A. J., & Ordman, A. M. (1982). Specificity of planning and choice applied to adult self-control. *Journal of Personality and Social Psychology, 42*(3), 576–585.

- Klassen, R. M., Ang, R. P., Chong, W. H., Krawchuk, L. L., Huan, V. S., Wong, I. Y. F., & Yeo, L. S. (2009). A cross-cultural study of adolescent procrastination. *Journal of Research on Adolescence, 19*(4), 799–811.
- Kleingeld, A., van Mierlo, H., & Arends, L. (2011). The effect of goal setting on group performance: A meta-analysis. *Journal of Applied Psychology, 96*(6), 1289–1304.
- Kniberg, H. (2011). *Scrum checklist*. Retrieved from <http://www.crisp.se/scrum/checklist>
- Koriat, A. (2012). The relationships between monitoring, regulation and performance. *Learning and Instruction, 22*(4), 296–298.
- Kozlowski, S. W. J., & Bell, B. S. (2003). Work groups and teams in organizations. In *Handbook of psychology: Industrial and organizational psychology, vol. 12*. (pp. 333–375). Hoboken, NJ, US: John Wiley & Sons Inc.
- Krueger, J., & Mueller, R. A. (2002). Unskilled, unaware, or both? the better-than-average heuristic and statistical regression predict errors in estimates of own performance. *Journal of Personality and Social Psychology, 82*(2), 180–188.
- Kruger, J., & Evans, M. (2004). If you don't want to be late, enumerate: Unpacking reduces the planning fallacy. *Journal of Experimental Social Psychology, 40*(5), 586–598.
- Langfred, C. W. (2000). The paradox of self-management: Individual and group autonomy in work groups. *Journal of Organizational Behavior, 21*(5), 563–585.
- Langfred, C. W. (2005). Autonomy and performance in teams: The multilevel moderating effect of task interdependence. *Journal of Management, 31*(4), 513–529.
- Laran, J. (2010). Choosing your future: Temporal distance and the balance between self-control and indulgence. *Journal of Consumer Research, 36*(6), 1002–1015.
- Latham, G. P., & Seijts, G. H. (1999). The effects of proximal and distal goals on performance on a moderately complex task. *Journal of Organizational Behavior, 20*(4), 421–429.
- Lee, G., & Xia, W. (2010). Toward agile: an integrated analysis of quantitative and qualitative field data on software development agility. *Mis Quarterly, 34*(1), 87–114.

- LePine, J. A., Piccolo, R. F., Jackson, C. L., Mathieu, J. E., & Saul, J. R. (2008). A meta-analysis of teamwork processes: Tests of a multidimensional model and relationships with team effectiveness criteria. *Personnel Psychology, 61*(2), 273–307.
- Levesque, C. S., Williams, G. C., Elliot, D., Pickering, M. A., Bodenhamer, B., & Finley, P. J. (2007). Validating the theoretical structure of the treatment self-regulation questionnaire (trsqr) across three different health behaviors. *Health Education Research, 22*(5), 691–702.
- Levine, J. M., Alexander, K. M., & Hansen, T. (2010). Self-control in groups. In *Self control in society, mind, and brain* (pp. 449–472). Oxford University Press.
- Lindsay, D. S., & Jacoby, L. L. (1994). Stroop process dissociations: The relationship between facilitation and interference. *Journal of Experimental Psychology: Human Perception and Performance, 20*(2), 219–234.
- Locke, E. A., & Latham, G. P. (2002). Building a practically useful theory of goal setting and task motivation: A 35-year odyssey. *American Psychologist, 57*(9), 705–717.
- Locke, E. A., & Latham, G. P. (2006). New directions in goal-setting theory. *Current Directions in Psychological Science, 15*(5), 265–268.
- Long, D. L., & Prat, C. S. (2002). Working memory and Stroop interference: An individual differences investigation. *Memory & Cognition, 30*(2), 294–301.
- Luszczynska, A., & Schwarzer, R. (2003). Planning and self-efficacy in the adoption and maintenance of breast self-examination: A longitudinal study on self-regulatory cognitions. *Psychology & Health, 18*(1), 93–108.
- MacKenzie, M. B., Mezo, P. G., & Francis, S. E. (2012). A conceptual framework for understanding self-regulation in adults. *New Ideas in Psychology, 30*(2), 155–165.
- MacLeod, C. M. (1991). Half a century of research on the Stroop effect: An integrative review. *Psychological Bulletin, 109*(2), 163–203.
- MacLeod, C. M. (1998). Training on integrated versus separated Stroop tasks: The progression of interference and facilitation. *Memory & Cognition, 26*(2), 201–211.

- Mahoney, M. J., & Thoresen, C. E. (1972). Behavioral self-control: Power to the person. *Educational Researcher*, *1*(10), 5–7.
- Manderlink, G., & Harackiewicz, J. M. (1984). Proximal versus distal goal setting and intrinsic motivation. *Journal of Personality and Social Psychology*, *47*(4), 918–928.
- Mann, T., de Ridder, D., & Fujita, K. (2013). Self-regulation of health behavior: Social psychological approaches to goal setting and goal striving. *Health Psychology*, *32*(5), 487–498.
- Markham, S. E., & Markham, I. S. (1995). Self-management and self-leadership reexamined: A levels-of-analysis perspective. *The Leadership Quarterly*, *6*(3), 343–359.
- Masicampo, E. J., & Baumeister, R. F. (2011). Consider it done! plan making can eliminate the cognitive effects of unfulfilled goals. *Journal of Personality and Social Psychology*, *101*(4), 667–683.
- Masicampo, E. J., & Baumeister, R. F. (2012). Committed but closed-minded: When making a specific plan for a goal hinders success. *Social Cognition*, *30*(1), 37–55.
- Mataix-Cols, D., & Bartrés-Faz, D. (2002). Is the use of the wooden and computerized versions of the Tower of Hanoi puzzle equivalent? *Applied Neuropsychology*, *9*(2), 117–120.
- Mathieu, J. E., Gilson, L. L., & Ruddy, T. M. (2006). Empowerment and team effectiveness: An empirical test of an integrated model. *Journal of Applied Psychology*, *91*(1), 97–108.
- McCafferty, I., & Laight, D. (1997). Empowering the team. *Total Quality Management*, *8*(2/3), 233–236.
- McCrea, S. M., Liberman, N., Trope, Y., & Sherman, S. J. (2008). Construal level and procrastination. *Psychological Science*, *19*(12), 1308–1314.
- McHugh, O., Conboy, K., & Lang, M. (2012). Agile practices: The impact on trust in software project teams. *IEEE Software*, *29*(3), 71–76. doi: 10.1109/MS.2011.118
- Mehta, A., Feild, H., Armenakis, A., & Mehta, N. (2009). Team goal orientation and team performance: The mediating role of team planning. *Journal of Management*, *35*(4), 1026–1046.

- Melara, R. D., & Algom, D. (2003). Driven by information: A tectonic theory of Stroop effects. *Psychological Review*, *110*(3), 422–471.
- Mercier, P., & Ladouceur, R. (1983). Modification of study time and grades through self-control procedures. *Canadian Journal of Behavioural Science*, *15*(1), 70–81.
- Metcalf, J., & Mischel, W. (1999). A hot/cool-system analysis of delay of gratification: Dynamics of willpower. *Psychological Review*, *106*(1), 3–19.
- Michie, S., Abraham, C., Whittington, C., McAteer, J., & Gupta, S. (2009). Effective techniques in healthy eating and physical activity interventions: A meta-regression. *Health Psychology*, *28*(6), 690–701.
- Mirowsky, J., & Ross, C. E. (2007). Creative work and health. *Journal of Health and Social Behavior*, *48*(4), 385–403.
- Mischel, W., & Baker, N. (1975). Cognitive appraisals and transformations in delay behavior. *Journal of Personality and Social Psychology*, *31*(2), 254–261.
- Mischel, W., Shoda, Y., & Peake, P. K. (1988). The nature of adolescent competencies predicted by preschool delay of gratification. *Journal of Personality and Social Psychology*, *54*(4), 687–696.
- Mischel, W., Shoda, Y., & Rodriguez, M. L. (1989). Delay of gratification in children. *Science*, *244*(4907), 933–938.
- Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100.
- Moe, N. B., Dingsøyr, T., & Dybå, T. (2009). Overcoming barriers to self-management in software teams. *Software, IEEE*, *26*(6), 20–26.
- Moffitt, T. E., Arseneault, L., Belsky, D., Dickson, N., Hancox, R. J., Harrington, H., ... Caspi, A. (2011). A gradient of childhood self-control predicts health, wealth, and public safety. In *Proceedings of the National Academy of Sciences of the United States of America* (pp. 2693–2698). National Academy of Sciences. doi:10.1073/pnas.1010076108

- Moller, A. C., Deci, E. L., & Ryan, R. M. (2006). Choice and ego-depletion: The moderating role of autonomy. *Personality and Social Psychology Bulletin*, *32*(8), 1024–1036.
- Morgan, M. (1985). Self-monitoring of attained subgoals in private study. *Journal of Educational Psychology*, *77*(6), 623–630.
- Mumford, M. D., Schultz, R. A., & Van Doorn, J. R. (2001). Performance in planning: Processes, requirements, and errors. *Review of General Psychology*, *5*(3), 213–240.
- Muraven, M. (2008). Autonomous self-control is less depleting. *Journal of Research in Personality*, *42*(3), 763–770.
- Muraven, M. (2010a). Building self-control strength: Practicing self-control leads to improved self-control performance. *Journal of Experimental Social Psychology*, *46*(2), 465–468.
- Muraven, M. (2010b). Practicing self-control lowers the risk of smoking lapse. *Psychology of Addictive Behaviors*, *24*(3), 446–452.
- Muraven, M., & Baumeister, R. F. (2000). Self-regulation and depletion of limited resources: Does self-control resemble a muscle? *Psychological Bulletin*, *126*(2), 247–259.
- Muraven, M., Baumeister, R. F., & Tice, D. M. (1999). Longitudinal improvement of self-regulation through practice: Building self-control strength through repeated exercise. *The Journal of Social Psychology*, *139*(4), 446–457.
- Muraven, M., Gagné, M., & Rosman, H. (2008). Helpful self-control: Autonomy support, vitality, and depletion. *Journal of Experimental Social Psychology*, *44*(3), 573–585.
- Muraven, M., Rosman, H., & Gagné, M. (2007). Lack of autonomy and self-control: Performance contingent rewards lead to greater depletion. *Motivation and Emotion*, *31*(4), 322–330.
- Muraven, M., Tice, D. M., & Baumeister, R. F. (1998). Self-control as a limited resource: Regulatory depletion patterns. *Journal of Personality and Social Psychology*, *74*, 774–789.

- Navarro, G. (2001). A guided tour to approximate string matching. *ACM computing surveys*, *33*(1), 31–88.
- Neal, D. T., Wood, W., & Drolet, A. (2013). How do people adhere to goals when willpower is low? The profits (and pitfalls) of strong habits. *Journal of Personality and Social Psychology*, *104*(6), 959–975.
- Nerdinger, F., Blickle, G., & Schaper, N. (2008). *Arbeits- und Organisationspsychologie*. Springer.
- Nerur, S., Mahapatra, R., & Mangalaraj, G. (2005). Challenges of migrating to agile methodologies. *Communications of the ACM*, *48*(5), 72–78.
- Neubach, B., & Schmidt, K.-H. (2008). Haupt- und Interaktionseffekte von Selbstkontrollanforderungen auf Indikatoren der Arbeitsbeanspruchung. *Zeitschrift für Arbeits- und Organisationspsychologie*, *52*(1), 17–24.
- Noyes, J. M., & Garland, K. J. (2003). Solving the Tower of Hanoi: does mode of presentation matter? *Computers in Human Behavior*, *19*(5), 579–592.
- Oaten, M., & Cheng, K. (2005). Academic examination stress impairs self-control. *Journal of Social and Clinical Psychology*, *24*(2), 254–279.
- Oaten, M., & Cheng, K. (2006a). Improved self-control: The benefits of a regular program of academic study. *Basic and Applied Social Psychology*, *28*(1), 1–16.
- Oaten, M., & Cheng, K. (2006b). Longitudinal gains in self-regulation from regular physical exercise. *British Journal of Health Psychology*, *11*(4), 717–733.
- O'Donoghue, T., & Rabin, M. (2008). Procrastination on long-term projects. *Journal of Economic Behavior & Organization*, *66*(2), 161–175.
- Osch, L. v., Lechner, L., Reubsæet, A., & De Vries, H. (2010). From theory to practice: An explorative study into the instrumentality and specificity of implementation intentions. *Psychology & Health*, *25*(3), 351–364.
- Palfai, T. (2004). Automatic processes in self-regulation: Implications for alcohol interventions. *Cognitive and Behavioral Practice*, *11*(2), 190–201.
- Pallant, J. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS*. McGraw-Hill International.
- Park, S., Kim, M.-S., & Chun, M. M. (2007). Concurrent working memory load can facilitate selective attention: Evidence for specialized load. *Journal of*

- Experimental Psychology: Human Perception and Performance*, 33(5), 1062–1075.
- Paulhus, D. L. (1991). Measurement and control of response bias. In *Measures of social psychological attitudes* (Vol. 1, pp. 17–59). San Diego, CA, US: Academic Press.
- Pelletier, L. G., Fortier, M. S., Vallerand, R. J., & Brière, N. M. (2001). Associations among perceived autonomy support, forms of self-regulation, and persistence: A prospective study. *Motivation and Emotion*, 25(4), 279–306.
- Perrin, C. J., Miller, N., Haberlin, A. T., Ivy, J. W., Meindl, J. N., & Neef, N. A. (2011). Measuring and reducing college students' procrastination. *Journal of Applied Behavior Analysis*, 44(3), 463–474.
- Pinheiro, J., Bates, D., DebRoy, S., Sarkar, D., & R Core Team. (2014). nlme: Linear and nonlinear mixed effects models [Computer software manual]. Retrieved from <http://CRAN.R-project.org/package=nlme>
- Postle, B. (2006). Working memory as an emergent property of the mind and brain. *Neuroscience*, 139(1), 23–38.
- Pychyl, T. A., Morin, R. W., & Salmon, B. R. (2000). Procrastination and the planning fallacy: An examination of the study habits of university students. *Journal of Social Behavior & Personality*, 15(5), 135–150.
- R Core Team. (2014). R: A language and environment for statistical computing [Computer software manual]. Vienna, Austria. Retrieved from <http://www.R-project.org/>
- Revelle, W. (2014). psych: Procedures for psychological, psychometric, and personality research [Computer software manual]. Evanston, Illinois. Retrieved from <http://CRAN.R-project.org/package=psych>
- Richeson, J. A., & Trawalter, S. (2005). Why do interracial interactions impair executive function? A resource depletion account. *Journal of Personality and Social Psychology*, 88(6), 934–947.
- Rising, L., & Janoff, N. S. (2000). The Scrum software development process for small teams. *IEEE Software*, 17(4), 26–32.

- Ryan, R. M., & Deci, E. L. (2002). Overview of self-determination theory: An organismic-dialectical perspective. In *Handbook of self-determination research*. (pp. 3–33). Rochester, NY US: University of Rochester Press.
- Sabri, M., Melara, R. D., & Algom, D. (2001). A confluence of contexts: Asymmetric versus global failures of selective attention to stroop dimensions. *Journal of Experimental Psychology: Human Perception and Performance*, *27*(3), 515–537.
- Salminen, T., Strobach, T., & Schubert, T. (2012). On the impacts of working memory training on executive functioning. *Frontiers in Human Neuroscience*, *6*, 1–14. doi: 10.3389/fnhum.2012.00166
- Schatz, B., & Abdelshafi, I. (2006). The agile marathon. In *Proceedings of AGILE 2006 conference*. doi: 10.1109/AGILE.2006.51
- Schelling, T. C. (1984). Self-command in practice, in policy, and in a theory of rational choice. *The American Economic Review*, *74*(2), 1–11.
- Schmeichel, B. J. (2007). Attention control, memory updating, and emotion regulation temporarily reduce the capacity for executive control. *Journal of Experimental Psychology: General*, *136*(2), 241–255.
- Schmeichel, B. J., & Hofmann, W. (2011). Working memory capacity in social psychology. In *Cognitive methods in social psychology*. (pp. 184–205). New York, NY US: Guilford Press.
- Schmeichel, B. J., Vohs, K. D., & Duke, S. C. (2011). Self-control at high and low levels of mental construal. *Social Psychological and Personality Science*, *2*(2), 182–189.
- Schmeichel, B. J., Volokhov, R. N., & Demaree, H. A. (2008). Working memory capacity and the self-regulation of emotional expression and experience. *Journal of Personality and Social Psychology*, *95*(6), 1526–1540.
- Schmidt, K.-H., Hupke, M., & Diestel, S. (2012). Does dispositional capacity for self-control attenuate the relation between self-control demands at work and indicators of job strain? *Work & Stress*, *26*(1), 21–38.
- Schmidt, K.-H., & Neubach, B. (2010). Selbstkontrollanforderungen bei der Arbeit. Fragebogen zur Erfassung eines bislang wenig beachteten Belastungsfaktors. *Diagnostica*, *56*(3), 133–143.

- Schroder, K. E. E., Ollis, C. L., & Davies, S. (2013). Habitual self-control: A brief measure of persistent goal pursuit. *European Journal of Personality, 27*(1), 82–95.
- Schwaber, K. (2004). *Agile project management with Scrum*. O'Reilly Media, Inc.
- Schwaber, K., & Sutherland, J. (2011). *The Scrum guide*. Retrieved from http://www.scrum.org/storage/scrumguides/Scrum_Guide%202011.pdf
- Schwarz, N., & Bless, H. (2007). Mental construal processes: The inclusion/exclusion model. In *Assimilation and contrast in social psychology*. (pp. 119–141). New York, NY US: Psychology Press.
- Schwarz, N., Strack, F., & Mai, H.-P. (1991). Assimilation and contrast effects in part-whole question sequences: A conversational logic analysis. *Public Opinion Quarterly, 55*(1), 3–23.
- Scrum.org. (2013). *What is Scrum*. Retrieved from <https://www.scrum.org/Resources/What-is-Scrum>
- Shakuf, V., & Algom, D. (2013). Who neglects base rate, perceivers or investigators: The effect of base rate on Stroop and Garner effects [Abstract]. In J. Wackermann, M. Wittmann, & W. Skrandies (Eds.), *Fechner Day 2013 - Proceedings of the 29th Annual Meeting of the International Society for Psychophysics*. Retrieved from <http://www.fechnerday.com/fd2013/pdfs/fd2013-proc-book-c.pdf>
- Sheeran, P., & Webb, T. L. (2012). From goals to action. In *Goal-directed behavior* (pp. 175–202). Psychology Press.
- Shimamura, A. P. (2000). The role of the prefrontal cortex in dynamic filtering. *Psychobiology, 28*(2), 207–218.
- Sitzmann, T., & Johnson, S. K. (2012). The best laid plans: Examining the conditions under which a planning intervention improves learning and reduces attrition. *Journal of Applied Psychology, 97*(5), 967–981.
- Sonnentag, S., & Frese, M. (2003). Stress in organizations. In *Handbook of psychology: Industrial and organizational psychology* (Vol. 12, pp. 453–491). Hoboken, NJ, US: John Wiley & Sons Inc.

- Sonnentag, S., & Jelden, S. (2009). Job stressors and the pursuit of sport activities: A day-level perspective. *Journal of Occupational Health Psychology, 14*(2), 165–181.
- Soutschek, A., Strobach, T., & Schubert, T. (2013). Working memory demands modulate cognitive control in the Stroop paradigm. *Psychological Research, 77*(3), 333–347.
- Steel, P. (2007). The nature of procrastination: A meta-analytic and theoretical review of quintessential self-regulatory failure. *Psychological Bulletin, 133*(1), 65–94.
- Steel, P., & Ferrari, J. (2013). Sex, education and procrastination: An epidemiological study of procrastinators' characteristics from a global sample. *European Journal of Personality, 27*(1), 51–58.
- Stegmann, S., van Dick, R., Ullrich, J., Charalambous, J., Menzel, B., Egold, N., & Wu, T. T.-C. (2010). Der Work Design Questionnaire: Vorstellung und erste Validierung einer deutschen Version. *Zeitschrift für Arbeits- und Organisationspsychologie, 54*(1), 1–28.
- Stewart, G. L., & Barrick, M. R. (2000). Team structure and performance: Assessing the mediating role of intrateam process and the moderating role of task type. *Academy of Management Journal, 43*(2), 135–148.
- Stinebrickner, R., & Stinebrickner, T. R. (2004). Time-use and college outcomes. *Journal of Econometrics, 121*(1/2), 243–269.
- Stock, J., & Cervone, D. (1990). Proximal goal-setting and self-regulatory processes. *Cognitive Therapy and Research, 14*(5), 483–498.
- Storbeck, J. (2012). Performance costs when emotion tunes inappropriate cognitive abilities: Implications for mental resources and behavior. *Journal of Experimental Psychology: General, 141*(3), 411–416.
- Sutherland, J. (2004). Agile development: Lessons learned from the first scrum. *Cutter Agile Project Management Advisory Service: Executive Update, 5*(20), 1–4. Retrieved from <https://www.scrumalliance.org/resources/35>
- Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics (5th ed.)*. Allyn & Bacon/Pearson Education.

- Tangney, J. P., Baumeister, R. F., & Boone, A. L. (2004). High self-control predicts good adjustment, less pathology, better grades, and interpersonal success. *Journal of Personality, 72*(2), 271–322.
- Taylor, S. E., Pham, L. B., Rivkin, I. D., & Armor, D. A. (1998). Harnessing the imagination: Mental simulation, self-regulation, and coping. *American Psychologist, 53*(4), 429–439.
- Thaler, R. H., & Shefrin, H. M. (1981). An economic theory of self-control. *The Journal of Political Economy, 89*, 392–406.
- Tice, D. M., & Baumeister, R. F. (1997). Longitudinal study of procrastination, performance, stress, and health: The costs and benefits of dawdling. *Psychological Science, 8*(6), 454–458.
- Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological Review, 110*(3), 403–421.
- Trope, Y., & Liberman, N. (2010). Construal-level theory of psychological distance. *Psychological Review, 117*(2), 440–463.
- Trudel, R., & Murray, K. B. (2013). Self-regulatory strength amplification through selective information processing. *Journal of Consumer Psychology, 23*(1), 61–73.
- Twenge, J. M., Muraven, M., & Tice, D. M. (2004). *Measuring state self-control: Reliability, validity, and correlations with physical and psychological stress*. Unpublished manuscript, San Diego State University.
- Ulich, E. (2005). *Arbeitspsychologie* (6., überarb. und erw. Aufl. ed.). Zürich; Stuttgart: Vdf, Hochschulverl. an der ETH; Schäffer-Poeschel.
- Ülkümen, G., Chakravarti, A., & Morwitz, V. G. (2010). Categories create mind-sets: The effect of exposure to broad versus narrow categorizations on subsequent, unrelated decisions. *Journal of Marketing Research, 47*(4), 659–671.
- Ülkümen, G., & Cheema, A. (2011). Framing goals to influence personal savings: The role of specificity and construal level. *Journal of Marketing Research, 48*(6), 958–969.
- Vallacher, R. R., & Wegner, D. M. (1987). What do people think they're doing? Action identification and human behavior. *Psychological Review, 94*(1), 3–15.

- Vallacher, R. R., & Wegner, D. M. (1989). Levels of personal agency: Individual variation in action identification. *Journal of Personality and Social Psychology*, *57*(4), 660–671.
- Van Dillen, L. F., Papias, E. K., & Hofmann, W. (2013). Turning a blind eye to temptation: How cognitive load can facilitate self-regulation. *Journal of Personality and Social Psychology*, *104*(3), 427–443.
- Van Mierlo, H., Rutte, C. T. G., Kompier, M. A. J., & Doorewaard, H. A. C. M. (2005). Self-managing team work and psychological well-being: Review of a multilevel research domain. *Group & Organization Management*, *30*(2), 211–235.
- Vansteenkiste, M., Simons, J., Lens, W., Sheldon, K. M., & Deci, E. L. (2004). Motivating learning, performance, and persistence: The synergistic effects of intrinsic goal contents and autonomy-supportive contexts. *Journal of Personality and Social Psychology*, *87*(2), 246–260.
- Venables, W., & Ripley, B. (2002). *Modern applied statistics with S* (4th ed.). Springer.
- Vohs, K. D., Baumeister, R. F., Schmeichel, B. J., Twenge, J. M., Nelson, N. M., & Tice, D. M. (2008). Making choices impairs subsequent self-control: A limited-resource account of decision making, self-regulation, and active initiative. *Journal of Personality and Social Psychology*, *94*(5), 883–898.
- Vohs, K. D., & Schmeichel, B. J. (2007). Self-regulation: How and why people reach (and fail to reach) their goals. In *The self* (pp. 139–162). Psychology Press.
- Von Bertalanffy, L. (1950). An outline of general system theory. *British Journal for the Philosophy of Science*.
- Von Bertalanffy, L. (1972). The history and status of general systems theory. *Academy of Management Journal*, *15*(4), 407–426.
- Wall, T. D., Kemp, N. J., Jackson, P. R., & Clegg, C. W. (1986). Outcomes of autonomous workgroups: A long-term field experiment. *Academy of Management Journal*, *29*(2), 280–304.
- Wang, G. (2013). *Manage objectives, actions, and uncertainty in Scrum*. Retrieved from <http://www.scrumalliance.org/community/articles/2013/september/manage-%28objectives-actions-and-uncertainty%29-in-scr.aspx>

- Ward, G., & Allport, A. (1997). Planning and problem-solving using five-disc tower of London task. *The Quarterly Journal of Experimental Psychology A: Human Experimental Psychology*, *50A*(1), 49–78.
- Ware, J. J. E., Kosinski, M., & Keller, S. D. (1996). A 12-item short-form health survey: construction of scales and preliminary tests of reliability and validity. *Medical care*, *34*(3), 220–233.
- Webb, T. L., & Sheeran, P. (2003). Can implementation intentions help to overcome ego-depletion? *Journal of Experimental Social Psychology*, *39*(3), 279–286.
- Weingart, L. R. (1992). Impact of group goals, task component complexity, effort, and planning on group performance. *Journal of Applied Psychology*, *77*(5), 682–693.
- Weldon, E., Jehn, K. A., & Pradhan, P. (1991). Processes that mediate the relationship between a group goal and improved group performance. *Journal of Personality and Social Psychology*, *61*(4), 555–569.
- Welsh, M., Cicerello, A., Cuneo, K., & Brennan, M. (1995). Error and temporal patterns in Tower of Hanoi performance: Cognitive mechanisms and individual differences. *Journal of General Psychology*, *122*(1), 69–81.
- West, D., Grant, T., Gerush, M., & D’Silva, D. (2010). Agile development: Mainstream adoption has changed agility. *Forrester Research*. Retrieved from http://pmshow2012.programmedevelopment.com/public/uploads/files/forrester_agile_development_mainstream_adoption_has_changed_agility.pdf
- Whisman, M. A., & McClelland, G. H. (2005). Designing, testing, and interpreting interactions and moderator effects in family research. *Journal of Family Psychology*, *19*(1), 111–120.
- Wieber, F., Thürmer, J. L., & Gollwitzer, P. M. (2012). Collective action control by goals and plans: Applying a self-regulation perspective to group performance. *The American Journal of Psychology*, *125*(3), 275–290.
- Wiedemann, A. U., Lippke, S., Reuter, T., Ziegelmann, J. P., & Schüz, B. (2011). The more the better? The number of plans predicts health behaviour change. *Applied Psychology: Health and Well-Being*, *3*(1), 87–106.
- Williams, P. G., & Thayer, J. F. (2009). Executive functioning and health: Introduction to the special series. *Annals of Behavioral Medicine*, *37*(2), 101–105.

- Wills, T. A., Isasi, C. R., Mendoza, D., & Ainette, M. G. (2007). Self-control constructs related to measures of dietary intake and physical activity in adolescents. *Journal of Adolescent Health, 41*(6), 551–558.
- Winkler, N., Kroh, M., & Spieß, M. (2006). *Entwicklung einer deutschen Kurzskala zur zweidimensionalen Messung von sozialer Erwünschtheit* (Discussion Papers of DIW Berlin No. 579). DIW Berlin, German Institute for Economic Research.
- Xiao, S., Dang, J., Mao, L., & Liljedahl, S. (2014). When more depletion offsets the ego depletion effect. *Social Psychology*. doi: 10.1027/1864-9335/a000197
- Yeatts, D. E., & Barnes, D. (1996). What are the key factors for self-managed team success? *Journal for Quality & Participation, 19*(3), 68–77.
- Zelenski, J. M., Santoro, M. S., & Whelan, D. C. (2012). Would introverts be better off if they acted more like extraverts? Exploring emotional and cognitive consequences of counterdispositional behavior. *Emotion, 12*(2), 290–303.

List of Tables

1	Cronbach's Alpha of all Scales (Study 1)	57
2	Descriptive Statistics and Scale Intercorrelations (Study 1)	60
3	Trait Self-Control Regression Results (Study 1)	61
4	State Self-Control Regression Results (Study 1)	63
5	Performance Regression Results (Study 1)	72
6	Stress Regression Results (Study 1)	76
7	Health Regression Results (Study 1)	79
A1	Items per Scale (Study 1)	173

List of Figures

1	Scrum Artifacts and Temporal Structure	16
2	Research Model (Study 1)	24
3	Text-Formatting Task (Experiment 1)	96
4	Ego Depletion by Planning Specificity (Experiment 1)	101
5	Stroop Interference by Plan Specificity (Experiment 2)	120

List of Abbreviations

ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
BIF	Behavior Identification Form
BTX	Bildschirmtext
EF	Executive Function
SCL	Scrum Checklist; item of the Scrum Questionnaire was derived from the Scrum Checklist.
SG	Self-Generated; item of the Scrum Questionnaire was not derived from an existing scale.
SMWT	Self-Managing Work Team
SSCCS	State Self-Control Capacity Scale
TOH	Tower of Hanoi task
WMC	Working Memory Capacity

Appendix

Items per Scale (Study 1)

Table A1

Items per Scale (Study 1)

Identifier	Item text
Construal Level Switch	
CL-P-1	Das Product Backlog, das sich im Einklang mit der Product Roadmap / der Product Vision befindet, wird vom Product Owner klar erklärt.
CL-P-2 ^{ab}	Nach der Sprint Planung beträgt die Anzahl der Backlog Items im geplanten Sprint Backlog normalerweise durchschnittlich (alte unabgeschlossene und neue Backlog Items) - weniger als 5 / 5-10 / 11-15 / 16-20 / mehr als 20
CL-R-1 ^a	Üblicherweise habe ich mit Kunden oder internen Abnehmern meines Teams Kontakt. - täglich / häufiger als 1x/Sprint / 1x/Sprint / weniger als 1x/Sprint / nie
CL-R-2 ^a	Meine Entwicklung wird von unseren Kunden oder internen Abnehmern im frühesten Fall nach Sprint Ende verwendet in - 7 Tagen danach / 30 Tagen danach / 3 Monaten danach / mehr als 3 Monate danach / nie/mir unbekannt
CL-S-1	Bei meinen Tasks denke ich einmal täglich oder häufiger darüber nach, wozu ich diese ausführe.
CL-S-2	Das Product Backlog und die Product Roadmap / die Product Vision sind während des Sprints hochgradig sichtbar.
Concrete Planning	
CP-C-1	Mein Scrum Team bricht die Backlog Items auf konkrete Tasks herunter und schätzt die Aufwände.
CP-C-2	Am Ende der Sprint Planung bin ich normalerweise davon überzeugt, dass das Sprint Backlog zum Sprint Ende erreichbar ist.
CP-C-3 ^a	Nach einer durchschnittlichen Task Planung sind die kleinsten von uns geplanten Tasks durchzuführen in ... weniger als 2 h / 2 h-1 Tag / 1-2 Tage / 2-5 Tage / mehr als 5 Tage
CP-M-1	Wir führen Sprint Planning Meetings durch, in denen wir den Sprint Backlog für den nächsten Sprint festlegen.
CP-P-1	Meine Entwicklung ist gut im Voraus planbar.
CP-P-2	Während eines Sprints kann ich normalerweise genau so viel Zeit für meine Sprint Tasks verwenden, wie ich bei der Sprint Planung angenommen hatte.
Short Iterations	
ED-C-1	Ich finde die Sprintlänge angemessen und gut.
ED-C-2	Ich arbeite hart, um alle zugesagten Backlog Items vollständig zum Review fertig zu stellen.
ED-C-3 ^a	Wir erhalten unmittelbare und deutliche Informationen darüber, wie gut wir unsere Arbeit machen.
ED-C-4	Von den geplanten Sprint Backlog Items haben wir zum Sprint Review durchschnittlich folgenden Anteil der Backlog Items vollständig mit allen Tasks abgeschlossen.
ED-M-0 ^a	(calculated from ED-M-1 to ED-M-3: 0 = Sprint 4 weeks, 1 = less than 4 weeks)

(continued)

Table A1
Items per Scale (Study 1; continued)

Identifier	Item text
ED-M-1	Die Sprintlänge in unserem Team ist (1 fest, 2 variabel) (removed from dataset, see ED-M-0)
ED-M-2	fest _____ Woche / Tage (removed from dataset, see ED-M-0)
ED-M-3	variabel bis _____ Wochen / Tage (removed from dataset, see ED-M-0)
Health	
HT-H-1	Wie würdest Du Deinen Gesundheitszustand im Allgemeinen beschreiben?
HT-H-2 ^a	Ich habe weniger geschafft als ich wollte.
HT-H-3 ^a	Ich konnte nicht so sorgfältig wie üblich arbeiten.
HT-H-4	...ruhig und gelassen?
HT-H-5	...voller Energie?
HT-H-6 ^a	...entmutigt und traurig?
HT-P-1	Wie oft hast Du in den letzten 7 Tagen Sport getrieben? _____ mal
HT-P-2	und wie lange insgesamt? _____ Stunden
Team Performance	
PF-F-1	Der Effizienz der Teamarbeit
PF-F-2	Der vom Team produzierten Arbeitsmenge
PF-F-3	Der Einhaltung von Terminen durch das Team
PF-F-4	Der Qualität der Teamarbeit
PF-F-5	Der Fähigkeit des Teams die Sprint-Ziele zu erreichen
PF-F-6 ^a	Mein Team hätte seine Arbeit schneller mit der selben Qualität erledigen können.
PF-F-7	Mein Team hat die Ziele so schnell wie möglich erreicht.
PF-R-1	Alles in allem hilft uns Scrum produktiver zu arbeiten.
Progress Monitoring	
RM-A-1 ^b	Sobald wir zum Beispiel im Daily Scrum bemerken, dass das Sprint Ziel nicht mehr zu erreichen ist, passen wir das Sprint Backlog an.
RM-E-1	Im Daily Scrum kommen Probleme und Hindernisse zum Vorschein.
RM-E-2	Ich finde das Daily Scrum nützlich, um uns als Team zu koordinieren.
RM-M-0 ^b	(Summarizing results from RM-M-1 and RM-M-2, removing single deviating entries in teams)
RM-M-1	Wir führen ein Daily Scrum durch: (1=täglich, 2=xmal/Woche, 3=nie) (removed from dataset, see RM-M-0)
RM-M-2	(if RM-M-1 equals 2, then x times per week; removed from dataset, see RM-M-0)
RM-M-3	Die Aufwandsschätzungen des laufenden Sprints werden in oder nach jedem Daily Scrum aktualisiert.
RM-O-1	Ich nehme am Daily Scrum teil, weil die Besprechung sehr wichtig ist, damit die Teamzusammenarbeit so gut wie möglich ist.
RM-O-2 ^a	Ich nehme am Daily Scrum teil, weil ich den Gruppendruck spüre, dabei anwesend sein zu müssen.
RM-S-1	Mir ist wichtig, im Auge zu behalten, wie gut ich bei der Arbeit abschneide.
RM-S-2	Mir ist normalerweise bewusst, wie gut ich eine Aufgabe durchführe.
Process Improvements	
RR-A-1	Mit der Zeit verbessern wir unsere Zusammenarbeit als Team.
RR-A-2	Wir setzen einige Verbesserungsvorschläge aus unseren Retrospektiven tatsächlich um.

(continued)

Table A1
Items per Scale (Study 1; continued)

Identifier	Item text
RR-M-1	Wir führen Retrospective Meetings typischerweise durch: (bei Durchführung nach Bedarf bitte die durchschnittlichen Abstände bisher angeben)
RR-S-1	Die Vertrauenskultur im Team macht es mir leicht z.B. in Meetings wie dem "Retrospective Meeting" offen über Probleme zu sprechen, ohne Nachteile zu befürchten.
RR-S-2	Ich habe das Gefühl, ich kann in meinem Team Probleme der Umsetzung von Scrum offen ansprechen.
State Self-Control	
SC-S-1	Die letzten 24h fühlte ich mich sehr aktiv.
SC-S-2	Die letzten 24h fühlte ich mich sehr munter.
SC-S-3	Die letzten 24h fühlte ich mich sehr schwungvoll.
SC-S-4	Die letzten 24h fühlte ich mich sehr tatkräftig.
Trait Self-Control	
SC-T-1	Ich bin gut darin, Versuchungen zu widerstehen.
SC-T-2 ^a	Es fällt mir schwer, schlechte Gewohnheiten abzulegen.
SC-T-3 ^a	Ich tue manchmal Dinge, die schlecht für mich sind, wenn sie mir Spaß machen.
SC-T-4 ^a	Ich wünschte, ich hätte mehr Selbstdisziplin.
SC-T-5 ^a	Es fällt mir schwer, mich zu konzentrieren.
SC-T-6	Ich kann effektiv auf langfristige Ziele hinarbeiten.
SC-T-7 ^a	Manchmal kann ich mich selbst nicht daran hindern, etwas zu tun, obwohl ich weiß, dass es falsch ist.
SC-T-8 ^a	Ich handle oft, ohne alle Alternativen durchdacht zu haben.
SC-T-9	Ich lehne Dinge ab, die schlecht für mich sind.
SC-T-0	Andere würden sagen, dass ich eine eiserne Selbstdisziplin habe.
Social Desirability	
SD-S-1	Ich bin immer ehrlich zu anderen.
SD-S-2 ^a	Ich habe gelegentlich mal jemanden ausgenutzt.
Low Stress	
ST-A-1 ^{ab}	In den letzten sechs Monaten gab es für mich Situationen in der Arbeit, in denen ich mich an der Grenze meiner Belastbarkeit fühlte.
ST-A-2 ^a	Diejenigen, die mir am nächsten stehen, sagen, dass ich mich für meinen Beruf zu sehr aufopfere.
ST-S-1 ^{ab}	Wie oft hattest Du im letzten Monat das Gefühl, wichtige berufliche Dinge in Deinem Leben nicht beeinflussen zu können?
ST-S-2	Wie oft hattest Du Dich im letzten Monat sicher im Umgang mit Deinen persönlichen Aufgaben und Problemen bei der Arbeit gefühlt?
ST-S-3	Wie oft hattest Du im letzten Monat das Gefühl, dass sich die Dinge in der Arbeit nach Deinen Vorstellungen entwickeln?
ST-S-4 ^a	Wie oft hattest Du im letzten Monat das Gefühl, dass sich berufliche Aufgaben oder Probleme so sehr aufgestaut haben, dass Du diese nicht bewältigen konntest?
Team Autonomy	
TA-O-1	Wir können selbst entscheiden, in welcher Reihenfolge wir unsere Arbeit machen.
TA-O-2	Wir können unsere Arbeit so planen, wie wir es möchten.
TA-O-3	Unsere Arbeit gewährt uns einen großen Entscheidungsspielraum.

(continued)

Table A1
Items per Scale (Study 1; continued)

Identifier	Item text
TA-O-4	Wir können selbst entscheiden, mit welchen Mitteln wir zum Ziel kommen.
TA-S-1	Ich habe den Eindruck, dass mein Scrum-Team von außen nicht kontrolliert wird.
TA-S-2 ^a	Mein Scrum-Team handelt sehr selbstbestimmt.
TA-S-3	Mein Scrum-Team nutzt die ihm zugestandene Autonomie nicht.

^a Item inverted.

^b Item removed from the respective scale during scale validation.

Complete Questionnaire (Study 1)

All four pages of the Scrum Questionnaire are displayed starting next page (company logo and minor company specific information removed).

Fragebogen zum Thema Scrum

Liebe Teilnehmerin, lieber Teilnehmer,

Danke, dass Du Dir die Zeit nimmst, diesen Fragebogen zu beantworten. Er enthält Fragen zu der konkreten Umsetzung von Scrum in Deinem Team, zu den Scrum Meetings, zu Deiner Wahrnehmung von Scrum und zu Deiner Person. Der Fragebogen ist anonym. Daher notiere bitte keine User oder Ähnliches. Der Fragebogen wird ausschließlich zu Forschungszwecken statistisch ausgewertet.

Die Beantwortung der Fragen ist freiwillig. Bitte lies Dir die Aussagen auf der linken Seite aufmerksam durch und markiere auf der rechten Seite genau *eine* Antwort. Fülle möglichst alle Fragen aus und beantworte die Fragen, ohne lange darüber nachzudenken.

Sprint Planning Meeting

	völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
1.01 Wir führen Sprint Planning Meetings durch, in denen wir den Sprint Backlog für den nächsten Sprint festlegen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.02 Das Product Backlog, das sich im Einklang mit der Product Roadmap / der Product Vision befindet, wird vom Product Owner klar erklärt.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.03 Meine Entwicklung ist gut im Voraus planbar.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.04 Mein Scrum Team bricht die Backlog Items auf konkrete Tasks herunter und schätzt die Aufwände.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.05 Am Ende der Sprint Planung bin ich normalerweise davon überzeugt, dass das Sprint Backlog zum Sprint Ende erreichbar ist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1.06 Nach einer durchschnittlichen Task Planung sind die <i>kleinsten</i> von uns geplanten Tasks durchzuführen in ...	weniger als 2h	2h - 1 Tag	1 - 2 Tagen	2 - 5 Tagen	mehr als 5 Tagen
1.07 Nach der Sprint Planung beträgt die Anzahl der Backlog Items im geplanten Sprint Backlog normalerweise durchschnittlich (alte unabgeschlossene und neue Backlog Items)	weniger als 5	5 - 10	11 - 15	16 - 20	mehr als 20

Daily Scrum Meeting

2.01 Wir führen ein Daily Scrum durch:

- täglich _____ mal pro Woche / alle _____ Tage
 nie

	völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
2.02 Die Aufwandsschätzungen des laufenden Sprints werden in oder nach jedem Daily Scrum aktualisiert.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.03 Bei meinen Tasks denke ich einmal täglich oder häufiger darüber nach, <i>wozu</i> ich diesen ausführe.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.04 Das Product Backlog und die Product Roadmap / die Product Vision sind während des Sprints hochgradig sichtbar.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.05 Im Daily Scrum kommen Probleme und Hindernisse zum Vorschein.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.06 Sobald wir zum Beispiel im Daily Scrum bemerken, dass das Sprint Ziel nicht mehr zu erreichen ist, passen wir das Sprint Backlog an.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.07 Ich finde das Daily Scrum nützlich, um uns als Team zu koordinieren.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.08 Ich nehme am Daily Scrum teil, weil die Besprechung sehr wichtig ist, damit die Teamzusammenarbeit so gut wie möglich ist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2.09 Ich nehme am Daily Scrum teil, weil ich den Gruppendruck spüre, dabei anwesend sein zu müssen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Review Meetings und Sprints

3.01 Die Sprintlänge in unserem Team ist

 fest: _____ Wochen / Tage variabel: von _____ bis _____ Wochen / Tage

völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
--------------------------	------------------------	---------------	----------------------	------------------------

3.02 Ich finde die Sprintlänge angemessen und gut.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

3.03 Während eines Sprints kann ich normalerweise genau so viel Zeit für meine Sprint Tasks verwenden, wie ich bei der Sprint Planung angenommen hatte.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

3.04 Ich arbeite hart, um alle zugesagten Backlog Items vollständig zum Review fertig zu stellen.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

3.05 Wir erhalten unmittelbare und deutliche Informationen darüber, wie gut wir unsere Arbeit machen.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

3.06 Üblicherweise habe ich mit Kunden oder internen Abnehmern meines Teams Kontakt.

täglich	häufiger als 1x / Sprint	1x / Sprint	weniger als 1x / Sprint	nie
---------	--------------------------------	----------------	-------------------------------	-----

3.07 Meine Entwicklung wird von unseren Kunden oder internen Abnehmern im *frühesten* Fall nach Sprint Ende verwendet in ...

7 Tagen danach	30 Tagen danach	3 Monaten danach	mehr als 3 Monate danach	nie / mir unbe- kannt
----------------------	-----------------------	------------------------	--------------------------------	-----------------------------

3.08 Von den geplanten Sprint Backlog Items haben wir zum Sprint Review durchschnittlich folgenden Anteil der Backlog Items vollständig mit allen Tasks abgeschlossen.

alle / 100%	mehr als 75%	mehr als 50%	etwa 50%	weniger als 50%
----------------	-----------------	-----------------	-------------	--------------------

Retrospective Meeting4.01 Wir führen Retrospective Meetings typischerweise durch:
(bei Durchführung nach Bedarf bitte die durchschnittlichen Abstände bisher angeben)

gar nicht	seltener als alle 6 Sprints	alle 4-6 Sprints	alle 2-3 Sprints	jeden Sprint
--------------	-----------------------------------	---------------------	---------------------	-----------------

4.02 Die Vertrauenskultur im Team macht es mir leicht z.B. in Meetings wie dem "Retrospective Meeting" offen über Probleme zu sprechen, ohne Nachteile zu befürchten.

völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
--------------------------	------------------------	---------------	----------------------	------------------------

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

4.03 Ich habe das Gefühl, ich kann in meinem Team Probleme der Umsetzung von Scrum offen ansprechen.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

4.04 Mit der Zeit verbessern wir unsere Zusammenarbeit als Team.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

4.05 Wir setzen einige Verbesserungsvorschläge aus unseren Retrospektiven tatsächlich um.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Mein Scrum Team

⋮	⋮	⋮	⋮	⋮
---	---	---	---	---

5.01 Ich habe den Eindruck, dass mein Scrum-Team von außen nicht kontrolliert wird.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.02 Mein Scrum-Team handelt sehr selbstbestimmt.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.03 Mein Scrum-Team nutzt die ihm zugestandene Autonomie nicht.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.04 Wir können selbst entscheiden, in welcher Reihenfolge wir unsere Arbeit machen.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.05 Wir können unsere Arbeit so planen, wie wir es möchten.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.06 Unsere Arbeit gewährt uns einen großen Entscheidungsspielraum.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.07 Wir können selbst entscheiden, mit welchen Mitteln wir zum Ziel kommen.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

5.08 Alles in allem hilft uns Scrum produktiver zu arbeiten.

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
--------------------------	--------------------------	--------------------------	--------------------------	--------------------------

Die folgenden Fragen erfordern, dass Du Dein Scrum Team mit anderen Teams vergleichst. In Relation zu vergleichbaren Teams in denen Du schon gearbeitet hast oder die Du beobachtet hast, wie würdest Du Dein Team beurteilen hinsichtlich:

	sehr niedrig	eher niedrig	gleich	eher hoch	sehr hoch
5.09 Der Effizienz der Teamarbeit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.10 Der vom Team produzierten Arbeitsmenge	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.11 Der Einhaltung von Terminen durch das Team	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.12 Der Qualität der Teamarbeit	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.13 Der Fähigkeit des Teams die Sprint-Ziele zu erreichen	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
5.14 Mein Team hätte seine Arbeit schneller mit der selben Qualität erledigen können.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5.15 Mein Team hat die Ziele so schnell wie möglich erreicht.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Ich & Scrum

Nachfolgend einige standardisierte Fragen zu Deinen persönlichen Einstellungen. Bitte versuche, möglichst ehrlich zu antworten. Die Daten werden absolut anonym behandelt.

	völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
6.01 Mir ist wichtig, im Auge zu behalten, wie gut ich bei der Arbeit abschneide.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.02 Mir ist normalerweise bewusst, wie gut ich eine Aufgabe durchführe.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.03 Ich bin gut darin, Versuchungen zu widerstehen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.04 Es fällt mir schwer, schlechte Gewohnheiten abzulegen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.05 Ich tue manchmal Dinge, die schlecht für mich sind, wenn sie mir Spaß machen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.06 Ich wünschte, ich hätte mehr Selbstdisziplin.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.07 Ich bin immer ehrlich zu anderen.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.08 Es fällt mir schwer, mich zu konzentrieren.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.09 Ich kann effektiv auf langfristige Ziele hinarbeiten.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.10 Manchmal kann ich mich selbst nicht daran hindern, etwas zu tun, obwohl ich weiß, dass es falsch ist.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.11 Ich handle oft, ohne alle Alternativen durchdacht zu haben.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.12 Ich lehne Dinge ab, die schlecht für mich sind.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.13 Andere würden sagen, dass ich eine eiserne Selbstdisziplin habe.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6.14 Ich habe gelegentlich mal jemanden ausgenutzt.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



Stress und Gesundheit

Zuletzt noch Fragen zum Thema Stress und zu Deiner Einschätzung Deiner Gesundheit. Die folgenden Fragen beschäftigen sich damit, wie häufig Du Dich während des letzten Monats durch Stress belastet fühltest.

	nie	selten	manch- mal	häufig	sehr oft
7.01 Wie oft hattest Du im letzten Monat das Gefühl, wichtige berufliche Dinge in Deinem Leben nicht beeinflussen zu können?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.02 Wie oft hattest Du Dich im letzten Monat sicher im Umgang mit Deinen persönlichen Aufgaben und Problemen bei der Arbeit gefühlt?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.03 Wie oft hattest Du im letzten Monat das Gefühl, dass sich die Dinge in der Arbeit nach Deinen Vorstellungen entwickeln?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.04 Wie oft hattest Du im letzten Monat das Gefühl, dass sich berufliche Aufgaben oder Probleme so sehr aufgestaut haben, dass Du diese nicht bewältigen konntest?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	völlig unzu- treffend	eher unzu- treffend	weder noch	eher zu- treffend	völlig zu- treffend
7.05 In den letzten sechs Monaten gab es für mich Situationen in der Arbeit, in denen ich mich an der Grenze meiner Belastbarkeit fühlte.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.06 Diejenigen, die mir am nächsten stehen, sagen, dass ich mich für meinen Beruf zu sehr aufopfere.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.07 Die letzten 24h fühlte ich mich sehr aktiv.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.08 Die letzten 24h fühlte ich mich sehr munter.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.09 Die letzten 24h fühlte ich mich sehr schwungvoll.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.10 Die letzten 24h fühlte ich mich sehr tatkräftig.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.11 Wie würdest Du Deinen Gesundheitszustand im Allgemeinen beschreiben?	schlecht	weniger gut	gut	sehr gut	ausge- zeichnet

Hattest Du in den vergangenen 4 Wochen aufgrund *seelischer Probleme* irgendwelche Schwierigkeiten bei der Arbeit oder anderen alltäglichen Tätigkeiten im Beruf bzw. zu Hause (z.B. weil Du dich niedergeschlagen oder ängstlich fühltest)?

	nie	selten	manch- mal	ziem- lich oft	meis- tens	immer
7.12 Ich habe weniger geschafft als ich wollte.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.13 Ich konnte nicht so sorgfältig wie üblich arbeiten.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
In diesen Fragen geht es darum, wie Du dich fühlst und wie es Dir in den vergangenen 4 Wochen gegangen ist.	⋮	⋮	⋮	⋮	⋮	⋮
Wie oft warst Du in den <i>vergangenen 4 Wochen</i> ...	⋮	⋮	⋮	⋮	⋮	⋮
7.14 ...ruhig und gelassen?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.15 ...voller Energie?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.16 ...entmutigt und traurig?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7.17 <i>Wie oft</i> hast Du in den letzten 7 Tagen Sport getrieben? _____ mal <i>und wie lange insgesamt?</i> _____ Stunden						

Abschluss und demographische Daten

8.01 Hast Du noch Anmerkungen zu der Umsetzung von Scrum in Deinem Team?

8.02 Alter (Jahre): <30 31-40 41-50 51-60 >60

8.03 Betriebszugehörigkeit _____ Jahre Erfahrung als Entwickler _____ Jahre

Vielen Dank für Deine Teilnahme!



UNIVERSITÄT
HEIDELBERG
ZUKUNFT
SEIT 1386

**FAKULTÄT FÜR VERHALTENS-
UND EMPIRISCHE KULTURWISSENSCHAFTEN**

**Promotionsausschuss der Fakultät für Verhaltens- und Empirische Kulturwissenschaften
der Ruprecht-Karls-Universität Heidelberg**
Doctoral Committee of the Faculty of Behavioural and Cultural Studies, of Heidelberg University

**Erklärung gemäß § 8 Abs. 1 Buchst. b) der Promotionsordnung der Universität Heidelberg
für die Fakultät für Verhaltens- und Empirische Kulturwissenschaften**
Declaration in accordance to § 8 (1) b) and § 8 (1) c) of the doctoral degree regulation of Heidelberg
University, Faculty of Behavioural and Cultural Studies

Ich erkläre, dass ich die vorgelegte Dissertation selbstständig angefertigt, nur die angegebenen Hilfsmittel benutzt und die Zitate gekennzeichnet habe.

I declare that I have made the submitted dissertation independently, using only the specified tools and have correctly marked all quotations.

**Erklärung gemäß § 8 Abs. 1 Buchst. c) der Promotionsordnung
der Universität Heidelberg für die Fakultät für Verhaltens- und Empirische
Kulturwissenschaften**

Ich erkläre, dass ich die vorgelegte Dissertation in dieser oder einer anderen Form nicht anderweitig als Prüfungsarbeit verwendet oder einer anderen Fakultät als Dissertation vorgelegt habe.

I declare that I did not use the submitted dissertation in this or any other form as an examination paper until now and that I did not submit it in another faculty.

Vorname Nachname
First name Family name

Datum, Unterschrift
Date, Signature
