

**GRITTY AND HABITUAL: RESEARCH ON THE THEORY OF PLANNED  
BEHAVIOR AND AUTONOMOUS MOTIVATION FOR PHYSICAL ACTIVITY IN  
ADOLESCENTS**

**Jinyoung Choi**

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Psychology  
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Faculty of Sport and Health Sciences  
University of Jyväskylä

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## ABSTRACT

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Grit is perseverance and passion for long-term goals, an individual trait that can lead to successful outcome. Habit is considered as goal-directed automaticity, repeated with low awareness, which may interact with behavior and intention for the behavior. The theory of planned behavior (TPB) describes constructs in predicting behavior with the intention to act. There have been several studies on each of the three elements mentioned above (grit, habit, TPB) and autonomous motivation in physical activity (PA). However, few studies look at the relationship altogether between these variables.

This study examined the associations of psychological constructs based in the TPB with grit and habit. As a pilot study of a larger project, the study aims to examine if individual differences in grit and habit can predict intentions and behavior of PA. It was hypothesized that grit and habit will both have effect on PA and the TPB variables.

277 Finnish secondary school students (grades 7, 8 and 9) were asked to fill out a questionnaire at two points in time (week 1 and 5). The questionnaire contained questions from three different questionnaires that measure grit (Duckworth & Peterson, Matthews & Kelly, 2007), habit (Gardner et al., 2012), and the constructs of the TPB (Ajzen, 1985). Reliabilities were analyzed with Cronbach's  $\alpha$  and the correlational coefficient  $r$ . The relationships between the variables were quantitatively measured through correlational and regression analysis using SPSS.

Correlations revealed that grit and habit correlated each in varying degrees to attitude, subjective norms, perceived behavioral control, intention and PA. Longitudinal correlations were found especially with habit, intention, and PA ( $r \geq .20$ ). Grit had small longitudinal correlation with PA ( $r = .13$ ). ANOVA results indicated that students with higher grit or higher automaticity were more physically active in both Time 1 and 2. There were no combined effects of grit and habit on PA.

Regression results demonstrated the cross-sectional and longitudinal effect of grit and habit on PA, with intention as a mediating variable. Grit and habit are considered as important predictors to physical activity of adolescents, and as suitable targets for intervention. The results of the study will be important in understanding the effect of grit and habit on the variables of autonomous motivation in the TPB.

*Keywords: Theory of planned behavior, grit, habit, autonomous motivation, physical activity*

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## 1 INTRODUCTION

Many social-cognitive and behavioral science theories help to explain how autonomous motivation may lead to positive outcomes, due to factors such as greater interest, effort, and task involvement (Ryan & Deci, 2000; Skinner & Belmont, 1993). To seek and identify the environment in which autonomous motivation for physical activity can be fostered, numerous studies have been conducted, and reviewed by Ntoumanis and Biddle (1999).

Autonomous motivation and motivational environment are important factors to examine in relation to the initiation and continuation of physical activity (Hagger & Chatzisarantis, 2008). Previous studies have investigated the motivational environment and the autonomous motivation of adolescents to exercise, and found that autonomy-supportive environments in school may facilitate the motivation and the actual behavior of leisure-time physical activity of students across diverse cultures (Chatzisarantis & Hagger, 2009; González-Cutre, Sicilia, Beas-Jiménez & Hagger, 2014; Hagger, Chatzisarantis, Barkoukis, Wang & Baranowski, 2005; Hagger, Chatzisarantis, Culverhouse & Biddle, 2003; Hagger, et al., 2009; Lim & Wang, 2009; Wallhead, Hagger & Smith, 2010). In such educational settings, students can foster their autonomous motivation for exercise in the physical education environment. By studying their volitional (intentional) behavior and their impulsive (automatic) behavior that manifest in reflection to their environment, we can identify the antecedents of autonomous motivation for physical activity behavior of adolescents.

Therefore, it is important to study and understand how these volitional and impulsive traits influence autonomous motivation and actual physical activity behavior. This study was planned to fill the gap in the literature by focusing on the relationship between intentional behavior (through the grit variable), automatic behavior (through the habit variable), and physical activity, within the boundary outlined by the theory of planned behavior. These variables and the theory will be introduced further in the following sections.

### 1.1 Theory of planned behavior

Among the wide range of social-cognitive theoretical models, one of the most frequently used for explaining volitional behavior is the theory of planned behavior (TPB; Ajzen, 1985). As a lot of human activity is goal-directed, Ajzen (1985) believed

that actions were controlled by intentions, as other different constructs determined the intentions.

Fishbein and Ajzen assume that humans act sensibly, thus introducing the theory of reasoned action (TRA) to predict volitional behaviours (as cited in Ajzen, 1985). According to Ajzen (1985), the TRA posits intention as a direct determinant to a certain behaviour, while a construct “personal in nature,” or *attitude*, and another “reflecting social influence,” or *subjective norms*, determine intentions. Attitude would measure the positive or negative personal evaluation of doing the behaviour. Subjective norm is the personal perception of social pressures to do (or not do) a behaviour.

However, Ajzen (1985) acknowledges that intentions may change over a certain period of time, to which he adds another determinant to intention: *perceived behavioural control*. Perceived behavioural control is a personal evaluation of one’s capability regarding one’s behaviour engagement. With these three beliefs that lead to intended behaviour, intention is hypothesized to mediate their effects on behaviour. The theory of planned behaviour (TPB) model is created to understand and predict behaviour and the autonomous motivation to perform the behaviour.

As claimed by Hagger, Chatzisarantis, and Biddle (2002), TPB has been extensively demonstrated to explain a substantial amount of variance in the physical activity context, more so than TRA, as perceived behavioral control shows to have a strong influence on the physical activity intentions. In their meta-analysis of studies utilizing TRA and TPB to explain physical activity and its intention, they found medium to large effect sizes in attitude, perceived behavioral control, and physical activity in relation to intention, while a smaller effect size was shown for subjective norm–intention link. Their path analysis corroborates numerous previous studies and analyses that intention is the sole predictor of physical activity, which mediates the effects of attitude and subjective norms. Their results of testing TPB exhibits that perceived behavioral control has both direct and indirect (through intention) effect on behavior. Their meta-analysis also concludes that TPB model demonstrates better fit, as well as account for more variance in intention than its prior version, TRA (Hagger, Chatzisarantis & Biddle, 2002).

With further studies focusing on the TPB and how autonomous motives predict behavior, Hagger, Chatzisarantis, and Harris (2006) claim that autonomous motivation from self-determination theory influences intentions, the effect of subjective norms and perceived behavioral control on intentions, and intentions on physical activity behavior.

There have also been studies on the trans-contextual model (TCM; Hagger et al., 2003), of which TPB lays out the framework in predicting autonomous motivation for physical activity in several contexts, for example, in- and out-of-school (Hagger, Chatzisarantis, Culverhouse & Biddle, 2016). As one of the widely utilized model, TPB proves to work as a framework in predicting the autonomous motivation in the context of physical activity.

## 1.2 Grit

The concept of *grit* proliferated to find out the reason behind difference in educational accomplishments. In the beginning, however, there was a broader question to explore *grit* as a variable to not only education, but general performance: “*Why do some individuals accomplish more than others of equal intelligence?*” (Duckworth, Peterson, Matthews & Kelly, 2007, p. 1087). Despite some elements such as IQ and talent, *grit* can also be considered as an intrapersonal factor that is associated with autonomous motivation and success in performance.

According to Duckworth and her colleagues (2007, p.1087), *grit* is described as “perseverance and passion for long-term goals.” Not necessarily related to IQ, *grit* is an essential characteristic in reaching high achievement in many different contexts and with diverse populations, such as education and academic performance (Duckworth et al, 2007; Eskreis-Winkler, Duckworth, Shulman & Beal, 2014; Robertson-Kraft & Duckworth, 2014; Wolters, & Hussain, 2015), military, workplace, and marriage (Eskreis-Winkler, et al., 2014), as demonstrated with West Point cadets as well as finalists in a national spelling contest (Duckworth et al, 2007; Kelly, Matthews & Bartone, 2014).

*Grit* has been considered as an influencing factor not only for the academic performance of students in schools (Duckworth et al, 2007; Eskreis-Winkler et al., 2014; Wolters, & Hussain, 2015), but also the effectiveness of the teachers (Duckworth, Quinn, & Seligman, 2009). Robertson-Kraft and Duckworth (2014) conducted a study where they found out that novice teachers with higher *grit* scores were more effective in teaching their students than their less gritty colleagues.

Other literatures reveal that *grit* buffers the association between negative life events and suicide ideation (Blalock, Young, & Kleiman, 2015), predicts the well-being of those who go through physician and nurse training (Gaeta et al., 2017; Jin & Kim, 2017; Salles, Cohen & Mueller, 2014), predicts costly perseverance (Lucas, Gratch, Cheng &

Marsella, 2015), relates to work ethic (Meriac, Slifka & LaBat, 2015), protects against cognitive impairment (Rhodes, Devlin, Steinberg & Giovannetti, 2017), indicates better work performance (Suzuki, Tamesue, Asahi & Ishikawa, 2015), helps to cope actively (Silvia, Eddington, Beaty, Nusbaum & Kwapil, 2013) and relates to pursuing happiness (Von Culin, Tsukayama & Duckworth, 2014).

### 1.2.1 Consistency of interest and perseverance of effort

Grit can be explained with two facets: Perseverance of effort and consistency of interest. As such, grit was thought mostly as a determinant variable for successful performance in many studies. However, as studies progressed, the two different dimensions seemed to associate differently with other variables.

Meriac and his colleagues (2015) discuss that hard work dimension of work ethics correlated to the perseverance effort dimension of grit, while the relationship between delay of gratification dimension and consistency of interest facet was not statistically significant. Wolters and Hussain (2015) also reveal that while perseverance of effort was consistently predicting all seven indicators of self-regulated learning (SRL), consistency of interest could not predict five out of the seven, nor the actual achievement. In a study by Von Culin and her colleague (2014), the two dimensions of grit correlated differently with the three different motivational orientations. They found out that orienting toward engagement in activities was closely associated with perseverance of effort, while pursuing pleasure had stronger (negative) correlations with consistency of interests, from which they suggest that the differences of how people approach happiness may lead to individual differences in grit (Von Culin et al., 2014). The two different subscales of grit even predicted the bodily autonomic processes (sympathetic and parasympathetic activities) differently (Silvia et al., 2013).

There seems to be separate dimensional-level relationship for the two facets of grit with different variables and dimensions. This imbalanced structure of grit was extensively analyzed in a meta-analytic review by Credé, Tynan, and Harms (2017). They claim that criterion validity of perseverance of effort facet is particularly stronger than consistency of interest. In their synthesis, they suggest the perseverance facet may give the prime utility of grit, thus questioning the construct validity of grit as one variable (Credé et al., 2017).



### 1.2.2 Grit in sport and exercise settings

For the interest of this study, there are also several studies that focused on grit in the domain of sport and exercise. Larkin and his colleagues (2016) examined the influence of grit on sport participation, specifically with elite youth soccer players. Their findings were the first to show that the grittier soccer players were significantly more involved in sport-related activities than those with less grit. Grit was a significant factor for larger sport engagement in wheelchair basketball players as well (Martin, Byrd, Watts & Dent, 2015). Grit seems to work not only as a predictor, but also a moderator between receiving motivational feedback and athlete performance (Moles, Auerbach & Petrie, 2017). According to Moles and his colleagues (2017), when the grit of high school adolescent soccer players was low, they were more influenced by the mastery-focused feedback compared to an ego-involving one. They assume that low-grit athletes gain more control for their success after getting feedback about making effort and working hard, while high-grit athletes tend to be less effected by ego-oriented feedback due to their already-stabilized persistence, helping them to stay focused (Moles et al., 2017).

In the context of exercise, grit is also shown to be a significant predictor of behavior. In one study, grit was suggested as an important differentiator of the transtheoretical model (TTM) for high intensity and moderate intensity exercise (Reed, Pritschet & Cutton, 2012). In another study of grit and exercise behavior, Reed (2014) also demonstrated that grit as a potential individual difference trait for exercise, as exercisers in his study had significantly higher grit scores than the non-exercisers. From such studies, one can infer how grit is an important factor to consider in relation to exercise behavior. Reed and his colleagues (2012) suggest in their research that grit may be associated with the consistent effort to reach and maintain higher exercise and fitness levels.

In addition, Sharkey and her colleagues (2017) examined the relationship between grit and health care management skills, as well as quality of life of 470 undergraduates. In their study, they found out that grittier students had greater health care management skills and higher mental and physical quality of life (Sharkey et al., 2017). The studies show how grit may play an important role in health and physical activity.

As literatures support the connection of gritty athletes to successful and positive sport and exercise performance, researchers are also interested in finding out the predictors of higher grit scores. According to Gilchrist, Fong, Herbison, and Sabiston (2017), there also correlations between pride and grit of student-athletes and recreational runners.

They conclude that the authentic experiences of feeling pride may be necessary to increase the resilient and positive attitude, as well as grit in sport and exercise contexts (Gilchrist et al., 2017). Kitano and his colleagues (2018) associate participating in organized sport activities to grit, as they analyzed students in Japan and found out that support from significant others, engaging in intense physical activity, and good sleep quality may be important to facilitate grit.

There were also few literatures that indicate that grit may not be an influential factor of achievement in sport and exercise settings, each with individual reasons for the findings. In her explorative economic experiment, Bessey (2018) found out that grit was not related to health behaviors such as drinking, smoking and physical activity, when analyzed with personality traits and other economic preference patterns. She indicated that it was an unexpected result, but give reasons to the small sample, and that previous findings of grit could have captured the effects of other personality traits that associates strongly to grit (Bessey, 2018). In another study about adolescents' physical fitness and academic performance, Cosgrove, Chen and Castelli (2018) also found a surprising result that grit did not predict health fitness. The authors suggested that the finding could be due to agency in academic performance that overrides that of health in low socio-economic status schools with different priorities and resources.

### 1.2.3 Measuring Grit

Duckworth and her colleagues (2007) have created and validated a self-report questionnaire of 12 items, Grit Scale (Grit-O), hoping to find correlations with focused effort and interest over time and high accomplishments. Their results revealed that the individual differences in grit are a determining factor in the significant variances in the successful outcomes in diverse contexts. With such prominent results from Duckworth et al. (2007), the Short Grit Scale (Grit-S) of 8 items has been created for a more efficient measure of grit (Duckworth & Quinn, 2009). In their article, the Grit-S is presented as a more efficient measure, where the questionnaire is shorter in length with only 8 items, but also psychometrically more significant. Other studies also support the validity and reliability of 8-item Grit-S as a tool for measuring grit, more so than the 12-item Grit-O (Meyer, Markgraf & Gnacinski, 2017).

### 1.3 Habit

*Habit* was considered as a psychological construct by Verplanken and Orbell (2003), who describe it as an automatic behavior, or automaticity, that are manifested in response to particular cues, with a history of repetition. Verplanken and Aarts (1999) also explain that habit “are functional in obtaining certain goals or end-states.” They limit the terminology to goal-directed behaviors, thus excluding compulsive or reflexive behaviors such as biting your nails (Verplanken & Aarts, 1999). Therefore, according to Verplanken and Aarts (1999), habit is not seen as a non-volitional trait, where there is no intention. In fact, the initiation of the behavior is quite intentional to achieve a certain goal, but the following execution and repetitiveness of the behavior may be unintentional.

This is another important trait of habit – that it is developed by repetition in a stable environment. Such repetition allows a flow of behaviour that may be executed subconsciously, thus freeing the mind for other thoughts at the same time (Verplanken & Orbell, 2003). This flow explains the ‘efficiency’ character of automaticity (habit) among the four characteristics of habit mentioned by Bargh (1994). Other than ‘efficiency’, there are also three other traits of automaticity: Awareness, intention, and control. With these four characteristics in mind, Verplanken and Orbell (2003) dictates that habit is featured as intentional, only somewhat controllable, manifested without one being aware, and efficient. They also create a questionnaire based on these four traits of habit, referred to as the ‘Self-Report Habit Index’ (Verplanken & Orbell, 2003). Measurement of habit will be discussed further in another following sub-section.

#### 1.3.1 Automaticity and Intention

Although habit is thought to be formed intentionally as mentioned previously, it is counterintuitive to think of automatic behavior as intentional (Ouellette & Wood, 1998). According to Ouellette and Wood (1998), the three reasons why habit may be considered as non-volitional are because: people are not aware consciously of their behaviour, intentions become simplified and general, and separate behaviour becomes a flow or “a chunk” of behaviour once habit is formed. Simply put, since habit takes our mind off details that could be intentionally paid attention to, we become unaware although it leads our behaviour in the moment. On the other hand, *intention* also directs behaviour by reflecting the attitude, subjective norms, and perceived behavioural

control of an individual, which is explained in the theory of planned behaviour (Ajzen, 1985).

However, Strack and Deutsch (2004) claim social behaviour is an effect of both parallel systems, *impulsive* and *reflective*, and they highlight the importance of studying the influence of the impulsive system with constructs in the reflective system. With their *dual-process model*, they hope for additional insight to social behaviours that are not determined and cannot be explained by volitional variables (Strack & Deutsch, 2004). Pesseau and his colleagues (2014) also tested the dual process model on behaviors of health professionals managing type-2 diabetes in primary care. They found evidence of both impulsive and reflective processes accounting for variability in the behavior of clinicians, and they emphasize the importance of understanding and creating an intervention aimed at both processes for predicting behavior (Pesseau et al., 2014). Instead of generalizing intention and automaticity as two opposite poles that elicit behaviour, habit and intention can therefore be thought as co-influencing behaviour.

As coextensive both impulsive and reflective systems can be in manifesting behaviour, many literatures look at the direction of their effects, and how automaticity and intention influence behaviour. Many studies focus on habit mediating the intention-behaviour relationship (de Bruijn, 2011; de Bruijn, Kremers, de Vet, de Nooijer, van Mechelen & Brug, 2007; de Bruijn & Rhodes, 2011; Gardner, de Bruijn & Lally, 2011; Rhodes, de Bruijn & Matheson, 2010), while some others talk about habit and intention as variables that independently affect behaviour (Allom, Mullan, Cowie & Hamilton, 2016; Hamilton, Kirkpatrick, Rebar & Hagger, 2017; Kaushal & Rhodes, 2015).

In a systematic review by Gardner and his colleagues (2011), they discuss habit as a moderator of intention and behavior in nutrition and physical activity, because their results show that intention effects behavior less when habit is stronger. De Bruijn (2011) points out that the intention-behavior gap is less with stronger habit in exercisers, as well as in fruit consumption of Dutch adults (de Bruijn et al., 2007), and that stronger habit to exercise makes the behavior less intentional (de Bruijn & Rhodes, 2011). The meta-analysis by Hagger, Polet, and Lintunen (2018) also supports that the influence of intention on behavior is likely to decrease when habit is included as a predictor into the reasoned action approach model. Chatzisarantis and Hagger (2007) also add that non-habitual exercisers tend to translate their intention into their actions more than the habitual exercisers. Thus, it is important to make a behavior habitual for a successful volitional transition from intention to the behavior (Rhodes, de Bruijn & Matheson,

2010). However, Allom and her colleagues (2016), as well as Hamilton and her colleagues (2017) claim that the effects of intention and habit are exerted independently on behavior, and in their case, physical activity.

### 1.3.2 Physical activity (PA) and adolescent habit formation

According to Kaushal & Rhodes (2015), the minimum requirement to form a habit is four bouts a week for six weeks. However, adolescence may still be the stage of developing a habit of exercise and PA. In addition, Aarts, Paulussen, and Schaalma (1997) introduce how children's daily PA habits do not continue until adolescence and adulthood. As habit is reduced, intention starts to influence PA more (de Bruijn, 2011). It might at this stage of adolescence that we need to pay extra attention to in order to understand the impact of intention (cognitive-reflective) and habit (impulsive) on physical activity and its sustainable habit formation.

Researchers indicate how physical activity has an automatic component that should not be overlooked (Rhodes and de Bruijn, 2010; Rhodes, de Bruijn & Matheson, 2010). As the actual formation of habit, the habit antecedent model of Kaushal and Rhodes (2015) showed that consistency, low behavioral complexity, environment, and affective judgments influenced habit formation over 12 weeks. Their model also reveals that habit and intention are parallel predictors of physical activity. According to Rhodes and de Bruijn (2010), the intensity of physical activity also influences the effect of habit on the intention-behavior link.

### 1.3.3 Measuring habit

While many can believe that habit can be measured simply by counting how many times the behaviour is manifested, Verplanken and Orbell (2003) introduced the variable "*habit*," representing a psychological construct of habitual behaviour strength, rather than simple frequency of behaviour. They recognize the behavioural frequency as only a proxy variable for measuring the habit strength for the behaviour, especially because simple frequency measure does not "tap the heart of the habit construct," which is automaticity. Verplanken and Melkevik (2008) also emphasizes that habit does not equal frequency but encompasses the character of automaticity within it as a variable. Instead of finding statistical correlations between past and future behaviour, habit is an interesting variable to look at if it is focused on the "mindset" and the impulsive cue-response association (Verplanken & Aarts, 1999). With this, the twelve-item Self-

Report Habit Index (SRHI) was developed, which proved to be useful in measuring habit strength of a certain behaviour (Verplanken & Orbell, 2003) and reliable (Verplanken & Melkevik, 2008).

After a few years, Gardner, Abraham, Lally, and de Bruijn (2012) slimmed the twelve-item questionnaire down to a four-item automaticity subscale, the Self-Report Behavioural Automaticity Index (SRBAI). After testing if this new automaticity-specific questionnaire would measure an individual's habit patterns, they conclude that SRBAI was indeed successful in capturing habitual behaviour patterns and predicting future behaviour (Gardner et al., 2012).

To my knowledge, there have been very few studies that clarify grit and its effect on or interaction with different variables of autonomous motivation in physical activity and exercise. Many previous studies examined solely the direct relationship between grit and performance outcomes, primarily in the field of education. In addition, there is hardly any research on grit and its connection to adolescence physical activity and the motivational process for physical activity of adolescent students in schools. As for habit, there were relatively more studies on its relationship with autonomous motivation in the physical activity context. However, automaticity has not been researched with both grit and the constructs of the TPB at the same time, which can prove to be useful in finding interesting patterns and associations amongst the variables.

## 2 PUPOSE OF THE STUDY

The aim of the study is to examine the relationship between grit, habit, physical activity, and constructs of the theory of planned behavior (TPB). Furthermore, I intend to explore if individual differences in grit and habit can predict the intentions, attitudes, norms, control toward physical activity and physical activity behavior.

This study hopes to demonstrate and explain any significant cross-sectional and longitudinal associations of grit and habit on different elements in the theory of planned behavior in relation to physical activity. The following are several hypotheses that are in line with this aim.

### HYPOTHESES

H1: Grit and habit correlate with the constructs of TPB and PA.

H2: Higher grit or habit scores are associated with being more physically active.

H3: Individual differences in grit and habit can predict the difference in PA and the intention to be physically active.

Firstly, it is hypothesized that grit and habit scores will correlate with attitudes, subjective norms, and perceived behavioral control towards PA, as well as intention and actual PA behavior. (H1). Furthermore, those with higher grit and habit scores are expected to be more physically active in real life (H2). Finally, I hope to find such correlations showing a longitudinal effect, so that the changes in grit and habit will predict the changes in intention for PA and PA behavior (H3).

### 3 METHODS

The study was conducted as part of the Petals and IMPAct projects (led by Martin Hagger and Taru Lintunen – <https://www.fidiproimpact.com/>). The Petals project includes an intervention study in the PE classes to increase the students' motivation for physical activity. Data was collected from the participants with two questionnaires that were administered 5 weeks apart.

#### 3.1 Participants and procedure

The participants were Finnish secondary school students, 7<sup>th</sup> to 9<sup>th</sup> graders ( $n = 277$ , girls = 143, boys = 134,  $M_{\text{age}} = 13.68$ ,  $SD = .914$ ) from two schools in Kymenlaakso, South-East of Finland (School A,  $n = 144$ , and School B,  $n = 133$ ). Out of the 388 students in the beginning from both schools, 287 gave consent to participate, 61 denied participation, and 40 students did not explicitly deny participation. 277 students were matched with questionnaires at both Time 1 and 2.

The schools were contacted beforehand for participation by Finnish researchers in the project. The participation was voluntary, and the participants were informed that their data will be treated anonymously and exclusively for research purposes. The data collection took place two months after the beginning of the semester. The questionnaires were collected during normal school hours, and the questionnaire took about 15 to 20 minutes for the students to fill out, both at Time 1 and Time 2, 4 weeks later.

The researchers who went to the schools presented themselves to the participants that they were from the University of Jyväskylä. The students were explained about the study briefly, that it is about physical activity, that the participation was voluntary, and that they were able to withdraw at any time they wanted. They were told not to collaborate with their friends, and to ask for help if they don't understand.

#### 3.2 Measures

The questionnaires, originally in English, were translated into Finnish by the Finnish Doctoral degree students in the project. They were then back-translated into English by another Finnish researcher in the project, so as to compare with the original and ensure internal reliability. The original and back-translated questionnaire showed no significant difference in the meaning of sentences and words (See Appendices A and B for the original and translated questionnaire).



The first questions were about basic demographic questions (age, gender, birthday, school, and class) as well as their PE teachers' names and their parents' profession.

*Measures of variables in the theory of planned behavior:* Ajzen's (1985) Theory of Planned Behavior Questionnaire (Appendix A, page 45) has been used in numerous studies in diverse areas of studies to measure attitude, subjective norms, perceived behavioral control, and intentions of an individual. These were all measured on 7-point Likert scales.

*Attitude* (Appendix A, first question) was measured with three items on a 7-point Osgood semantic differential scale, where 1 indicated a low level or degree and 7 indicated a high level or degree (unenjoyable-enjoyable, bad-good, useless-useful). The sentences started with a common stem: "Participating in active sports and/or vigorous physical activities during my leisure time in the next 5 weeks is..." The more positive their answers were, the higher score they had for their *attitude* in physical activity. The internal consistency for the scale of *attitude* was satisfactory for both Times 1 and 2 ( $\alpha = .82, .88$  respectively).

The *subjective norms* (Appendix A, questions 6 and 7) component had two questions ("Most people who are important to me think I should do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks" and "Most people important to me put pressure on me to do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks") which measured the trait from strongly disagree (1) to strongly agree (7). The correlation between the two items were .71 for Time 1 and .74 for Time 2.

Another two statements assessed *perceived behavioral control* (Appendix A, questions 4 and 5), where one question ("I am confident I could do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks") was rated from strongly disagree (1) to strongly agree (7), and another ("How much control do you have over doing active sports and/or vigorous physical activities in my leisure time in the next 5 weeks?") was rated from very little control (1) to complete control (7). The correlation between the two items were .53 for Time 1 and .68 for Time 2.

Finally, *intention* (Appendix A, questions 2 and 3) was assessed with answers from strongly disagree (1) to strongly agree (7) to two questions ("I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks" and "I

plan to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks”). The correlation between the two items were .88 for both Times 1 and 2,

*Measure for grit:* Duckworth and her colleagues (2007) developed the Grit Scale (Appendix A, page 47) to measure an individual’s sustainability of effort and consistency of interest, which constitutes the two dimensions of grit. For each dimension, the questionnaire had six questions, making up 12 questions for the entire scale. Six statements tap their sustainability of effort (ex. “I have overcome setbacks to conquer an important challenge”), where the other six items measured the consistency of interest (ex. “My interests change from year to year.”). The answers of participating students were rated between 1 (not like me at all) to 4 (very much like me), and the consistency of interest items were reverse-scored (1 to 4, 2 to 3, 3 to 2, and 4 to 1). The calculated overall score, which is the addition of the 12 items, constituted the student’s grit score. The reliability of the grit scale was satisfactory, as the Cronbach’s Alpha for Time 1 was .72, and .76 for Time 2. (See the Appendix C for individual item’s  $\alpha$ .)

*Measure for automaticity of behavior:* To measure habitual exercise, the questionnaire contained the four questions from Gardner and his colleague’s (2012) Self-Reported Behavioral Automaticity (Habit) Index (Appendix A, page 46). The adapted four-item scale asks the participants to rate the certainty on a 7-point Likert scale (from completely uncertain to completely certain) of the following statements: “Physical activity is something I do automatically,” “Physical activity is something I do I do without having to consciously remember,” “Physical activity is something I do without thinking,” and “Physical activity is something I start doing before I realize I’m doing it.” Higher scores on this scale meant that the students exercise more habitually, or automatically. The alpha coefficient for this scale was .91 for both Time 1 and 2. (See the Appendix D for individual item’s  $\alpha$ .)

*Measure for physical activity:* To measure the participants’ actual physical activity behavior, the questionnaire contained the two questions which ask the frequency of exercise during their leisure time (Appendix A, page 46; “In the course of the past five weeks, how often on average, have you participated in vigorous physical activities during your leisure time for at least 20 minutes at a time?”, “How frequently did you have you participated in vigorous physical activities during your leisure time for at least

20 minutes at a time?”). Their answers could be recorded between 1 to 6 for their exercise out of school. The correlation between the two items for both Time 1 and Time 2 were high ( $r = .88, .86$  consecutively).

### 3.3 Ethical issues

The ethical permission for the study was granted by the ethical board of University of Jyväskylä.

Since the participants are underage, we required consent forms from the students' parents for their children to participate. The consent was asked in School A through paper form, while in School B, an online message system was used. The data was collected during normal school days, and for those ( $N = 61$ ) who denied participation, alternative tasks were given.

It was decided to include those who did not explicitly deny participation into the data, as we believed that it would not do harm or violate the individual rights of the students if we were to include their answers on their physical activity.

### 3.4 Data preparation and analysis

The collected data was analyzed with IBM SPSS Statistics. After inputting all the responses into an excel file, I and my student colleague imported the data onto the SPSS program. We went through the data preparation procedure, which included recoding the data (i.e. the reverse items in the grit scale), replacing missing values through linear interpolation (only 0.648% was missing), and computing the means of each variable. At this stage, we also created the *change variable* (a calculated difference between T2 and T1) to quantify the change between the two times. The descriptive, correlational, ANOVA and regression analysis was done of and between the variables of grit, habit, and the theory of planned behavior with the statistics program mentioned above.

### 3.5 Validity of the measures

All the questionnaires are based on strong theoretical background and are used in various previous studies. The measures, therefore, are expected to be valid.

## 4 RESULTS

To explore the effect of grit and habit on physical activity and the motivational elements for physical activity in the Theory of Planned Behavior, *change variables* were created by calculating the difference between the mean score in T1 and T2. Thus, in addition to the individual variables at T1 and T2, the variables of change were added for separate analysis.

### 4.1 Descriptive and correlational analysis

During the exploratory data analysis, the Kolmogorov-Smirnov test results showed that the variables were not normally distributed among the variables of change. In addition, the Test of Normality results also showed that all the variables except for *grit* in T1 and T2 were not normally distributed, and histograms show the distributions were skewed to the right. This was probably due to the high overall tendency to exercise in the Finnish adolescent sample. However, after comparing the correlational data between the Spearman's and Pearson's correlations, it could be concluded that the results are similar enough to use the Pearson's correlations.

The following tables show the results of basic descriptive and correlational statistics for the variables in T1 and T2, as well the change between the two times (Table 1, 2, and 3, consecutively). According to the T-tests, there were no gender differences.

**Table 1.** Means, standard deviations, and correlations among variables at Time 1. (N = 277)

	<i>M</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>	1	2	3	4	5	6	7
1.Attitude	5,92	1,19	1,00	7,00	1						
2.SN	4,79	1,38	1,00	7,00	,31**	1					
3.PBC	6,01	1,00	1,50	7,00	,49**	,31**	1				
4.Intention	5,34	1,54	1,00	7,00	,54**	,40**	,60**	1			
5.PA	4,50	1,24	1,00	6,00	,60**	,38**	,51**	,78**	1		
6.Grit	2,83	,49	1,58	4,00	,33**	,16**	,38**	,44**	,46**	1	
7.Habit	5,08	1,49	1,00	7,00	,50**	,29**	,45**	,63**	,67**	,44**	1

*Note.* SN = subjective norms, PBC = perceived behavioral control, and PA = physical activity. \*\* =  $p < .01$  (2-tailed).

**Table 2.** Means, standard deviations, and correlations among variables at Time 2. (N = 277)

	<i>M</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>	1	2	3	4	5	6	7
1.Attitude	5,92	1,19	1,00	7,00	1						
2.SN	4,75	1,38	1,00	7,00	,38**	1					
3.PBC	5,97	1,00	1,00	7,00	,59**	,38**	1				
4.Intention	5,41	1,54	1,00	7,00	,72**	,49**	,62**	1			
5.PA	4,51	1,24	1,00	6,00	,63**	,47**	,48**	,80**	1		
6.Grit	2,84	,49	1,58	4,00	,39**	,23**	,34**	,52**	,52**	1	
7.Habit	5,17	1,49	1,00	7,00	,57**	,38**	,53**	,67**	,64**	,46**	1

*Note.* SN = subjective norms, PBC = perceived behavioral control, and PA = physical activity. \*\* =  $p < .01$  (2-tailed).

**Table 3.** Means, standard deviations, and correlations among change variables. (N = 277)

	<i>M</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>	1	2	3	4	5	6	7
1.Attitude	,00	1,19	-6,00	6,00	1						
2.SN	-,04	1,38	-6,00	4,50	,09	1					
3.PBC	-,04	1,00	-6,00	3,00	,16**	,28**	1				
4.Intention	,07	1,54	-3,00	3,00	,26**	,16**	,24**	1			
5.PA	,02	1,24	-3,00	3,00	,19**	,10	,11	,28**	1		
6.Grit	,00	,49	-,75	1,46	-,03	-,04	,08	,06	,13*	1	
7.Habit	,09	1,49	-2,00	3,00	,17**	,16**	,14*	,26**	,20**	,08	1

*Note.* SN = subjective norms, PBC = perceived behavioral control, and PA = physical activity. \*\* =  $p < .01$  (2-tailed) and \* =  $p < .05$  (2-tailed).

The previous tables (1, 2, and 3) show the means, standard deviations, range (minimum and maximum), and correlations for variables in Time 1 and 2, and change variables. In all three graphs, *habit* has high correlations with *physical activity* (T1  $r = ,67$  and T2  $r = ,64$ ), as well as *intention* (T1  $r = ,63$ , T2  $r = ,67$ ). This is reflected in the medium level of correlations found between change variables as well ( $r = ,20$  and  $,26$ ).

The tables also show similar results to previous studies in that *attitude* and *perceived behavioral control* were more strongly correlated with *physical activity* than *subjective norms*.

The tables additionally demonstrate that *grit* has a recognizable correlation with physical activity. In Time 1, the correlation coefficient is ,46, and in Time2, ,53. Relationship is also reflected in the change variables, but a small correlation ( $r = ,13$ ,  $p < .05$ ). The relationship between *grit*, *habit*, and *physical activity* will be examined further with the ANOVAs below.

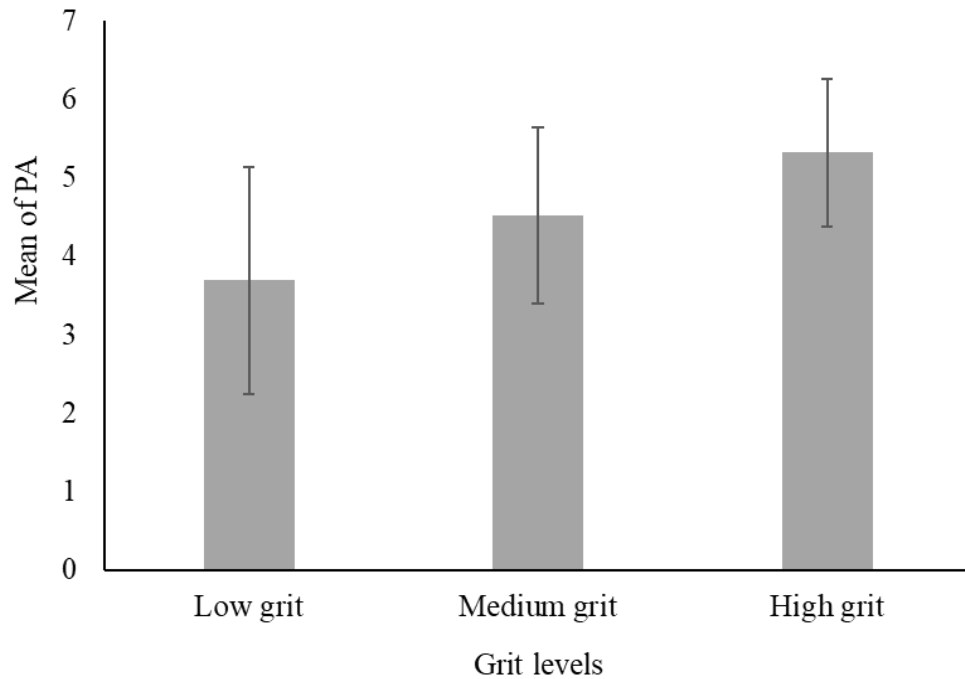
### **ANOVAs – comparing groups**

After analyzing the descriptive statistics, the sample was divided into low, medium, and high groups by calculating with two standard deviation points from the median (median  $\pm$  SD). With low, medium, and high groups in *grit* and *habit*, one-way ANOVA was conducted to see the difference of physical activity between the three groups of the two variables. In addition, Univariate ANOVA was conducted to see the combined effects of both *grit* and *habit* on *physical activity*.

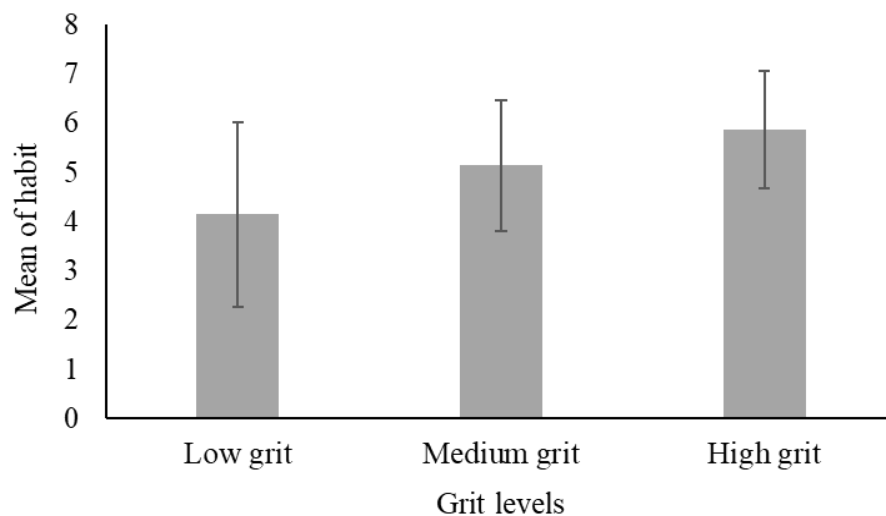
#### *Time 1 – One-way ANOVA for grit and habit*

In Time 1, there was a statistical difference between the three (low, medium, and high) groups of *grit* according to one-way ANOVA ( $F(2, 274) = 19,97$ ,  $p = 0,00$  for *physical activity*, and  $F(2, 274) = 15,18$ ,  $p = 0,00$  for *habit*). As the data did not meet the homogeneity of variances assumption ( $p = 0,00$  for *physical activity*, and  $p = 0,00$  for *habit*), the Games-Howell post hoc test was done.

The post hoc test revealed two things. Firstly, it showed that *physical activity* score was statistically significantly higher in the medium *grit* group ( $4,52 \pm 1,13$ ,  $p = 0,00$ ,  $N = 197$ ) and high *grit* group ( $5,32 \pm 0,94$ ,  $p = 0,00$ ,  $N = 37$ ) compared to low *grit* group ( $3,69 \pm 1,44$ ,  $N = 43$ ). There was also statistical difference between the medium and high *grit* group ( $p = 0,00$ ) of the *physical activity* score. Secondly, the post hoc test indicated that *habit* score was also statistically significantly higher in medium *grit* group ( $5,14 \pm 1,33$ ,  $p = 0,01$ ) and high *grit* group ( $5,87 \pm 1,20$ ,  $p = 0,00$ ) compared to the low *grit* group ( $4,15 \pm 1,88$ ). There was statistical difference between the medium and high *grit* group for *habit* as well ( $p = 0,00$ ). The following two figures demonstrate visually the score of *physical activity* and *habit* according to the three levels of *grit*.



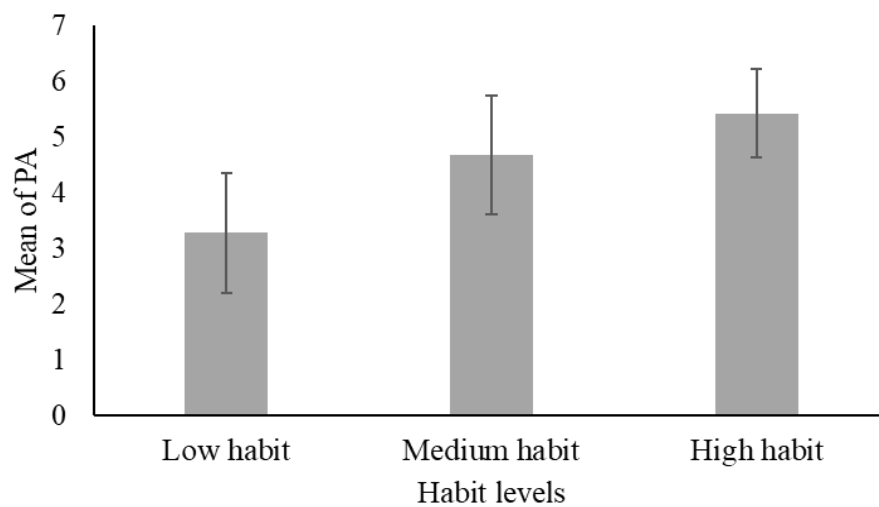
**Figure 1.** Means of *physical activity* for low, medium, and high *grit* students at T1.



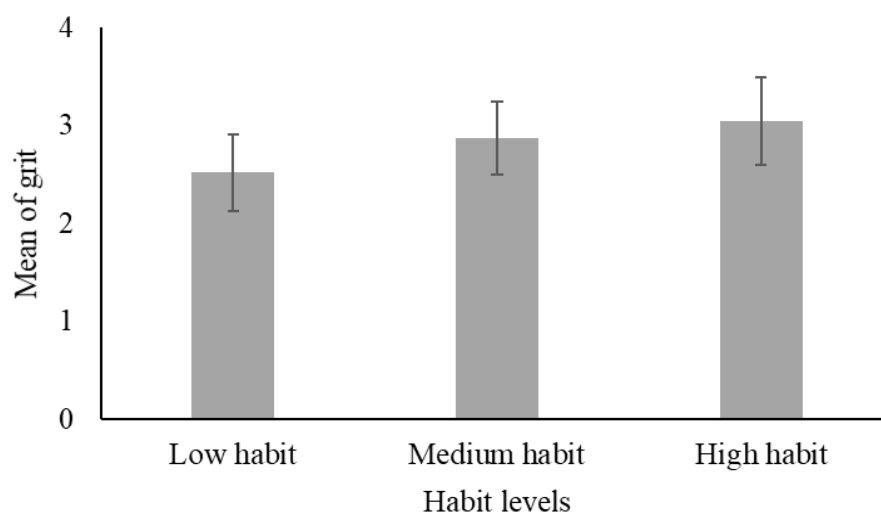
**Figure 2.** Means of *habit* for low, medium, and high *grit* students at T1.

Similarly, another one-way ANOVA test indicated a statistically significant difference between three (low, medium, and high) groups of *habit* ( $F(2, 274) = 64,14, p = 0,00$  for *physical activity* and  $F(2, 274) = 26,87, p = 0,00$  for *grit*). The data for *physical activity* did not meet the homogeneity of variance assumption ( $p = 0,00$ ), while for *grit*, it could be concluded that the variances were equal ( $p = 0,15$ ), thus it was necessary to use different post hoc tests for each variable. Post hoc comparisons, using

Games-Howell for *physical activity* and Tukey HSD for *grit*, indicated that *physical activity* scores and *grit* scores were higher with the medium *habit* group ( $4,68 \pm 1,06$ ,  $p = 0,00$  for *physical activity*;  $2,87 \pm 0,37$ ,  $p = 0,00$  for *grit*,  $N = 172$ ) and high *habit* group ( $5,43 \pm 0,80$ ,  $p = 0,00$  for *physical activity*;  $3,05 \pm 0,45$ ,  $p = 0,00$  for *grit*,  $N = 45$ ) compared to the low *habit* group ( $3,28 \pm 1,08$  for *physical activity*;  $2,52 \pm 0,39$  for *grit*,  $N = 60$ ). There were also differences between medium and high *habit* groups ( $p = 0,00$  for *physical activity*;  $p = 0,02$  for *grit*). The two figures (3 and 4) below clearly shows the differences of *physical activity* and *grit* scores between low, medium, and high *habit* groups.



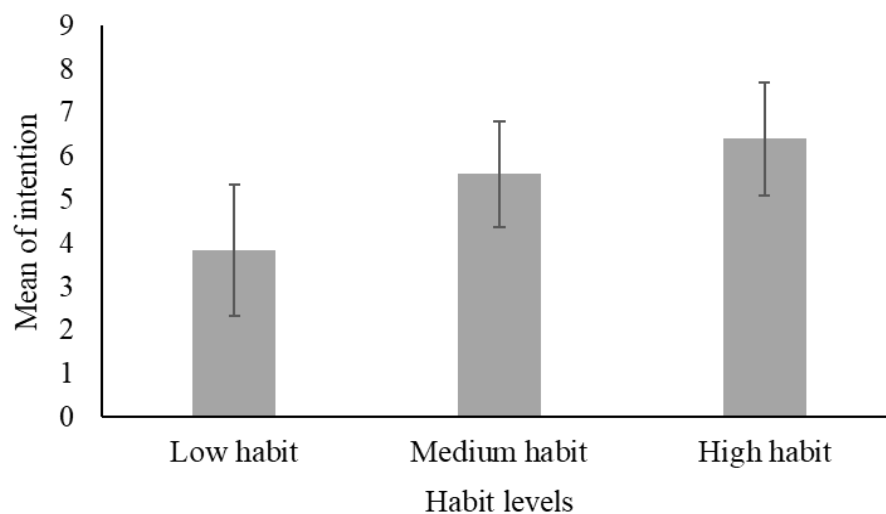
**Figure 3.** Means of *physical activity* for low, medium, and high *habit* students at T1.



**Figure 4.** Means of *grit* for low, medium, and high *habit* students at T1.



Also, ANOVA results showed that there were significant differences in *intention* between the three groups of *habit* ( $F(2, 274) = 58,15, p = 0,00$ ). The data did not meet the homogeneity of variances assumption ( $p = 0,01$ ), thus the Games-Howell post hoc test was done. Post hoc comparison tests revealed that *intention* was higher with the high *habit* group ( $6,40 \pm 1,29, p = 0,00$ ), and the medium *habit* group ( $5,59 \pm 1,22, p = 0,00$ ), compared to the low *habit* group ( $3,84 \pm 1,51, p = 0,00$ ). There were differences between high and medium *habit* groups as well ( $p = 0,00$ ). Figure 5 below shows the means of *intention* for low, medium, and high *habit* students at T1.



**Figure 5.** Means of *intention* for low, medium, and high *habit* students at T1.

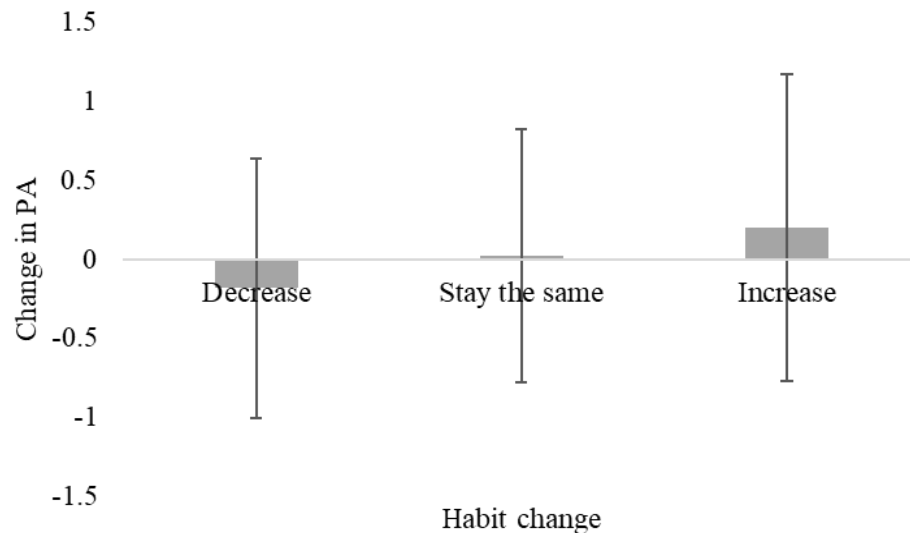
One-way ANOVA results at T2 showed identical patterns in cross-sectional results, thus it has been omitted to avoid repetition.

#### *One-way ANOVA of change variables*

Regarding the *change variables*, the three groups could be divided into those who showed decrease in a certain trait, those who stayed the same, and those who showed increase in the trait over the 5 weeks. After the distinction of the three groups, ANOVA results revealed that significant differences could be found with *change in physical activity* between the three groups for *change in habit* ( $F(2, 274) = 5,20, p = 0,01$ ). However, *change in physical activity* was not significantly different among the three groups of *grit* ( $p = 0,32$ ).

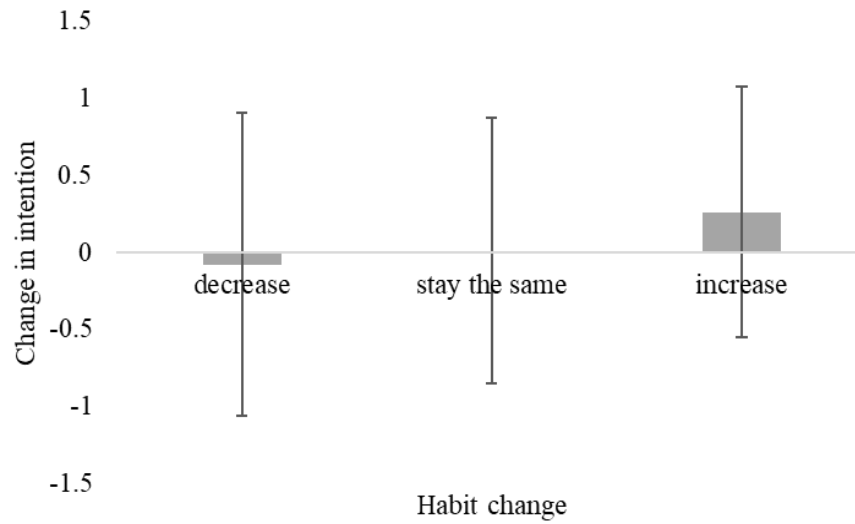
Homogeneity of variances were assumed ( $p = 0,09$ ) with *physical activity* scores, thus Tukey HSD was analyzed. The post hoc test indicated significant statistical differences

in how much the *physical activity* scores have changed among those with increased *habit* scores ( $0,20 \pm 0,97$ ,  $p = 0,00$ ,  $N = 115$ ) compared to those with decreased *habit* scores ( $-,18 \pm -,82$ ,  $N = 110$ ). However, there was no statistical difference in the change of *physical activity* scores between the groups of students whose *habit* scores stayed the same ( $N = 52$ ) and whose scores increased ( $p = 0,42$ ), or the students with decreased scores of *habit* ( $p = 0,39$ ). Figure 6 shows the change in *physical activity* according to the three different changes in *habit* scores over time.



**Figure 6.** Means of *change in physical activity* for students who reported less, same, or more *habit* score over the 5 weeks.

Another ANOVA results showed that there was a difference in *change in intention* between groups ( $F(2, 274) = 4,28$ ,  $p = 0,02$ ). Homogeneity of variances was assumed ( $p = 0,15$ ), and Tukey HSD was done. The post hoc test reveals the statistical difference between those who decreased in *habit* ( $-0,08 \pm 0,98$ ,  $p = 0,01$ ) compared to those who increased in *habit* ( $0,26 \pm 0,81$ ). The middle group ( $0,01 \pm 0,86$ ), whose *habit* stayed more or less the same, did not show any statistically significant differences between groups. Figure 7 below shows the mean *change in intention* for the three groups of different *changes in habit*.



**Figure 7.** Means of *change in intention* for students who reported less, same, or more *habit* score over the 5 weeks.

The following table summarizes the different groups made in the ANOVA results analysis, including the number of students in the separated groups, and the mean and standard deviations of different variables of each groups.

**Table 4.** Summary of the number of students in separate groups and their mean and standard deviation value from ANOVA results

<i>Groups</i>	<i>N</i>	<i>Variable</i>	<i>M</i>	<i>SD</i>
Low grit	43	Habit	4,15	1,88
		PA	3,96	1,44
Medium grit	197	Habit	5,14	1,33
		PA	4,52	1,13
High grit	37	Habit	5,87	1,20
		PA	5,32	,94
Low habit	60	Grit	2,52	0,39
		PA	3,28	1,08
		Intention	3,84	1,51
Medium habit	172	Grit	2,87	0,37
		PA	4,68	1,06
		Intention	5,59	1,22
High habit	45	Grit	3,05	0,45
		PA	5,43	,79
		Intention	6,40	1,29
Decreased grit	118	Habit change	-,03	,87
		PA change	-,06	,83
Grit stayed the same	33	Habit change	,15	,92
		PA change	,08	,79
Increased grit	126	Habit change	,18	,89
		PA change	,08	,98
Decreased habit	110	Grit change	-,03	,29
		PA change	-,18	,82
		Intention change	-,08	,98
Habit stayed the same	52	Grit change	,01	,30
		PA change	,02	,80
		Intention change	,01	,86
Increased habit	115	Grit change	,03	,30
		PA change	,20	,97
		Intention change	,26	,81
Total	227			

#### *Univariate ANOVA*

Univariate ANOVA was conducted to find out if there are any combined effects of *grit* and *habit* on *physical activity*. However, the results indicated that there were not any

combined effects of *grit* and *habit* on *physical activity* in Time 1 ( $p = 0,08$ ), Time 2 ( $p = 0,58$ ), or as change variables ( $p = 0,74$ ).

#### 4.2 Regression results

In order to see the effect of *grit* or *habit* on *physical activity* with the dynamics of the other variables in the theory of planned behavior (*attitude*, *subjective norms*, *perceived behavioral control*, and *intention*), regression analysis was conducted after the descriptive and correlational analyses. The following sections report the results of regression analyses for *grit* and *habit* on *physical activity*, first with the variable *intention*, followed by full regression analyses along with the other three constructs of the theory of planned behavior in Time 1 and 2, and as change variables to examine their longitudinal effect.

First, *grit*, *habit*, and *intention* were assumed as predictors for *physical activity*, the dependent variable. By analyzing the results, it was possible to carefully deduct the direction and order of effect of variables of *grit* and *habit* on *physical activity* with the theory of planned behavior in mind.

#### ***Grit as a predictor for physical activity along with intention***

**Table 5.** Regression results for *grit* and *intention* on *physical activity* on Time 1, 2, and as change variables.

Model	<i>R</i>	<i>R</i> <sup>2</sup>	Sig.	Independent variables	$\beta$	Sig.
Time 1	,789	,623	,000	Intention	,718	,000
				Grit	,139	,001
Time 2	,810	,656	,000	Intention	,718	,000
				Grit	,152	,000
Change variables	,298	,089	,000	Intention	,268	,000
				Grit	,114	,049

The results shown from the table above indicate that *intention* may work as a mediating variable between *grit* and *physical activity* in Times 1 and 2, as *intention*

shows a considerable amount of effect ( $\beta = ,72, p = 0,00$ ;  $\beta = ,72, p = 0,00$ , for Times 1 and 2, respectively) on *physical activity* while taking *grit* into account. The last part of table 5, which shows the change variables regression results, also demonstrates the effect of *intention* and *grit* together on *physical activity* as change variables. This means that the changes in *intention* and *grit* between Time 1 and 2 predict the change of *physical activity* between Time 1 and 2 ( $R = 0,30, p = 0,00$ ). The results indicate cross-sectional and longitudinal effects of *grit* on *physical activity* through *intention*.

### ***Habit as a predictor for physical activity with/through intention***

The following table shows the regression analysis results of *habit* on *physical activity* consecutively in Time 1, 2, and as change variables.

**Table 6.** Regression of *habit* and *intention* on *physical activity* on Time 1, 2, and as change variables.

Model	<i>R</i>	<i>R</i> <sup>2</sup>	Sig.	Independent variables	$\beta$	Sig.
Time 1	,814	,663	,000	Intention	,591	,000
				Habit	,302	,000
Time 2	,813	,661	,000	Intention	,669	,000
				Habit	,196	,000
Change variables	,305	,093	,000	Intention	,240	,000
				Habit	,136	,023

It can be inferred again that *intention* may be a mediator for *habit* to predict *physical activity* of the students, as it has higher effect size on *physical activity* than *habit* (see Table 6). Similar to the previous table of *grit*, the end of table 11, showing the change variable regression results, also demonstrates the longitudinal effect of *habit* on *physical activity* through *intention*.

### **Effect of *grit*, *habit*, and the variables of theory of planned behavior on *physical activity***

The following tables of regression results show how the variables in the theory of planned behavior, *grit*, and *habit* effect and predict *physical activity* in Time 1 and 2, as well as in *change variables*.

**Table 7.** Regression results of different sets of independent variables on *physical activity* in Time 1.

Model	<i>R</i>	<i>R</i> <sup>2</sup>	Sig.	Independent variables	$\beta$	Sig.
1	,809	,654	,000	Attitude	,244	,000
				Subjective norm	,046	,158
				Perceived behavioral control	-,009	,851
				Intention	,630	,000
2	,816	,666	,000	Attitude	,234	,000
				Subjective norm	,061	,117
				Perceived behavioral control	-,028	,544
				Grit	,120	,003
				Intention	,592	,000
3	,831	,690	,000	Attitude	,191	,000
				Subjective norm	,051	,168
				Perceived behavioral control	-,024	,583
				Habit	,250	,000
				Intention	,514	,000
4	,833	,695	,000	Attitude	,188	,000
				Subjective norm	,055	,137
				Perceived behavioral control	-,036	,416
				Habit	,231	,000
				Grit	,080	,041
				Intention	,497	,000

*Note.* Model 1 = TPB variables, Model 2 = TPB and *grit* variables, Model 3 = TPB and *habit* variables, Model 4 = TPB, *grit*, and *habit* variables.



**Table 8.** Regression results of different sets of independent variables on *physical activity* in Time 2.

Model	<i>R</i>	<i>R</i> <sup>2</sup>	Sig.	Independent variables	$\beta$	Sig.
1	,809	,654	,000	Attitude	,112	,038
				Subjective norm	,105	,011
				Perceived behavioral control	-,055	,245
				Intention	,702	,000
2	,819	,670	,000	Attitude	,109	,039
				Subjective norm	,110	,007
				Perceived behavioral control	-,058	,212
				Grit	,150	,000
				Intention	,625	,000
3	,820	,673	,000	Attitude	,084	,110
				Subjective norm	,096	,018
				Perceived behavioral control	-,083	,078
				Habit	,190	,000
				Intention	,616	,000
4	,827	,684	,000	Attitude	,086	,100
				Subjective norm	,101	,011
				Perceived behavioral control	-,081	,079
				Habit	,163	,001
				Grit	,124	,003
				Intention	,564	,000

*Note.* Model 1 = TPB variables, Model 2 = TPB and *grit* variables, Model 3 = TPB and *habit* variables, Model 4 = TPB, *grit*, and *habit* variables.

**Table 9.** Regression results of different sets of independent variables on *change in physical activity*.

Model	<i>R</i>	<i>R</i> <sup>2</sup>	Sig.	Independent variables	<i>β</i>	Sig.
1	,305	,093	,000	Attitude	,112	,043
				Subjective norm	,042	,486
				Perceived behavioral control	,018	,771
				Intention	,232	,000
2	,329	,108	,000	Attitude	,130	,031
				Subjective norm	,051	,398
				Perceived behavioral control	,006	,921
				Grit	,123	,035
				Intention	,224	,000
3	,326	,106	,000	Attitude	,111	,065
				Subjective norm	,030	,617
				Perceived behavioral control	,012	,840
				Habit	,120	,048
				Intention	,207	,001
4	,345	,119	,000	Attitude	,119	,048
				Subjective norm	,039	,514
				Perceived behavioral control	,002	,976
				Habit	,110	,068
				Grit	,114	,049
				Intention	,201	,001

*Note.* Model 1 = TPB variables, Model 2 = TPB and *grit* variables, Model 3 = TPB and *habit* variables, Model 4 = TPB, *grit*, and *habit* variables.

It can be seen from Table 7 that in Time 1, *attitude*, *grit*, *habit*, and *intention* have significantly influenced *physical activity* compared to other variables. *Intention*, especially, seemed to have the largest effect size ( $\beta$ ) out of the group of variables, which can be interpreted as *intention* being as a mediator between *physical activity* and the other variables.

According to Table 8, it seems that *subjective norms*, *grit*, *habit*, and *intention* had significant effect on *physical activity* in Time 2. Similar to Time 1, *intention* was the predictor with the largest effect size ( $\beta$ ) among all the other variables, and the previous inference of *intention* being the mediating variable can be made again with these regression results.

The table of regression results on the variables of change (Table 9) shows that *attitude*, *grit*, and *habit* predict somewhat significantly. However, it is demonstrated that *intention* is the most direct and influential variable that predicts *physical activity* longitudinally.

To summarize the three tables of regression results, *grit* and *habit* seemed to be statistically significant predictors of *physical activity*, sometimes more than or similar to the three constructs of the theory of planned behavior, which are *attitude*, *subjective norms*, and *perceived behavioral control*. More importantly, however, *intention* was shown to be the most direct predictor (and thus a mediating variable for other independent variables) of *physical activity*, cross-sectionally and longitudinally.

## 5 DISCUSSION

The aim of this study was to examine the relationship between grit, habit, the motivational variables of the theory of planned behaviour (TPB) and physical activity (PA). Furthermore, it purports to explore grit and habit as predicting variables for PA. The three hypotheses in the beginning of the study stood positively. Correlational results indicate that grit and habit are correlated cross-sectionally and somewhat longitudinally to the constructs of TPB and PA (H1). Furthermore, ANOVA results indicate that students with higher grit or habit scores are more physically active (H2). Finally, regression results indicate that grit and habit change predict change in PA through the intention to be physically active (H3). As the results supported the TPB (Ajzen, 1985) where attitude, subjective norms, perceived behavioural control predict PA mediated by intention, the analyses of the descriptive, correlational, and regression results also corroborates the previous literature (Chatzisarantis & Hagger, 2007; De Bruijn, 2011; González-Cutre et al., 2014; Hagger et al., 2002; 2003; 2005; 2006; 2012; Hamilton et al., 2017; Wallhead et al., 2010) that intention is ultimately the strongest predictor of PA. This was followed by habit, attitude, and grit. Attitude was the strongest predictor of intention, followed by perceived behavioural control, with subjective norms as the weakest predictor. In the study, however, attitude also seemed to correlate longitudinally with physical activity. Several reasons for this finding, such as age (adolescents) and culture (Finnish students), can be discussed.

It is important to note, however, that results indicated habit to be the second strongest predictor of PA. Habit is indeed not only a construct measuring past behaviour, but the measure of habit strength, characterized by its goal-directedness and automaticity. Bearing this in mind, the results validate that habit, or automaticity, is an important variable that determines future PA. From the regression models of both times 1 and 2, as well as of change variables, it can be seen that adding the habit variable into the models increases the effect size on PA.

While previous studies only focused on grit or habit respectively with TPB variables in studying their effect on physical activity behaviour, this study was able to fill the gap and produce new information on both grit and habit as variables that influence physical behaviour, as all three hypotheses stand. Grit and habit are both quite interesting variables in this study. While they seem to independently predict PA with preliminary analysis, the regression analysis with other variables such as intention can be interpreted quite differently. Although it could be concluded that grit and habit effect PA mediated

by intention, there seems to be another aspect missing that should be taken account, which may be self-control.

This idea arose with reading literature on self-control related to grit and habit. Galla and Duckworth (2015) suggests that beneficial habits are important in associating self-control with positive outcomes in life, where higher self-control leads to beneficial habits with positive results. They also indicate that it is possible for beneficial habits to foster self-control, predicting positive life outcomes. Not only with habit, but also with grit, I could find a crossing-point with self-control. Duckworth and Gross (2014) discuss self-control, which they define as “the capacity to regulate attention, emotion, and behavior in the presence of temptation,” as a key determinant for success along with grit. Although grit and self-control both require an individual to prioritize and align intentional actions, the authors claim that the two operate distinctively over a different time scope.

This may be true, as Smallets, Townsend, and Stephens (2016) also point out that when people do not have control over the task, grit is not associated with its engagement or performance. What could be derived from the literature to refer to this study is that grit and habit implies building consistency. Self-control could be the fruits of such consistent behavior over time, which in turn may lead to successful performance in the sport and exercise context. Therefore, although there could be some vague reasons to how the associations work that could be clarified, grit and habit seem to be important predictors to physical activity of adolescents, and they are suitable targets for intervention.

### **Limitations and further studies**

There are inevitably some limitations to this study. One is the fact that self-report questionnaires were used for data collection, which may result in recall bias (Prince et al., 2008). For future studies, and specifically for the following steps of the larger research which this study is a part of, an actual measurement of PA behavior would be necessary for the development of an intervention program.

Another limitation that should be considered is the skewed distribution of the data. As the distribution of the data is quite influential, appropriate tests and measures had to be taken during the analysis process with SPSS. All the cross-sectional data with the exception of grit variable were generally skewed to the right, indicating that the students

had high level of PA and PA-related traits. This may be perchance due to the cultural background, where Finnish adolescents are exposed to a physically-active environment with smaller differences in social classes and with the government supporting child and youth sports financially (as discussed in Kantomaa, Tammelin, Näyhä & Taanila, 2007). For further studies, one can extend the study to different cultures and contexts (i.e. different samples of diverse sports or distinctive ages, or an intercultural study between different nation samples), so that the results could be analyzed for global validity.

Further limitation to discuss is the duration of this study. One can debate how “longitudinal” a study can be, in which this study started out proposing that 4 weeks indeed shows longitudinal results. However, the variables in the TPB, as well as grit and habit are relatively quite stable throughout time, and the question had to be asked, “Are there enough changes between week 1 and 5 to analyze any longitudinal effects?” Unfortunately, the means of change variables range from -0.04 to 0.09. Although some participants may have dramatic changes (which could be observed by looking at the minimum and maximum of change variables in table 3), the change variables stayed very close to 0. Especially with the grit variable, the mean was 0.00, while even the standard deviation was a mere 0.49. Four weeks may not be enough time to observe significant changes over time for such consistent individual traits such as grit and habit.

For future longitudinal research, it would be recommended to conduct the study for a longer period of time. For deeper analysis into the relationship between variables, a mixed-method approach, encompassing both quantitative and qualitative analysis, is also recommended to bring up more interesting and potential important points of discussion to the research. Adding a qualitative study may allow for a more holistic view on the motivation to exercise among adolescents. Also, as Verplanken and Aarts (1999) mentioned, it would be important to focus on the research on habit (with grit and other variables), not as statistical correlations between behavior change over time, but as a characteristic mindset to explore the underlying cue-response link of an individual. A separate analysis of the two different facets of grit could be done in future research in response to the comparatively low Cronbach’s alpha of the Grit Scale ( $\alpha = .72$  and  $.76$ , each at Time 1 and 2). As the review Credé and his colleagues (2017) suggests, the perseverance of effort facet may have stronger validity than the consistency of interest facet. Future research could focus separately on these two different facets of grit.

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## APPENDICES

## Appendix A – Questionnaire in English

*Participating in active sports and/or vigorous physical activities during my **leisure time** **in the next 5 weeks** is...* (Circle the number that best describes your answer and circle **ONE** number on **EACH** line).

Unenjoyable	1	2	3	4	5	6	7	Enjoyable
Bad	1	2	3	4	5	6	7	Good
Useless	1	2	3	4	5	6	7	Useful

*I intend to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks.* (Circle the number that best describes your answer)

Strongly disagree	1	2	3	4	5	6	7	Strongly agree
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I plan to do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks. (Tick the box that best describes your answer)

Strongly disagree	1	2	3	4	5	6	7	Strongly agree
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*How much control do you have over doing active sports and/or vigorous physical activities in my leisure time in the next 5 weeks?* (Circle the number that best describes your answer)

Very little control	1	2	3	4	5	6	7	Comple control
---------------------	---	---	---	---	---	---	---	----------------

*I am confident I could do active sports and/or vigorous physical activities during my leisure time in the next 5 weeks.* (Circle the number that best describes your answer)

Strongly disagree	1	2	3	4	5	6	7	Strongly agree
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Most people who are important to me think I should do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks. (Circle the number that best describes your answer)

Strongly disagree    1    2    3    4    5    6    7    Strongly agree

*Most people important to me put pressure on me to do active sports and/or vigorous physical activities during my leisure time for the next 5 weeks. (Circle the number that best describes your answer)*

Strongly disagree    1    2    3    4    5    6    7    Strongly agree

**In the course of the past five weeks**, how often on average, have you participated in vigorous physical activities **during your leisure time** for at least 20 minutes at a time? (Circle the number that best describes your answer)

Not at all	Once or twice	A few times	Several times	Most of the time	Most days per week
1	2	3	4	5	6

How frequently did you have you participated in vigorous physical activities during your leisure time in the course of the past five weeks for at least 20 minutes at a time? (Circle the number that best describes your answer)

Never	Once or twice	A few times	Several times	Most of the time	All of the time
1	2	3	4	5	6

This section of the survey asks you a little about yourself. Please indicate how you feel about physical activity below by circling a number on each of the scales below:

1. Physical activity is something I do automatically.

Completely uncertain	1	2	3	4	5	6	7	Completely certain
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2. Physical activity is something I do I do without having to consciously remember.

Completely uncertain	1	2	3	4	5	6	7	Completely certain
-------------------------	---	---	---	---	---	---	---	-----------------------

3. Physical activity is something I do without thinking.

Completely uncertain    1    2    3    4    5    6    7    Completely certain

4. Physical activity is something I start doing before I realize I'm doing it.

Completely uncertain    1    2    3    4    5    6    7    Completely certain

Please indicate (by circling a number) how much each of the following statements reflects **what you are like most of the time**. Everyone feels differently about this so there are no right or wrong answers. Please answer **all the questions**.

	Not like me at all	Not much like me	Mostly like me	Very much like me
I have overcome setbacks to conquer an important challenge.	1	2	3	4
New ideas and projects sometimes distract me from previous ones.	1	2	3	4
My interests change from year to year.	1	2	3	4
Setbacks don't discourage me.	1	2	3	4
I have been obsessed with a certain idea or project for a short time but later lost interest.	1	2	3	4
I am a hard worker.	1	2	3	4
I often set a goal but later choose to pursue a different one.	1	2	3	4
I have difficulty maintaining my focus on projects that take more than a few months to complete.	1	2	3	4
I finish whatever I begin.	1	2	3	4
I have achieved a goal that took years of work.	1	2	3	4
I become interested in new pursuits every few	1	2	3	4



months.

I am diligent.	1	2	3	4
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### Thank you for your help

#### Appendix B – Questionnaire in Finnish

Aktiiviseen urheiluun ja/tai vauhdikkaaseen liikunnan harrastamiseen osallistuminen

**vapaa-ajallani seuraavien 5 viikon aikana** on...(ympyröi numero, joka parhaiten

kuvaa sinua ja ympyröi jokaiselta riviltä vain yksi numero)

Epämiellyttävää	1	2	3	4	5	6	7	Miellyttävää
Pahaksi	1	2	3	4	5	6	7	Hyväksi
Hyödytöntä	1	2	3	4	5	6	7	Hyödyllistä

Aion urheilla ja/tai liikkua vauhdikkaasti vapaa-ajallani seuraavien 5 viikon aikana

(ympyröi numero, joka parhaiten kuvaa)

Vahvasti eri mieltä	1	2	3	4	5	6	7	Vahvasti samaa mieltä
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Suunnittelen urheilevani ja/tai liikkuvani vauhdikkaasti vapaa-ajallani seuraavien 5

viikon aikana (ympyröi numero, joka parhaiten kuvaa)

Vahvasti eri mieltä	1	2	3	4	5	6	7	Vahvasti samaa mieltä
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Kuinka paljon pystyt vaikuttamaan siihen, että urheilet ja/tai liikut vauhdikkaasti vapaa-ajallasi seuraavien 5 viikon aikana (ympyröi numero, joka parhaiten kuvaa)

Pystyn vaikuttamaan hyvin vähän	1	2	3	4	5	6	7	Pystyn vaikuttamaan täysin
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Uskon, että pystyisin urheilemaan ja/tai liikkumaan vauhdikkaasti vapaa-ajallani seuraavien 5 viikon aikana (ympyröi numero, joka parhaiten kuvaa)

Vahvasti eri	1	2	3	4	5	6	7	Vahvasti
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mieltä samaa  
mieltä

Useimmat minulle tärkeät ihmiset haluavat, että urheilisin ja/tai liikkuisin vauhdikkaasti vapaa-ajallani seuraavien 5 viikon aikana (ympyröi numero, joka parhaiten kuvaa)

Vahvasti eri	1	2	3	4	5	6	7	Vahvasti
mieltä								samaa mieltä

Useimmat minulle tärkeät ihmiset odottavat minun urheilevan tai liikkuvan vauhdikkaasti vapaa-ajallani seuraavien 5 viikon aikana (ympyröi numero, joka parhaiten kuvaa)

Vahvasti eri	1	2	3	4	5	6	7	Vahvasti
mieltä								samaa mieltä

**Viimeisen 5 viikon aikana**, kuinka usein keskimäärin olet osallistunut vauhdikkaisiin fyysisiin aktiviteetteihin **vapaa-ajallasi** vähintään 20 minuuttia kerrallaan? (ympyröi numero, joka parhaiten kuvaa)

En ollenkaan	Kerran tai kahdesti	Muutaman kerran	Useita kertoja	Useimmiten	Useimpina päivinä viikossa
1	2	3	4	5	6

Kuinka säännöllisesti olet osallistunut vauhdikkaisiin fyysisiin aktiviteetteihin vapaa-ajallasi **viimeisen 5 viikon aikana** vähintään 20 minuuttia kerrallaan? (ympyröi numero, joka parhaiten kuvaa)

En ollenkaan	Kerran tai kahdesti	Muutaman kerran	Useita kertoja	Useimmiten	Joka kerta
1	2	3	4	5	6

Haluaisimme tietää, mitä mieltä olet liikunnan harrastamisesta. Ympyröi paras vaihtoehto kunkin kysymyksen kohdalla.

Liikunta on jotain, jota harrastan automaattisesti

Ei pidä	1	2	3	4	5	6	7	Pitää täysin paikkaansa
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Minun ei tarvitse tietoisesti muistaa harrastaa liikuntaa – harrastan sitä joka tapauksessa

Ei pidä	1	2	3	4	5	6	7	Pitää täysin paikkaansa
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Harrastan liikuntaa miettimättä asiaa sen tarkemmin

Ei pidä	1	2	3	4	5	6	7	Pitää täysin paikkaansa
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Aloitan usein liikunnan harrastamisen ennen kuin edes tajuan, että minähän tässä harrastan liikuntaa

Ei pidä	1	2	3	4	5	6	7	Pitää täysin paikkaansa
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Valitse vaihtoehto (ympyröimällä yksi numero), joka kuvastaa sitä, **millainen sinä olet useimmiten**. Jokainen ajattelee itsestään eri tavoin, joten oikeita ja vääriä vastauksia ei ole. Vastaathan **kaikkiin kysymyksiin** ja ympyröi vain yksi vaihtoehto.

	Ei kuvaa minua ollenkaan	Ei kuvaa minua kovin hyvin	Kuvaa minua useimmiten	Kuvaa minua todella hyvin
Minun täytyy voittaa vastoinkäymiset saavuttaakseni tärkeän tavoitteen	1	2	3	4
Uudet ideat ja tehtävät häiritsevät joskus aikaisempien tehtävieni toteuttamista	1	2	3	4
Kiinnostuksen kohteeni muuttuvat usein	1	2	3	4
Vastoinkäymiset eivät lannista minua	1	2	3	4
Olen ollut erittäin kiinnostunut jostain asiasta hetken, mutta kadottanut kiinnostukseni nopeasti	1	2	3	4
Olen ahkera	1	2	3	4

Asetan usein tavoitteen, mutta myöhemmin päätänkin pyrkiä toista tavoitetta kohden	1	2	3	4
Minun on vaikeaa pysyä keskittyneenä projekteissa, joiden toteuttaminen vaatii enemmän kuin muutaman kuukauden	1	2	3	4
Saan valmiiksi sen minkä aloitan	1	2	3	4
Olen saavuttanut tavoitteen, joka vaatii vuosien työn	1	2	3	4
Kiinnostun uusista tavoitteista muutaman kuukauden välein	1	2	3	4
Olen kova tekemään töitä	1	2	3	4

### KIITOKSET AVUSTASI

#### Appendix C – Alpha ( $\alpha$ ) of Grit Scale items

Time	Time 1	Time 2
Items	Cronbach's $\alpha$ if item deleted	Cronbach's $\alpha$ if item deleted
Grit 1	,74	,77
Grit 2	,71	,75
Grit 3	,69	,73
Grit 4	,71	,75
Grit 5	,67	,73
Grit 6	,69	,74
Grit 7	,69	,74
Grit 8	,68	,72
Grit 9	,68	,74
Grit 10	,71	,76
Grit 11	,75	,77
Grit 12	,70	,74
Total $\alpha$	,72	,76

#### Appendix D – Alpha ( $\alpha$ ) of Self-Report Behavioural Automaticity Index items

Time	Time 1	Time 2
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Items	Cronbach's $\alpha$ if item deleted	Cronbach's $\alpha$ if item deleted
Habit 1	,89	,89
Habit 2	,87	,86
Habit 3	,86	,87
Habit 4	,92	90
Total $\alpha$	,91	,91