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Mechanisms in Self-Determined Exercise Motivation: Effects of a Theory Informed Pilot Intervention

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Abstract The purpose was to examine the effects of an exercise pilot intervention informed by Self-determination theory. The 64 participants were randomized into experimental and control group. The main questions were whether the intervention would influence (a) exercise level, (b) motivation quality, and (c) autonomy and competence need satisfaction. We also examined the indirect effects of self-determined motivation on exercise. Significant intervention effects were found regarding exercise level and motivation quality. Also, intervention effect on exercise was found to be mediated by motivation quality and identified regulation. The results provide interesting information about the underlying mechanisms involved in exercise behaviour change.

Keywords Exercise · Intervention · Motivation · Self-determination

Although regular physical activity (PA) and exercise according to the World Health Organization (WHO 2013) are related to reduced risk of both physical and psychological health issues like diabetes, obesity, cardiovascular diseases, depression and quality of life almost half of the adult western population are considered insufficiently physically active to gain these health benefits (WHO 2011). There is therefore a strong need for adequately designed and well-delivered interventions that can increase PA and exercise (Biddle et al. 2012). Theory-based interventions enable researchers to identify the potential mediators of change (Rhodes and Pfaeffli 2010), and are more likely to successfully change behavior. PA and exercise behavior have been suggested to be multifaceted behaviors that are difficult to cover with just one theory (Bauman et al. 2002) and polytheoretical approaches are advocated (Baranowski et al. 1998). The present study will therefore address an intervention based on four different theoretical perspectives and methods.

Promoting adherence is a challenging issue when supporting regular PA and exercise (Portnoy et al. 2008), which in turn highlights the need to understand motivational processes involved in these behaviors (Teixeira et al. 2012). Motivation may be defined as "the internal and/or external forces that produce the initiation, direction, intensity, and persistence of behaviour" (Vallerand 2004, p. 428). A growing body of evidence supports the application of self-determination theory (Deci and Ryan 1985; Deci and Ryan 2000; Ryan and Deci 2002) in exercise and PA promotion (Fortier et al. 2012; Teixeira et al. 2012). Recent research has supported the combination of self-determination theory with relapse prevention model (RPM; Gustafson et al. 2011), and reviews have demonstrated PA intervention programs containing goal setting and relapse-prevention strategies (Kahn et al. 2002) to be useful and effective. Also, a natural fit has been suggested between the method motivational interviewing (MI) and the theoretical frame of self-determination theory (Deci and Ryan 2012; Markland et al. 2005; Vansteenkiste and Sheldon 2006) and that MI can

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complement self-determination theory with guidelines in terms of practical implications and methods (Patrick and Williams 2012). Moreover, self-determination theory has also been used in combination with cognitive behavioral therapy (CBT) methods (Khazaal et al. 2008). CBT provides a useful methodological platform for the implementation of various active ingredients/contents (e.g. self-determination theory based strategies) in interventions, including for example goal setting (Linton and Flink 2011), psycho-education (Lukens and Mc Farlane 2004), behavior chain analysis and rationale (Sudak 2011).

The relationship between self-determination theory -related concepts and behavior has been described in a process model proposed by Williams et al. (2006). The proposed mechanisms of the specific motivational sequence have been supported in several studies (Teixeira et al. 2012; Wilson and Rodgers 2004; (Weman-Josefsson et al. 2015) as well as in interventions (Edmunds et al. 2007; Edmunds et al. 2008; Fortier et al. 2012). The process model demonstrates the self-determination theory motivational sequence by describing a hypothesized causal mechanism behind sustainable health behavior change and psychological well-being (Fortier et al. 2012). It is postulated that if an intervention increases psychological need satisfaction, self-determined motivation will increase, which in turn will predict the final progression into positive behavioral and psychological outcomes. According to self-determination theory, self-determined motivation has a positive impact on health-related behavior (Deci and Ryan 2000), a notion with substantial support (Pingree et al. 2010; Silva et al. 2010; Williams et al. 2006) also in physical activity and exercise interventions studying indirect effects of self-determination theory concepts and behavior (Fortier et al. 2012). Self-determination theory is a multidimensional theory emphasizing the social context and its ability to facilitate or thwart optimal motivation, as well as the extent to which behaviors are generally either self-determined or controlled in nature (i.e., motivation quality). In the organismic integration (OIT) sub-theory of self-determination theory (Deci and Ryan 2000), motivation quality is described on a continuum, with amotivation (non-regulation) and intrinsic motivation (self-determined regulation) at the ends and four types of extrinsic motivation (controlled regulations) in between, representing increasing degrees of self-determination (i.e., external, introjected, identified, and integrated regulation).

According to another sub-theory of self-determination theory, basic needs theory (BNT), self-determined motivation is based on the satisfaction of three basic psychological needs: competence, relatedness and autonomy (Ryan and Deci 2002). The need for competence reflects feeling effective when interacting with other people and obtaining desired outcomes, the need for relatedness involves the need to feel connected to other people, to be part of a social context, while the need for autonomy contains feelings of volition and choice, to be the agent of our own actions (Deci and Ryan 2000). According to self-determination theory, people seek out need-supportive settings (e.g., objectives and relations), and self-determined motivation and psychological well-being will be promoted when the three needs are satisfied. This means that these two sub-theories are closely related, with BNT used as a map of how self-determined regulations in motivation develop and OIT explaining how externally regulated behaviors can be converted into self-determined beliefs in order to satisfy basic needs (Hagger and Chatzisarantis 2008). Therefore, a person's motivation to any activity will depend on the degree of need satisfaction when doing it. Given that the psychological needs are reachable, humans will have a natural tendency to carry out stimulating, vitalizing activities and sustain health supporting behaviors (Deci and Ryan 2000).

In self-determination theory, the term internalization describes the process whereby motivational regulation becomes more self-determined; and this process depends on the degree to which the social context supports or thwarts the satisfaction of the basic psychological needs (Deci and Ryan 2000; Ryan and Deci 2002). Practical implications for internalization promotion include utilizing an interpersonal style providing autonomy support, structure and involvement (Ntoumanis 2012; Sheldon et al. 2003). Autonomy support concerns a practitioner's actions and communication aiming to facilitate a person's locus of causality, volition and perceived options (Reeve et al. 2003) and involves an autonomy, competence and relatedness need satisfaction promoting environment, to facilitate internalization and minimize control and pressure (Sheldon et al. 2003). In short, this includes providing a meaningful rationale, using non-controlling language, acknowledging negative feelings, offering choice and encouraging inner motivational resources (Su and Reeve 2010; Fortier et al. 2011).

In a brief overview of the supporting theoretical frameworks used here, MI is a practical method defined as a "*collaborative*, *person-centred form of guiding to elicit and strengthen motivation for change*" (Miller and Rollnick 2009, *p.* 137) with the purpose to alter a given behaviour, mainly by exploring and solving ambivalence (Miller and Rollnick 2002). MI practice consists of four basic principles: a) expressing empathy, b) developing discrepancy, c) rolling with resistance, and d) supporting self-efficacy (Miller and Rollnick 2002). The support for MI in promoting health behaviour change is emerging (Lundahl et al. 2010) also in the field of PA and exercise (e.g. van Keulen et al. 2011). In RPM (Marlatt and Gordon 1985; Larimer et al. 1999) cognitive and behavioural strategies are used to facilitate effective coping in various high-risk situation were an individual is at risk to relapse and return to previous behavior. A review made by Kahn et al. (2002) showed relapse-prevention strategies to be useful and effective in intervention programmes aiming

to promote PA. The psychological therapy method CBT include treatment principles such as goal setting (Linton and Flink 2011), psychoeducation (Lukens and Mc Farlane 2004), behaviour chain analysis and rationale (Sudak 2011) to mention a few.

Exercise interventions differ greatly in terms of program design and strategy (Teixeira et al. 2012) and few intervention studies examine indirect effects using recommended mediation analyses (Cerin and Mackinnon 2009; Rhodes and Pfaeffli 2010). The self-determination theory process model allows for identification of potential mediators in exercise behavior change and motivation and how participants' exercise behavior is affected through manipulation of the organismic integration theory and basic needs theory mechanisms of the process model. Therefore special attention has been given to specific parts of the self-determination theory process model in this study; particularly in terms of evaluation. Structured multicomponent exercise interventions are quite uncommon, especially outside health-care and clinical settings and the intention is to test an initial model and use the lessons learned in the construction of a more elaborated intervention model in an upcoming study. The elements of motivational interviewing and cognitive behavioral theory were mainly applied as methodological platforms for the implementation of the deliverance of the SDT-informed content in a structured manner.

The aim of this study was therefore to examine the effects of an exercise intervention informed by self-determination theory and with added elements of cognitive behavioral theory, motivational interviewing and relapse prevention model regarding (a) exercise behavior, (b) motivation quality, and (c) autonomy and competence need satisfaction. A secondary aim was to test the indirect (mediating) effects of motivation quality and psychological need satisfaction in the effect of the intervention on exercise behavior. We hypothesized that the effect of the intervention on exercise behaviour would be mediated by overall motivation quality (RAI-score). However, given the lack of previous research about, and knowledge of, the multiple and simultaneous mediating effects of the different regulations in intervention studies, we did not state a specific hypothesis for the multiple mediating analysis including all the separate regulations.

Methods

Participants

The sample was a Swedish convenience sample consisting of 64 undergraduate university students (49 women and 15 men, M_{age} = 27.3; *SD* = 7.4, age range 19–49 years). The inclusion criterion was that the participants were not currently engaging in exercise activities more than once a week.

Measures

The Behavioral Regulations in Exercise Questionnaire-2 (BREQ-2; Markland and Tobin 2004) was used to measure specific regulations (external, introjected, identified, and intrinsic regulations) as well as amotivation. Based on the separate regulation scores, an overall score (RAI-score, Relative Autonomy Index) for motivation quality can be constructed (by weighting and combining the different regulations.Higher RAI scores (over zero) denote more self-determined motivation. Using the RAI scores is previously recommended (Vallerand and Ratelle 2002), providing an overall index of the degree of self-determination. The BREQ-2 contains 19 statements (e.g., "It's important to me to exercise regularly") rated on a 5-graded Likert scale, between 0 (*not true for me*) and 4 (*very true for me*). The BREQ-2 has been validated and found to be stable in a number of translated versions (Moreno et al. 2010; Moustaka et al. 2010), also in Swedish (Weman-Josefsson 2014). Unlike the original scale, the BREQ (Mullan et al. 1997). BREQ-2 measures amotivation in addition to external, introjected, identified, and intrinsic regulations. Using the RAI score has been recommended (Vallerand and Ratelle 2002), providing an index of the degree of self-determination. Cronbach's alpha for the BREQ-2 was 0.73 to 0.86. Finally, 12 items representing autonomy and competence on the Psychological Needs in Exercise Scale (PNES; Wilson et al. 2006a; b) were used to measure psychological need satisfaction. The PNES originally contains 18 statements e.g., "I feel free to exercise in my own way" or "I feel capable of completing exercises that are challenging to me" rated on a six-graded Likert scale from 1 (*false*) to 6 (*true*). For this study's purpose, the six items representing relatedness were removed. Cronbach's alpha for both PNES subscales was >0.7. The PNES scale has supporting evidence of structural and convergent validity (Wilson et al. 2006a, b), and has shown stability coefficients from 0.52 to 0.69 and higher scores on PNES to be associated with more internalized exercise motivation (Wilson and Rogers 2008). Exercise level was measured using the Leisure Time Exercise Questionnaire (LTEQ; Godin and Shephard 1985) and contains three questions measuring the frequency of performing (a) strenuous, (b) moderate, and (c) light exercise during a regular week. Scale scores are transformed into scores of metabolic equivalent of exercise (MET) by multiplying the scores of strenuous exercise by 9, the scores of moderate exercise by 5 and the scores of light exercise by 3. The LTEQ is a frequently used self-reported measure of exercise, has sound test-retest reliability (Godin and Shephard 1985; Jacobs et al. 1993) as well as construct validity (Wilson et al. 2010), and its scores have a confirmed relation to accelerometer motion scores (Jacobs et al. 1993). The rationale for using the LTEQ is that compared to other popular and more detailed self-report measures (e.g. the IPAQ), it is user-friendly while also providing useful

information, and due to its frequent use study comparisons are possible.

Procedure

Translation Process

Both BREQ-2 and PNES were translated from English into Swedish according to the back-translation method (Brislin 1986). Subsequently, ten persons from a similar population as the target sample tested the comprehension and design of the questionnaires, using the think-aloud method (Ericsson and Simon 1993), which resulted in some minor clarifications and remodeling.

Intervention Procedure

Participants were enrolled by convenience sample and were initially informed of the study's aim and procedure. After completing baseline measures, the 64 voluntary participants were randomly matched to either an experimental group (n = 32) or a control group (n = 32) based on pre-intervention exercise level. Members of the experimental group were contacted by telephone to schedule a time for the intervention session, each lasting for approximately one hour. The intervention was implemented individually following a semi-structured intervention template based on self-determination theory (autonomy support, see page 4) and a selection of motivational interviewing, cognitive behavior theory and relapse prevention model strategies (see page 4–5). Mid-intervention (after three weeks), members of the experimental group received a follow-up telephone call and were offered a modification of their exercise goals if needed. The control group received no intervention. Six weeks after the intervention, both the experimental and the control group were assembled to complete the post-intervention measures. All participants received cinema tickets (value approx. €10). Informed consent was obtained as well as academy approval and the study was conducted according to the guidelines of American Psychological Association and the regional ethics board.

The intervention was performed by two clinical psychology students (the third and fourth author of this article) as part of their final exam and consisted of a selection of cognitive behavior theory and relapse prevention model strategies in terms of exercise-related participant narratives and decision balance (targeting the need for autonomy and relatedness constructs), health-related exercise rationale, exercise-barrier identification, chain analyses, and goal setting (targeting the need for competence construct). From a broader perspective, cognitive behavioral theory was in the intervention used as a methodological platform for the implementation of the active content ingredients of the intervention. For example, the cognitive behavioral theory methods of psychoeducation and chain-analyses were filled with self-determination theory content (mainly reflecting on the OIT continuum in a personalized context). According to recommendations advanced in previous research on self-determination theory (Fortier et al. 2012; Sheldon et al. 2003; Su and Reeve 2010) as well as self-determination theory in combination with MI (Markland et al. 2005; Patrick and Williams 2012), the intervention was conducted in an autonomy-supportive manner, using non-controlling language and conveying an empathic and non-judgmental approach, allowing participants to decide on potential behavior change themselves without attempting to force any decisions (targeting the needs of autonomy and relatedness). Taken together, the intervention provided vital elements of a working partnership in person-centered care (Ekman et al. 2011) as well as a self-determination theory-informed interpersonal style with structure and involvement (Ntoumanis 2012).

In order to allow personalized support and counselling, the trial leaders met all experimental group members individually. Initially, the participant's current relation to exercise as well as previous experiences was discussed based on a competence need rationale, followed by a decision balance procedure whereby participants listed exercise pros and cons. The listings were transferred to a whiteboard, where pros and cons could be compared in order to display whether one outweighed the other. Then the trial leader provided a cognitive behavioral theory based rationale for the potential positive effects of exercise on physical and mental health. The rationale was followed by an inventory of experienced exercise barriers and potential approaches to overcome such barriers using relapse-prevention strategies (Larimer et al. 1999; Marlatt and Gordon 1985), discussing potential drop-out situations and prevention strategies respectively. The trial leader described the differences between a slip, lapse, relapse and collapse, emphasizing the importance of participants not being self-judgmental when facing these difficulties but instead trying to regain their exercise routines. Cognitive behavioral theory based barrier chain analysis was conducted in order to increase awareness of the long- and short-term consequences of different actions (Sudak 2011), and the participant was instructed to reflect on possible factors that facilitated exercise. Next, a basic self-determination theory description was presented through cognitive behavioral theory based psychoeducation (Lukens and Mc Farlane 2004). Finally, potential interest in exercise initiation and prospective exercise activities were discussed based on the initial narrative. When potentially appropriate activities were established, participants were guided in exercise goal setting, employing specific, realistic and challenging goals based on cognitive behavioral theory guidelines (Linton and Flink 2011) as well as self-determination theory -informed intrinsic goal orientation (Lutz et al. 2008; Sebire et al. 2008). The agreed-on goal

formulation was subsequently compiled and distributed to each participant after the meeting. Three weeks after the first meeting, members of the experimental group were contacted by telephone for a follow-up, aiming to support participants by giving them an opportunity to discuss their exercise progress or any additional need for support in exercise initiation, to ask questions and modify their goals if needed.

Analysis

From the baseline measurements, independent *t* tests were performed using the LTEQ (MET, strenuous, moderate and light exercise), the BREQ-2 (RAI and amotivation, external, introjected, identified and intrinsic regulations respectively) and the PNES (autonomy and competence) in order to detect any primary differences between the two groups. Inter-provider fidelity was not measured and could therefore not be tested. Instrument reliability was tested using Cronbach's alpha. Between-group differences after the intervention (controlling for pretest scores) were tested by analyses of covariance (ANCOVA) and within-group differences were tested through paired samples *t* test. The significance level for all tests was set to $p < 0.05$. To test whether need satisfaction and motivational quality mediated the effect of the intervention on exercise, indirect effects were tested using multiple mediator models with a bootstrapping resampling approach to calculate product-of-coefficients and asymmetric 95 % confidence intervals based on 1000 resamples (Preacher and Hayes 2004, 2008). All mediation analyses were performed through the SPSS macro PROCESS (Hayes 2013).

Results

No statistical differences between the experimental group and control group were found in the LTEQ, BREQ-2, or PNES at the baseline measurement. Cronbach's alpha for the BREQ-2 and PNES was >0.70. Because the drop-out rate was low ($n = 3$) and displayed no extreme values, no drop-out analysis was done.

Changes Between pre and Post-Test

Generally, participants were more physically active, had a more self-determined motivation, had a higher identified regulation and felt more competent and autonomous at post-test. Significant differences between pre and post-tests were found in exercise level (MET) $F(1, 60) = 52.62$, $p < 0.001$ (^{2} partial =0.47); strenuous exercise $F(1,60) = 31.72$, $p < 0.001$ (^{2} partial =0.35); moderate exercise $F(1,60) = 19.82$, $p < 0.001$ (^{2} partial =0.25); light exercise $F(1,60) = 6.85$, $p = 0.05$ (^{2} partial =0.10); RAI $F(1, 60) = 12.51$, $p < 0.001$ (^{2} partial =0.17); identified regulation $F(1,60) = 33.11$, $p < 0.001$ (^{2} partial =0.36), competence $F(1, 60) = 7.32$, $p < 0.001$ (^{2} partial =0.11) and autonomy $F(1, 60) = 11.27$, $p < 0.001$ (^{2} partial =0.16).

Post-Intervention Differences Between Groups

The experimental group reported significantly higher total exercise $F(1,58) = 12.4$, $p < 0.001$ (^{2} partial =0.17) post-intervention than the control group did (see Table 1). In addition, experimental group participants also showed significantly higher levels of strenuous exercise $F(1,58) = 13.66$, $p = 0.040$ (^{2} partial =0.19) post-intervention than participants in the control group. Further, participants in the control group displayed significantly more external regulation than members of the experimental group did post-intervention $F(1, 58) = 4.41$, $p = 0.040$, however with a small effect size (^{2} partial =0.07). No statistical differences were found in autonomy need satisfaction $F(1,58) = 1.53$, $p = 0.222$, competence need satisfaction $F(1,58) = 0.70$, $p = 0.405$ (^{2} partial =0.26) or RAI score $F(1,58) = 2.01$, $p = 0.162$ (^{2} partial =0.12) between the experimental and control conditions post-intervention.

The Mediating Effect of Need Satisfaction and Motivation Quality

Mirroring the results from the ANCOVAs, the total effect (*c*-path) of the intervention on exercise post-test was significant $c = 12.77$, *SE*: 5.06, $p < 0.05$ and total RAI score post-test mediated the effect of the intervention on exercise post-test. The 95 % confidence intervals did not include zero, and ranged between 0.30 and 6.57. When considering all the BREQ-2 variables as mediators in the same model, the only significant indirect effect was found for identified regulation, with the bootstrap 95 % confidence intervals estimated to be between 0.12 and 11.58. In the experimental group, higher total RAI scores and identified regulation at post-test were significantly ($p < 0.05$) related to higher exercise at post-test (*b*-paths). The indirect effects of the other BREQ-2 variables and of the needs competence and autonomy were not significant, indicated by the fact that zero was included in the 95 % confidence bootstrap intervals for these variables.

Discussion

The purpose of the study was to examine potential effects of a multicomponent exercise pilot intervention informed by self-determination theory and using elements of cognitive behavior theory and relapse prevention model. The key intention of the intervention was to affect participants' exercise behavior through manipulation of the organismic integration theory and basic needs theory mechanisms of the process model; i.e., facilitate internalization through an interpersonal style

Table 1 Means (M) and standard deviations (SD) of study variables at Baseline and Post-intervention; Within-group changes Post-intervention; and Between-group differences post intervention

	Experimental group (n = 30; df = 29)			Control group (n = 31; df = 30)			Betweengroup diff. Post interv.		Effect size
	M (SD)	Within-change		M (SD)	Within-change		F	p	^{2}
		t	p		t	p			
PNSE – Autonomy	–	–	–	–	–	–	1.8	0.222	0.28
Baseline	28.5 (5.3)	–	–	30.4 (5.3)	–	–	–	–	–
Post-intervention	29.5 (6.8)	−1.8	0.077	32.1 (4.1)	−2.9	0.006	–	–	–
PNSE – Competence	–	–	–	–	–	–	0.7	0.405	0.12
Baseline	25.4 (7.5)	–	–	23.2 (7.4)	–	–	–	–	–
Post-intervention	26.2 (6.8)	−1.1	0.269	25.5 (6.2)	−2.6	0.016	–	–	–
BREQ2 – RAIa	–	–	–	–	–	–	1.0	0.162	0.03
Baseline	8.9 (4.0)	–	–	7.8 (6.3)	–	–	–	–	–
Post-intervention	10.7 (3.5)	−3.4	0.002	8.5 (6.4)	−1.8	0.094	–	–	–
BREQ2 – Amotivation	–	–	–	–	–	–	1.6	0.172	0.14
Baseline	0.2 (0.3)	–	–	0.5 (0.7)	–	–	–	–	–
Post-intervention	0.2 (0.3)	0.33	0.745	0.4 (0.7)	1.8	0.084	–	–	–
BREQ2 – External Reg.	–	–	–	–	–	–	4.2	0.044	0.07
Baseline	0.6 (0.6)	–	–	0.5 (0.6)	–	–	–	–	–
Post-intervention	0.5 (0.5)	1.5	0.136	0.6 (0.7)	−1.3	0.177	–	–	–
BREQ2 – Introjected Reg.	–	–	–	–	–	–	0.2	0.575	0.10
Baseline	1.7 (1.1)	–	–	1.7 (1.0)	–	–	–	–	–
Post-intervention	1.9 (1.0)	−0.98	0.337	1.7 (1.0)	−0.58	0.565	–	–	–
BREQ2 – Identified Reg.	–	–	–	–	–	–	1.9	0.981	0.24
Baseline	2.4 (0.6)	–	–	2.3 (0.9)	–	–	–	–	–
Post-intervention	2.9 (0.6)	−4.6	0.001	2.6 (0.8)	−3.6	0.001	–	–	–
BREQ2 – Intrinsic Reg.	–	–	–	–	–	–	1.6	0.222	0.16
Baseline	2.5 (0.9)	–	–	2.5 (1.0)	–	–	–	–	–
Post-intervention	2.7 (0.9)	−2.2	0.040	2.5 (1.1)	−0.25	0.806	–	–	–
LTEQ –Total Exercise	–	–	–	–	–	–	12.4	0.001	0.17
Baseline	19.0 (13.9)	–	–	19.0 (14.8)	–	–	–	–	–
Post-intervention	38.8 (23.8)	−6.9	0.001	26.0 (14.9)	−3.9	0.001	–	–	–
LTEQ –Moderate Exrc.	–	–	–	–	–	–	1.3	0.208	0.10
Baseline	7.9 (9.3)	–	–	7.2 (7.4)	–	–	–	–	–
Post-intervention	13.8 (11.8)	−3.6	0.001	10.6 (7.8)	−2.7	0.011	–	–	–
LTEQ –Light Exrc.	–	–	–	–	–	–	0.3	0.619	0.13
Baseline	6.7 (6.0)	–	–	6.5 (5.8)	–	–	–	–	–

Within-group change = paired samples t-test. Betweeen-group diff. Post interv. = ANCOVA. Reg. = Regulation. Exrc. = Exercise

[a] RAI = Relative Autonomy Index, a weighted score

[b] Total exercise = metabolic equivalent of exercise (MET), a weighted score

providing autonomy support, structure and involvement. Since physical activity and exercise behavior have been suggested to be multifaceted behaviors that are difficult to cover with one specific theory (Bauman et al. 2002) and polytheoretical approaches have been advocated (Baranowski et al. 1998; Ntoumanis 2012), elements of cognitive behavior theory and relapse prevention model were included; motivational interviewing and cognitive behavioral theory mainly as methodological platforms for the implementation of the deliverance of the self-determination theory informed content in a structured manner. Significant post-intervention effects (experiment versus control group) were found regarding exercise level, exercise intensity, and motivation quality.

Both groups saw an increased total exercise level (i.e., total MET), but the experimental group had significantly higher total and strenuous exercise levels than the control group did post-test. Hence, the results generally align with self-determination theory stipulations (Deci and Ryan 2000) and previous research (Teixeira et al. 2012) as well as previous interventions, (Edmunds et al. 2007; Edmunds et al. 2008; Fortier et al. 2012) and suggest that self-determination theory informed interventions could have a positive effect on exercise behavior. The study indicates the possibility that even brief interventions, such as the present one lasting six weeks, might yield effects similar to those of longer and more elaborate ones (Fortier et al. 2012). Since many physical activity and exercise interventions have been shown to be ineffective (Baranowski et al. 1998; Baranowski and Jago 2005) and few studies have demonstrated that a change in the mediators in turn changes behavioral outcome (Rhodes and Pfaeffli 2010), the results of this study provide conceptual theory links supporting self-determination theory stipulations and capacity. The results also point to the potential benefits of combining self-determination theory strategies with other theoretical components and methods in exercise interventions, at least in short programs, by utilizing a polytheoretical approach, in this case by providing support for previously suggested combinations of self-determination theory with motivational interviewing, (Deci and Ryan 2012; Markland et al. 2005; Patrick and Williams 2012; Vansteenkiste and Sheldon 2006) cognitive behavioral theory (Khazaal et al. 2008) and relapse prevention model (Gustafson et al. 2011). Since cognitive behavior theory and relapse prevention model constituted a methodological platform, measuring these constructs as outcomes was not included in the study objectives. Therefore interpretations of how mediating effects of self-determination theory related constructs relate to specific constructs of cognitive behavior theory and relapse prevention model cannot be made. Future studies would therefore do well in advancing these matters.

The experimental group displayed lower levels of external regulation than the control group did post-test, indicating that the experimental group had become less regulated by external factors during the intervention. These results concur with expectations from a self-determination theory perspective (Deci and Ryan 2000; Teixeira et al. 2012), suggesting that the intervention may have influenced motivation quality by promoting internalization. Granted the explorative nature of this hybrid (multicomponent) intervention approach, an initial speculation could be that the use of cognitive behavior theory and relapse prevention model strategies might have supported participants' feelings of control and self-regulation, while the autonomy-supportive interpersonal style might have lessened the prominence of external regulation. These circumstances together might have facilitated internalization (especially identified regulation which was shown to mediate the intervention effect, see discussion below), which in turn might have increased exercise level and intensity. There is also reason to mention that although lacking significant intervention effects on identified regulation, the analyses displayed a large effect size (^{2} partial 0.24, see Table 1) for identified regulation, which may indicate clinical relevance (Stoové and Andersen 2003), especially considering that significant *p*-values could be difficult to detect in such small samples.

When examining the indirect effects of self-determined motivation suggested by theory (Ryan and Deci 2002) and previous research (Fortier et al. 2012; Williams et al. 2006), the intervention effect (i.e., exercise) was found to be mediated by overall regulatory processes (RAI) and more specifically by identified regulation. The prominence of identified regulation in exercise behavior has previously been emphasized (Edmunds et al. 2007; Edmunds et al. 2006), and is in line with the suggestion that internalized controlled regulations are important in behaviors that are not instantly rewarding or enjoyable, such as exercise (Deci and Ryan 2000). A practical implication from this would therefore be to recognize the importance of facilitating internalization in exercise contexts, i.e., by providing autonomy support and structure and focusing on values and meaning connected to behavioral outcomes. A deeper understanding of the basic mechanisms at work in exercise behavior, and identifying elements that influence behavior in order to exclude ineffective ones, is fundamental to constructing effective interventions (Fortier et al. 2011) and needs to be further examined in more elaborate studies than ours.

No mediating effects regarding competence and autonomy need satisfaction were found and it seems, at least in the present study, that the mechanisms of self-determined motivation could be operative and generate increased exercise as an outcome even in the absence of statistically significant mechanisms of need satisfaction. This is not in line with theory expectations and therefore somewhat puzzling, but there are some circumstances that might have affected the results, for example by making intervention effects on psychological needs undetectable. For example, the baseline measures could be biased by an initial social desirability effect (Fortier et al. 2012), and the voluntary involvement could have caused higher baseline levels of motivation, perhaps even self-determined forms due to self-regulatory processes (Rhodes and Pfaeffli 2010). Also, inclusion criteria allowed participants to already engage in some exercise (once a week) which may have influenced their feelings of exercise related competence and autonomy at baseline. Moreover, several self-determination theory studies differ in terms of the number of needs assessed (Teixeira et al. 2012), and the decision to exclude the need for relatedness from PNES was based on its supposedly more distal (Deci and Ryan 2000) and, in exercise settings, debated role (McDonough and Crocker 2007; Wilson et al. 2006a, b; Wilson et al. 2002). Nevertheless, it is likely

that the positive effects on exercise were affected by the social support of the TL; and since the three needs are considered interdependent and highly interrelated on a general level (Deci and Ryan 2000), including the relatedness need dimension from the PNES might have added relevant information to facilitate interpretation. It is therefore recommended that future studies include all three needs.

In sum, the overall ambition to convey an autonomy-supportive approach with structure and involvement may have facilitated self-determined motivation and diminished the prominence of external regulations, which in turn may have contributed to increased exercise level and intensity.

Limitations and Contributions

With adequate study design and proper analysis, mediating variable analysis can not only inform practice by displaying whether an intervention changes the suggested mediators (the alpha-coefficient, or *a*-path), but also evaluate theory efficacy by demonstrating relevant conceptual links between different concepts (the beta-coefficient, or *b*-path), that is, whether a change in mediators also changes assumed outcomes (Cerin and Mackinnon 2009; MacKinnon et al. 2007). Mediating variable analysis provides a systematic evaluation of how theory works in an intervention, it reveals and explains the contribution of mediating variables, and thereby permitting researchers to focus on effective mechanisms (Baranowski et al. 1998; Cerin and Mackinnon 2009) and to understand what mechanisms can explain and/or predict the relationship between need satisfaction and exercise. Even small-scale studies can yield knowledge for effective intervention designs if proper mediating variable analysis is used, diminishing the practical limitations of heavy and expensive interventions and programs (Cerin et al. 2006). By focusing on changing mediators rather than behaviors, intervention magnitude (e.g., in terms of time and participants) could be condensed and yield more cost-effective programs. In this way, not only successful but also economically sound intervention design for behavior change could be facilitated (Baranowski et al. 1998; Cerin and Mackinnon 2009).

The present intervention effects should be considered with regard to the nature of the study (pilot intervention), the sample size (relatively small) and constitution (sample of convenience and predominately female) as well as the self-reported exercise measure (probability of biases like social desirability). Including a direct measure of exercise (e.g. step counters) would therefore have been ideal in order to permit the cross-reference of subjective and objective measures. On the other hand, we engaged a non-clinical sample in a real-world setting, which proliferated to the expected practical utility and lessened the resources needed in terms of time and facilities. The use of matching and randomization is expected to reduce confounder bias (Rothman et al. 2013), thereby strengthening the study and increasing the potential for assuming true intervention effects. Nevertheless, the difference between the control and experiment condition regarding researcher-participant interaction is a possible confounder, which will be addressed in future interventions by providing the control condition a more engaging task. The theory-informed content, in combination with advanced mediation analysis, provides conceptual links supporting self-determination theory capacity and usefulness. Since two measure points do not allow for testing within-person temporal change in the way that designs with additional measure points do (Cole and Maxwell 2003), a follow-up period and measure would have provided further information on aspects of adherence and intervention effects over time. Finally, measuring intervention fidelity were out of the scope of this study, CONSORT guidelines (Schulz and Altman 2010) are only partially applied due to the crude nature (pilot) of the study, and owing to study constraints constructs related to motivational interviewing, cognitive behavioral theory and relapse prevention model were not measured, altogether likely resulting in information loss.

Although a fairly small sample and short intervention period, the use of statistical methods with high power permits inferences of the mediating mechanisms impacting exercise behavior (Cerin et al. 2006). Using random assignment and a theory-informed intervention design are additional strengths that make this study a potentially valuable contribution to the field; and showing that even brief interventions like this one can have a positive impact on behavior and mediators is quite promising. Since behavior changes often occur within a person's close environments, this type of flexible interventions taking place in real-world setting (i.e., not in a restricted or controlled environment), could certainly increase the intervention's potential practical utility regarding resources (costs) in terms of time, facilities, staff and so on. Also, this sample might also be a valuable contribution since many previous studies have involved very specific samples, like clinical settings and overweight/obese women (Fortier et al. 2012). Based on the experiences from this pilot study, a digital intervention project has been initiated (see Weman-Josefsson et al. 2014), also targeting the mechanisms of self-determined exercise motivation using a multicomponent framwork.

Conclusions

The main findings of this study are that even brief interventions can have an effect, especially when using a multicomponent theory driven design. The pilot intervention proved to decrease external regulation and

demonstrated the mediating effects of motivation quality, especially the support for identified regulation, to be important in this particular exercise setting. Hence, given its probing nature and the somewhat crude design, the study represents a good start to build on. Testing more elaborate and sophisticated multicomponent interventions combining theoretical approaches and methods like cognitive behavior theory and relapse prevention model with the promising mediation processes in self-determination theory, we might surely advance our knowledge of the mechanisms behind exercise motivation and behavior.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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