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A self-determination process model of physical activity adoption in the context of a randomized controlled trial

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Abstract

Objective: The PA Counseling (PAC) trial tested a primary care intervention using Self-Determination Theory (SDT) as the guiding framework. This paper presents specific results related to SDT constructs in a physical activity (PA) context. Specifically, whether patients who received both brief autonomy supportive PA counseling from their health-care provider and intensive (3 month) autonomy supportive counseling from a PA counselor would report greater levels of autonomy support, autonomous motivation, perceived competence and PA adoption, than patients receiving only brief counseling. In addition, we tested Williams' SDT process model in the context of PA adoption.

Method: Measures of autonomous motivation and perceived competence for PA were measured at baseline and 6 weeks. PA was assessed at baseline and 13 weeks. An autonomy support index was calculated by multiplying minutes of counseling by perceptions of autonomy support. Group differences in autonomy support, autonomous motivation, perceived competence and PA were examined. The SDT process model of PA adoption was tested via path analysis.

Results: The results showed higher autonomy support and autonomous motivation at 6 weeks and higher PA levels at 13 weeks for the experimental group. The SDT process model for PA adoption showed that

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autonomous motivation and perceived competence at 6 weeks significantly predicted 13-week PA for the experimental group.

Conclusions: This study provides a rigorous field test of SDT theory in a PA context. It demonstrates the versatility and applicability of the SDT model for health behavior change. SDT-trained PA counselors appear to provide valuable contribution to facilitating patient behavior change, by increasing patient autonomous motivation for PA.

Keywords: Self-Determination Theory; Intervention; Physical Activity Counseling; RCT; Autonomous motivation; Perceived competence; Autonomy support

Introduction

From lowering blood pressure to improving mood, the multiple benefits of regular physical activity (PA) for healthy and diseased populations are well established (Brown et al., 2004; Knowler et al., 2002; Richardson, Kriska, Lantz, & Hayward, 2004; US Department of Health and Human Services and the US Department of Agriculture, 2005). However, what is less well known is how to optimally facilitate the adoption of a physically active lifestyle, and particularly how to assist people in maintaining this health behavior over the long term (Maciosek et al., in press).

Primary care has been targeted as a promising context to promote PA (see Fortier, Tulloch, & Hogg, 2006) and consequently multiple guidelines recommend that PA counseling be provided in the primary care setting (American College of Sports Medicine, 2000; Byers et al., 2002; Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001; National Heart, Lung and Blood Institute, 2004). However, PA interventions in primary care have shown mixed results, particularly for maintaining patient PA behavior change over time (Eakin, Glasgow, & Riley, 2000; Smith, Merom, Harris, & Bauman, 2002). Fiore et al.'s (2000) review in the tobacco dependence treatment area showed that interventions are more effective if physicians receive training and specialized health-care providers (HCP) are used for intensive patient counseling. Similar findings are emerging in the primary care PA promotion context (Tulloch, Fortier, & Hogg, in press). Thus, further research is needed to understand how physicians and allied HCPs can provide effective PA counseling.

The 5 A's model for behavior change counseling (Assess, Advise, Agree, Assist, and Arrange) has been shown to be effective and consequently has been adopted for health behavior change counseling, including PA by both the US Preventive Services Task Force (USPSTF) and the Canadian Task Force on Preventive Health Care (CTFPHC: Elford, MacMillan, Wathen, with the Canadian Task Force on Preventive Health Care, 2001; USPSTF: Whitlock, Orleans, Pender, & Allan, 2002). The National Cancer Institute developed this clinical framework for tobacco dependence treatment (Fiore et al., 2000). Both the tobacco dependence guideline and the USPSTF identify the importance of supporting patient autonomy in health behavior change counseling. Adopting a patient-centered collaborative approach which facilitates patient autonomy is also currently advocated in all medical care settings (ABIM, 2002; Woolf, Chan, & Harris, 2005).

Patient autonomy for health behavior change is a central concept of Self-Determination Theory (SDT; Deci & Ryan, 1985; Sheldon, Williams, & Joiner, 2003; Williams, 2002). Indeed, integral to

SDT is the concept of autonomous motivation. People are autonomously motivated when they engage in an activity or cease an activity for reasons that come from within oneself and are freely chosen. In a PA context, patients are autonomously motivated if they choose to initiate PA for enjoyment, because they think PA is important and will help them attain valued goals and/or because of personal commitment to improving their health and/or quality of life. SDT is the only theory of human motivation that assumes humans have a need for autonomy, and explicitly targets and measures it.

In the health behavior change context, research utilizing SDT has associated autonomous motivation with improved attendance and greater reductions in body mass indices within a weight-loss program (Williams, Grow, Freedman, Ryan, & Deci, 1996), long-term medication adherence (Kennedy, Goggin, & Nollen, 2004; Williams, Rodin, Ryan, Grolnick, & Deci, 1998), improved glycemic control and dietary self-care in diabetes patients (Senécal, Nowen, & White, 2000; Williams, Freedman, & Deci, 1998; Williams, McGregor, Zeldman, Freedman, & Deci, 2004), reductions in intensity and frequency of smoking in adolescents (Williams, Cox, Kouides, & Deci, 1999) and maintained smoking cessation in adults (Curry, Wagner, & Grothaus, 1991; Williams, Gagné, Ryan, & Deci, 2002). Recently, a randomized controlled trial (RCT) applied a SDT-based counseling intervention using the A's framework to reduce tobacco dependence. The intervention was effective in increasing autonomous motivation and facilitating prolonged tobacco abstinence, as well as improving lipid profiles (Williams et al., 2006; Williams et al., in press). Thus, autonomous motivation has been predictive of change in several health conditions and is modifiable from an intervention standpoint. Recently, in a study of diagnostic evaluation of patient chest pain, autonomous motivation was found to predict lifestyle change incorporating PA (Williams, Gagné, Mushlin, & Deci, 2005).

SDT has been strongly recommended as a suitable framework for understanding PA (Biddle & Nigg, 2000; Landry & Solmon, 2002). Indeed, there is consistent evidence of the utility of this theory for predicting PA behavior change (Fortier & Kowal, in press). Moreover, SDT has been recently used for PA interventions (Levy & Cardinal, 2004; Vansteenkiste, Simons, Soenens, & Lens, 2004; Wilson et al., 2005). In the Wilson et al.' (2005) study, it was found that a 4-week SDT school-based PA intervention was effective at increasing adolescents' short term moderate PA (as measured by an accelerometer). While results from SDT-based PA interventions show promise, additional research needs to ascertain the usefulness of this theory for changing PA behavior. Given the success of Williams et al.' (2006) primary care SDT tobacco cessation interventions, a similar approach should be taken for PA promotion. This is what was done in the PA Counseling (PAC) RCT. This article is limited to the SDT outcomes of this trial and focuses on PA adoption as the health behavioral outcome.

Another central concept of SDT is *perceived competence*. People perceive themselves to be competent when they feel capable of attaining important health outcomes, such as meeting a PA goal. The construct of perceived competence is very similar to the self-efficacy concept (Bandura, 1997), which has been found to be one of the strongest predictors of PA in adults (Trost, Owen, Bauman, Sallis, & Brown, 2002). Perceptions of competence to achieve health outcomes are enhanced through autonomous motivation (Williams, Freedman et al., 1998; Williams et al., 2004). The relationship between autonomous motivation and perceived competence in the PA context was recently demonstrated in a large study on ecological determinants of PA, where intrinsic motivation (the most autonomous form of motivation) was found to be an important

correlate of self-efficacy (McNeill, Wyrwich, Brownson, Clark, & Kreuter, 2006). From an SDT perspective, people are most successful at adopting a health behavior, such as initiating PA, when they have high levels of autonomous motivation and feel competent that they can achieve this outcome.

To facilitate autonomous motivation and perceived competence for health behavior change, SDT proposes that HCPs actively listen to, collaborate with, respect and thoroughly support the patient (Sheldon et al., 2003). SDT refers to this as being autonomy supportive and Williams' work has shown that HCPs can be trained to use this counseling approach (Williams & Deci, 2001; Williams et al., 2002; Williams et al., 2006) and that when they do (or patients perceive they do), patient's motivation becomes autonomous, their perceived competence is enhanced, and in turn their health behavior change is facilitated (Williams, 2002).

More clinical trial research is needed on autonomy support in the health-care context, especially from providers who deliver intensive interventions and thus have the opportunity to apply the style over multiple sessions. In addition, given that the practice of motivational interviewing (Miller & Rollnick, 2002) appears "tailor-made" for autonomy support (Markland, Ryan, Jayne Tobin, and Rollnick (2005), it is recommended that those providing intensive counseling would do well to be trained in an autonomy supportive style and incorporate motivational interviewing techniques to optimize patients' autonomous motivation, perceived competence and subsequent behavior change. This is the approach that was taken in the PAC randomized controlled trial (RCT).

The PAC trial tested a new interdisciplinary shared care 7A's PA counseling model based on SDT (see Fortier et al., 2006). In this model, behavioral counseling steps (As) are shared amongst the primary HCP (family physician or nurse-practitioner) and a newly integrated PA counselor. Specifically, HCPs delivered a brief (2–4 min) autonomy supportive PA counseling intervention (BPAC: set the agenda, ask, advise, and agree) to all patients and, in the experimental arm, a PA counselor supplemented with an intensive (3 month: 6 sessions) autonomy supportive PA counseling intervention (IPAC: assess, assist, and arrange).

The purpose of this paper is to determine if patients in the experimental arm will report higher levels of autonomy support, autonomous motivation and perceived competence at mid-intervention (6 weeks) and if this will translate into higher levels of PA at the end of the intervention (13 weeks). It is hypothesized that receiving both BPAC and IPAC relative to only BPAC would result in (1) higher perceived autonomy support, (2) higher autonomous motivation, (3) higher perceived competence, and (4) higher PA adoption (Williams et al., 2002, 2006).

The sequence between autonomy support, autonomous motivation, perceived competence and health behavior has been termed the SDT process model of health behavior change (Williams et al., 2006). The second purpose of this paper is to test this SDT process model in the context of PA adoption during the PAC RCT. It was hypothesized that previous findings would be replicated and specifically that in both the control and experimental groups: (1) autonomous motivation at study baseline and autonomy support would predict autonomous motivation at 6 weeks; (2) perceived competence at baseline would predict perceived competence at 6 weeks; (3) autonomous motivation and perceived competence at 6 weeks would predict PA at 13 weeks; and (4) perceived competence at 6 weeks would mediate the relationship between autonomous motivation at 6 weeks and PA at 13 weeks.

Methods

Study design

The PAC trial was a RCT integrating a SDT-trained PA counselor into a community-based primary care medical practice. Adult patients were recruited from a single, predominantly Francophone, primary care practice in Canada. Eligible participants were between the ages of 18 and 69 years, reported less than 150 min of PA per week, did not have any known unstable or uncontrollable diseases, received a PA prescription from their HCP during BPAC, and expressed an interest in meeting with a PA counselor. After being screened and receiving BPAC, participants were asked if they were interested in participating in the full study. Those who agreed were contacted by a trained research assistant and asked to visit the project's coordinating center to do baseline assessments and then be randomized. Participants provided written informed consent in the waiting room prior to their scheduled appointment with their HCP. A second written informed consent was obtained at the project's coordinating center for those participants who agreed to partake in the full study. A code number was assigned to each participant to match their data across time points. Participants were reimbursed for parking and lost time at work for the occasions they came to the coordinating center. This study was approved by the research ethics board of the specific academic institution.

The randomization procedure stratified participants by gender (60% women were randomized to each group, as determined by the demographics of the primary care practice) and age (equal numbers of participants in the age groups 18–49 years and 50–69 years were randomized to each group). Participants were then randomly assigned to either the experimental or control condition. In the control condition, participants received BPAC from their trained HCP. In the experimental condition, participants received BPAC and then received IPAC from a trained PA counselor. The control condition participants also received two counseling sessions (one face-to-face and one via telephone) upon completion of the study.

BPAC: All patients received a 2–4 min intervention from their HCP. This followed the first four As of the 7 A's model (set the agenda, ask, advise and agree) and included the delivery of a tailored written PA prescription. Providers introduced the topic of PA to patients and specifically asked them about their current level of PA. If patient's PA levels did not meet the minimal 150 min per week guideline, providers advised the patient to increase their PA levels and related it to their particular situation. The patient and provider then collaboratively agreed on a realistic and attainable 1-month PA goal, which the provider wrote down as a PA prescription. Patients in the control condition received no further PA counseling beyond this point.

The HCPs received three training seminars to learn to be autonomy supportive and to become proficient at delivering the first 4 A's of the intervention (BPAC).

IPAC: Patients randomized to the experimental condition received six additional PA counseling sessions, with a trained PA counselor over a 3-month period (IPAC) in addition to BPAC. IPAC consisted of the last 3 As of the 7 A's model (assess, assist, and arrange). The first, second, and last sessions were face-to-face with the PA counselor in the medical practice. The other three sessions were conducted via telephone. Specifically, the PA counselor assessed patients' PA behaviors and beliefs, then assisted them with the behavior change process by helping them to set appropriate PA goals, by facilitating the search for solutions to overcome barriers, by providing

encouragement, helping them solicit forms of social support, and linking them to various community services. The PA counselor also arranged follow-up sessions with patients to discuss and summarize their progress and to discuss relapse prevention techniques.

The PA counselor received 3-month training to develop her autonomy supportive style and to help her deliver the last 3 A's of the intervention (IPAC).

Procedures

Assessment intervals: Before receiving BPAC from their HCP, all patients completed a socio-demographic questionnaire (e.g., age, gender, years of education, employment status, ethnicity, presence of risk factors and diseases) in the waiting room and immediately after their appointment they were asked to rate their HCP's degree of autonomy support using the Health Care Climate Questionnaire (HCCQ) (Williams et al., 1996). Interested patients were invited to visit the PAC project's coordinating center for a baseline assessment, where the Treatment Self-Regulation Questionnaire (TSRQ) (Ryan & Connell, 1989; Williams et al., 1996), the Perceived Competence for Exercise Scale (PCES) (Williams et al., 1996), and the Godin Leisure Time Exercise Questionnaire (GLTEQ) (Godin & Shepard, 1985) were administered. Additional measurements of the TSRQ and PCES were conducted via phone assessment at 6 weeks. The GLTEQ was re-administered at 13 weeks at the PAC coordinating center. For experimental patients, the HCCQ was also administered, 24–48 h following their first and second intensive counseling sessions with the PA counselor (the time intervals for these assessments were 3 and 5 weeks following the baseline assessment). The PA counselor also kept a record of the duration of the counseling sessions throughout the intervention. The purpose of this assessment was to rate the PA counselor's degree of autonomy support.

Measures

At each time-point prior to assessing autonomous motivation and perceived competence, patients were asked to indicate at least one PA goal they wished to accomplish in the next 6 weeks (using the FITT principle). All SDT variables were measured in light of this goal. Furthermore, all patients were given the choice of answering the questionnaires in either French or English.

Autonomous motivation: Autonomous motivation was assessed using items from the TSRQ (Ryan & Connell, 1989; Williams et al., 1996). Patients were asked "Why do you want to attain your weekly PA goals over the next 6 weeks." They were presented with six autonomous reasons (e.g., "Because it is an important choice I really want to make."), which they rated using a 7-point Likert-type scale anchored by 1 (*strongly disagree*) and 7 (*strongly agree*). As per previous research (Williams, Gagné et al., 2005; Williams et al., 2002; Williams, McGregor, King, Nelson, & Glasgow, 2005), the mean of the six items were taken to make up the autonomous motivation score.[1] The high level of validity and internal consistency of this instrument has been demonstrated by Williams et al. (1999), Williams, Freedman et al. (1998), Williams et al. (2002), and Williams, Rodin et al. (1998). The reliability of the measure for this study was .78 at baseline and .82 at 6 weeks.

[1]The same analyses were conducted with the relative autonomy index and the same results were revealed.

Perceived competence: This scale was slightly adapted from the PCES (Williams et al., 1996). The 4-item scale used in this study assessed patients' perceived confidence in attaining their 6-week PA goal. Patients rated their degree of confidence on a 7-point Likert scale ranging from 1 (*not at all true*) to 7 (*very true*). Example items were: "I feel confident in my ability to attain my weekly PA goal over the next 6 weeks" and "I am able to meet the challenge of attaining my weekly PA goal over the next 6 weeks." Previous research has demonstrated good internal consistency of this scale ($\alpha > .84$) (Williams, Freedman et al., 1998; Williams, Rodin et al., 1998). In the present study, coefficient α was .93 at baseline and .96 at 6 weeks.[2]

Autonomy support: Patients were administered the HCCQ (Williams et al., 1996) to assess perceived autonomy support. This scale was specifically developed for use in a health-care setting. For the control condition, participants completed this measure immediately following their BPAC session with their HCP. For the experimental condition, participants completed the HCCQ immediately after their BPAC session and by phone after their two face-to-face IPAC sessions with their PA counselor. Patients responded to six items (e.g., "My physician/nurse listened to how I would like to do things regarding my PA"; "I felt my PA counselor provided me with choices and options about PA (including not being regularly active").) on a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7). For patients in the control group, HCP items are averaged, whereas for experimental participants, both HCP and PAC items (2 time-points) are used. High α levels have been demonstrated in previous studies (Williams, Freedman et al., 1998; Williams, McGregor et al., 2005; Williams et al., 2004; Williams, Rodin et al., 1998). For this study, the reliability coefficient ranged from .86 to .89 across the three measurements.

In order to account for (and thus control) for differences between the groups in terms of contact time, the perceived autonomy support score was multiplied with total counseling minutes for each participant. The total minutes of counseling for the control group was estimated at 3 min (i.e., the amount of time the HCPs were trained to deliver the intervention). For the experimental group, the total minutes of counseling was recorded by the PA counselor for the two sessions and 3 min was then added to that total to account for the BPAC. This variable, entitled the autonomy support index, was used in the analyses.

Self-report PA. The GLTEQ was used to evaluate current, self-reported PA (Godin & Shepard, 1985). Participants were asked to report the number of days in a typical week in the past 6 weeks that they engaged in PA for more than 20 min for light, moderate, and strenuous intensities. The frequencies were multiplied by 3, 5, and 9 for each intensity, respectively. These values were then summed to produce the total weekly leisure activity score at baseline and 13 weeks. This questionnaire has been validated and extensively used in numerous studies. Specifically, the GLTEQ has compared very favorably with other common self-report measures of PA (Jacobs, Ainsworth, Hartman, & Leon, 1993) and has been found to have a strong relationship with more objective measures such as activity monitor ($r = .45$) and fitness tests ($r = .56$) (see Kriska & Caspersen, 1997, for a review).

Statistical analysis

The data were initially screened using procedures outlined by Tabachnick and Fidell (2005). Multiple imputation with 50 iterations was used to treat missing data on all variables. As a

[2]Baseline perceived competence was correlated with baseline self-efficacy ($r = .50$, $p < .001$).

preliminary step, participants in the control and experimental conditions were compared across socio-demographic variables and study baseline variables using independent samples *t*-tests or χ^2 analysis. To assess change in autonomous motivation, perceived competence and PA over time (Purpose 1), three analyses of covariance (ANCOVA) were conducted. In the first ANCOVA, the mean 6-week autonomous motivation scores of the control and experimental groups were compared, controlling for baseline autonomous motivation. This same analysis was repeated for perceived competence and for self-report PA. Analysis of covariance is a preferred method over repeated measure analysis of variance for a randomized pre-test post-test design because it is more parsimonious and powerful (Cohen & Cohen, 1983).

The SDT process model of PA adoption (Purpose 2) was tested using a path analysis (Pedhazur, 1982). As per Williams et al. (2006), this was done separately for control and experimental groups. In the first multiple regression, 6-week autonomous motivation was regressed onto baseline autonomous motivation and perceived autonomy support. In the second multiple regression, 6-week perceived competence was regressed onto baseline perceived competence, and 6-week autonomous motivation. The mediating influence of 6-week perceived competence on the relationship between 6-week autonomous motivation and 13-week PA was evaluated in a series of three multiple regressions (Baron & Kenny, 1986). Specifically, perceived competence at 6 weeks was regressed onto autonomous motivation at 6 weeks. PA at 13 weeks was then regressed onto autonomous motivation at 6 weeks. In the final regression, PA at 13 weeks was regressed onto both perceived competence at 6 weeks and autonomous motivation at 6 weeks. In this model, evidence of a mediational effect would be supported if the inclusion of 6-week perceived competence in the third regression reduced the strength of the association between 6-week autonomous motivation and 13-week PA to non-significance. All data were analyzed using SPSS, v13. Statistical significance was set at $p < .05$ for all univariate and multivariate analyses.

Results

Sample characteristics

A total of 120 participants (61 experimental and 59 control) were included in the analyses. Overall, they ranged in age from 20 to 67 years ($\bar{X}$ age = 47.3); the majority of participants were Caucasian (96.7%), female (69%), francophone (88.3%), had a moderately high level of education (14.75 years), and a high BMI (30.74). Descriptive statistics of the sample by condition is presented in Table 1. When the sample was split between the experimental and control conditions, no significant differences were observed on any of the baseline socio-demographic characteristics (see Table 1).

Preliminary analyses

An inspection of the data suggested that missing values occurred randomly. At 13 weeks, 17% ($n = 20$) of individuals had dropped out of the project. Due to the small sample size, it was important to keep all patients and thus the missing data were replaced using multiple imputations. Basic statistical assumptions were verified across treatment conditions, and most variables

Table 1
Demographic characteristics for experimental and control conditions

Baseline characteristics	Experimental ($n = 61$)	Control ($n = 59$)	p-value
Mean years of age (SD)	47.2 (11.3)	47.5 (11)	.89
Number (%) of Caucasians	57 (93.4)	58 (98.3)	.33
Number (%) of females	42 (69)	41 (69)	.94
Mean years of education (SD)	14.6 (3.6)	14.9 (3.4)	.67
Mean BMI (SD) (kg/m^2)	31.2 (7.3)	30.2 (8.4)	.47
Employment status (%)			
Employed	41 (67.2)	39 (66.1)	.63
Not employed	10 (16.4)	7 (11.9)	
Other	10 (16.4)	13 (22)	
Mother tongue (%)			
French	51 (83.6)	55 (93.2)	.18
English	8 (13.1)	4 (6.8)	
Other	2 (3.3)	0 (0)	

Table 2
Correlations among study variables ($n = 120$)

Variables	1	2	3	4	5	6	7
1. Autonomous motivation—baseline	—						
2. Autonomous motivation—6 weeks	.578**	—					
3. Perceived competence—baseline	.408**	.336**	—				
4. Perceived competence—6 weeks	.190*	.244**	.563**	—			
5. Autonomy Support Index	.027	.145	.163	.161	—		
6. PA—baseline	−.170	−.042	−.030	.023	−.147	—	
7. PA 13 weeks—SQRT	.001	.149	.131	.199*	.287**	.236**	—

**$p < 0.01$.
*$p < 0.05$ level.

approximated normal distributions. Of note, 13-week PA was moderately skewed and kurtotic and, as such, a square-root transformation was used to reduce these inflated levels. All subsequent analyses were conducted with the transformed 13-week PA variable. Bivariate scatterplots supported linear relationships among study variables. No significant differences between the experimental and control conditions were found on any of the baseline motivational variables (i.e., autonomous motivation and perceived competence) using independent sample t-tests, supporting the randomization process. Bivariate correlations among the autonomy support index, motivational variables at baseline, motivational variables at 6 weeks, and PA at 13 weeks are presented in Table 2. Of note, for both conditions combined, there were significant associations between baseline autonomous motivation and autonomous motivation at 6 weeks, and baseline perceived competence and 6-week perceived competence. Autonomous motivation at 6 weeks was

Table 3
Means (SD) of study variables by group

	Experimental ($n = 61$)	Control ($n = 59$)	p-value
Motivational variables			
Autonomous motivation (TSRQ)			
Baseline	6.47 (.62)	6.43 (.67)	.75
6 weeks	6.48 (.58)	6.24 (.75)	.04
Perceived competence (PCES)			
Baseline	6.21 (.88)	5.92 (1.16)	.12
6 weeks	5.96 (1.15)	5.49 (1.35)	.17
Autonomy support index	674.97 (178.59)	19.53 (1.94)	.00
Outcome variable			
PA			
Baseline	15.54 (14.07)	20.01 (15.86)	.11
13 weeks	26.74 (6.18)	17.54 (13.36)	.00

also significantly correlated with perceived competence at 6 weeks, and it was weakly associated with 13-week PA ($p = .10$). Six-week perceived competence and autonomy support index were significantly associated with 13-week PA.

Effect of the intervention on motivational variables and PA

As can be seen in Table 3, autonomy support index significantly differed between the experimental and control conditions $t(60.0) = 28.66$, $p = .00$. After controlling for baseline autonomous motivation, participants in the experimental condition ($M = 6.48$, SD = 0.58) scored significantly higher than participants in the control condition ($M = 6.25$, SD = .75) with respect to 6-week autonomous motivation [$F(1, 117) = 4.47$, $p < .05$]. This yielded a small-to-medium effect (partial $\eta^2 = .04$). Similar analysis was conducted with perceived competence, but no significant difference was obtained in 6-week perceived competence between the experimental group ($M = 5.96$, SD = 1.15) and the control group ($M = 5.49$, SD = 1.35) after controlling for baseline perceived competence, [$F(1, 117) = 1.92$, $p = .17$]. Nevertheless, the difference between the experimental and control conditions was in the expected direction, but the effect was small (partial $\eta^2 = .02$). Participants in the experimental condition had a significantly higher level of PA at 13 weeks compared to participants in the control condition when controlling for baseline PA, [$F(1,117) = 16.83$, $p < .001$]. The effect size was large (partial $\eta^2 = .13$). Collectively, these results demonstrated that IPAC led to increased levels of autonomous motivation at 6 weeks and PA at 13 weeks. Based on these group differences and as per Williams et al. (2006), the SDT process model of PA adoption was tested separately for each condition.

Testing the SDT process model of PA adoption

Experimental condition model: Results of the path analysis testing the SDT process model revealed that baseline autonomous motivation was significantly related to 6-week autonomous

motivation ($p = .001$). Similarly, baseline perceived competence significantly predicted 6-week perceived competence ($p < .01$), while 6-week autonomous motivation did not ($p = .96$). The autonomy support index was not significantly associated with 6-week autonomous motivation ($p = .52$).

The mediating influence of 6-week perceived competence on the relationship between 6-week autonomous motivation and 13-week PA was then tested in a series of three regressions. In the first regression, 6-week autonomous motivation did not significantly predict 6-week perceived competence ($p = .52$). Six-week autonomous motivation was significantly associated with 13-week PA in second regression ($p < .01$). In the third regression, 6-week autonomous motivation ($p < .01$) and 6-week perceived competence ($p < .05$) were both significantly associated with 13-week PA. Taken together, results suggest that 6-week autonomous motivation and 6-week perceived competence are directly related to PA at 13 weeks.

Control condition model: For the control condition, the path analysis revealed that baseline autonomous motivation was significantly related to 6-week autonomous motivation ($p < .001$), and baseline perceived competence was significantly associated with 6-week perceived competence ($p < .001$). In addition, the autonomy support index was significantly associated with 6-week autonomous motivation ($p < .05$). Six-week autonomous motivation was not significantly associated with 6-week perceived competence ($p = .48$).

In terms of mediating influences, 6-week autonomous motivation significantly predicted 6-week perceived competence ($p < .05$), but not 13-week PA ($p = .44$). When entered together, neither 6-week autonomous motivation ($p = .37$) nor 6-week perceived competence ($p = .60$) significantly predicted 13-week PA. These results suggest that, for the control group, 6-week autonomous motivation and 6-week perceived competence were not directly related to PA at 13 weeks and that no mediation occurred. For both the experimental and control conditions, the final path model with direct links between 6-week autonomous motivation, 6-week perceived competence, and 13-week PA is presented in Fig. 1.

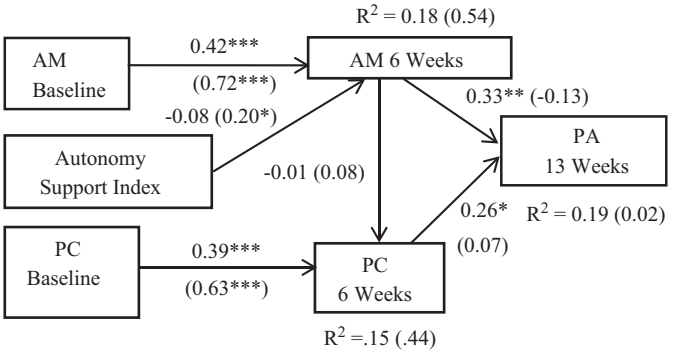

Fig. 1. Final SDT process of change model for experimental and control conditions. Values represent standardized path estimates; those in parentheses are for the control group. AM = autonomous motivation, PC = perceived competence, PA = PA. *$p < .05$. **$p < .01$. ***$p < .001$.

Discussion

The PA Counseling (PAC) trial is the first primary care PA promotion trial to use SDT as the guiding framework. This trial builds on the successful work of Williams et al. (2002, 2006) in the smoking cessation area. The purpose of this paper was to examine if patients who received both brief (2–4 min) autonomy supportive PA counseling (BPAC) from their HCP and intensive (3 months) autonomy supportive counseling (IPAC) from a PA counselor would report greater levels of autonomy support, short-term autonomous motivation and perceived competence, and subsequently greater PA initiation than patients receiving only BPAC. Results revealed that experimental patients reported higher levels on the autonomy support index, had higher levels of autonomous motivation mid-intervention, which translated into higher levels of PA at the end of the intervention (13 weeks). These findings support those of Williams et al. (2006), and extend them into the context of PA adoption. These results are also consistent with SDT's predictions on the positive effects of autonomous motivation on behavior (Ryan & Deci, 2000; Wilson et al., 2005) and are in line with past research in the PA area (Fortier & Kowal, in press; Wilson, Blanchard, Nehl, & Baker, in press). No significant differences were observed between the groups in perceived competence, however. This could be due to ceiling effects or the short assessment time-frame. At 6 weeks, experimental patients had had only two of the six sessions with the PA counselor. It can take time to build feelings of competence, thus assessing perceived competence for a longer period (i.e., 3–6 months) may reveal the predicted differences between groups.

A secondary purpose was to determine if previous results supporting the SDT process model of health behavior change (Williams et al., 2002, 2006) would be replicated for PA adoption in the context of the PAC RCT. Specifically, we investigated if the autonomy support index would influence autonomous PA motivation, if autonomous PA motivation would be associated with perceived competence towards PA and if both autonomous motivation and perceived competence would prospectively influence PA initiation. Results from the path analyses with the experimental group data showed a direct link for both 6-week autonomous motivation and 6-week perceived competence onto PA at 13 weeks, in line with SDT and with previous work (Williams, Gagné et al., 2005). Contrary to previous research (Williams et al., 2006), however, no mediation via perceived competence was found. Future research would do well to further investigate the interplay between perceived competence and autonomous motivation over time as different studies indicate that perceived competence is an antecedent of autonomous motivation (Vallerand & Ratelle, 2002; Kowal & Fortier, 2000), while others have found it to be affected by autonomous motivation. Testing different mediational and moderational models and integrating other concepts such as personal aspiriations and need satisfaction (Gagné, Ryan, & Bargmann, 2003; Ntoumanis, 2005; Wilson, Rodgers, Blanchard, & Gessell, 2003) would be most useful, especially to account for more variance in physical activity behavior.

To our surprise, the autonomy support index was not found to predict autonomous motivation at 6 weeks for experimental participants which runs contrary to SDT, our hypotheses as well as findings by Williams et al. (2002, 2006). What was a strength in this study, however, was that we controlled for the mere presence effect of the PA counselor by incorporating contact time for both groups in the analyses. This unpredicted finding could be due to ceiling effects in the variables. It is also possible that the PA counselor did something else to enhance/maintain autonomous motivation, such as support relatedness and/or suggest enjoyment enhancing strategies that was

not captured by the autonomy support index. An important issue to consider when interpreting these results is that both groups received an autonomy supportive intervention. A usual care control group (with a more neutral approach) would have been beneficial to find an impact with regards to the autonomy support variable. More PA intervention research investigating both amount and quality (autonomy support) of interactions is needed to come to a better understanding of the underpinnings of the changes in key self-determination variables and their relationship with PA. Combining brief versus intensive PA counseling interventions with neutral versus autonomy supportive approaches would be a rigorous and fruitful approach to take in this regard.

For the control group, none of the motivational variables were directly related to PA at 13 weeks. However, the autonomy support index was found to be significantly associated with 6-week autonomous motivation for controls. Given that control participants received an autonomy supportive intervention, this is not surprising. Williams et al. (2006) also found these relationships with their controls in their trial which supports the notion that the internalization process is independent of group/intervention. Moreover, many correlational studies have revealed a positive association between autonomy support and autonomous motivation, including a longitudinal study on lifestyle change including PA (Williams, Gagné et al., 2005).

When looking at the baseline autonomous motivation and perceived competence coefficients onto their respected 6-week variable, a difference between the two groups is apparent. These relationships are stronger for controls. One possible reason for this is that experimentals received an intervention (2 face-to-face counseling sessions) between these time-points, whereas the controls did not.

Several limitations of this study are important to consider. The sample size ($N = 120$) was fairly small, limiting choice of analytical technique and power in the analyses. In addition, the majority of the patients were Francophone and Caucasian, potentially limiting generalizability. Future studies should test this type of intervention with a larger, more diverse sample of patients, ideally among several primary care practices and use Structural Equation Modeling to test SDT PA behavioral change models. An additional limitation of this study is the ceiling effect observed with the motivation variables. Consideration should be given to using the BREQ-2 or using a difficult goal for the TSRQ. Given that participation in this study was voluntary and patients signed a consent form to ensure they were autonomously participating in the trial, patients were motivated toward PA at the beginning of the intervention, which may not be indicative of the general public. Finally, the self-report nature of the physical activity measure could be influenced by social desirability (Warnecke et al., 1997; Sallis & Saelens, 2000), so future research would do well to incorporate an objective measure of PA.

There are many implications of the results of this study for PA promotion in primary care. SDT-trained physicians are able to influence patient's autonomous motivation towards PA. SDT-trained PA counselors appear to provide a valuable contribution to facilitating patient PA behavior change, by fostering patient autonomous PA motivation. When implementing PA counseling interventions, it is important for health professionals to foster both autonomous motivation and perceived competence, particularly during the early phases of adopting a physically active lifestyle. This can be done by expressing empathy, providing encouragement, avoiding judgment, involving patients in decision making and solution finding, and by assisting in realistic goal setting.

This study provides a unique contribution to the literature on SDT-based interventions for health behavior change, and particularly for PA promotion. To our knowledge, no other study has tested an SDT-based PA counseling primary care intervention. Building on the work of Williams et al. in smoking cessation, this study provides a rigorous field test of SDT theory in a PA context. This study provides evidence of the versatility and applicability of the SDT model for health behavior change.

To build on the results of this study, future research should explore whether brief autonomy supportive PA counseling from HCPs is more influential than a usual care control condition. Ideally future studies should recruit participants who are not initially motivated to change their PA to avoid ceiling effects and to target those in most need of PA counseling. In addition, it would be important to extend the intensive intervention time frame (from 3 to 6–12 months) and to have a longer follow-up period once the intervention is terminated (6–12 months post intervention) to provide a more rigorous test of SDT and specifically to determine if a PA counselor can have long-term effects on participants' autonomous motivation and perceived competence and if this mediates not only short- but long-term effects in PA.

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