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Change in Explicit and Implicit Motivation Toward Physical Activity and Sedentary Behavior in Pulmonary Rehabilitation and Associations With Postrehabilitation Behaviors

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Objective: The aim of this study was twofold: (a) to determine whether Theory of Planned Behavior (TPB) variables and implicit attitudes toward physical activity and sedentary behavior would change during a 5-week pulmonary rehabilitation (PR) program, and (b) to investigate the relationships between behavioral intentions, implicit attitudes, physical activity, and sedentary behavior in postrehabilitation. ***Design:*** Out of 142 patients with respiratory disease included in this study, 119 completed 2 questionnaires measuring TPB variables with regard to physical activity and sedentary behavior, and an Implicit Association Test (IAT) measuring implicit attitudes toward physical activity in contrast to sedentary behavior. The TPB questionnaires and the IAT were administered at the beginning (Time 1) and the end of the program (Time 2). Six months after the program (Time 3), 62 patients provided self-reported measures of their recreational physical activity and screen-based, leisure-time sedentary behavior. ***Results:*** Over the course of pulmonary rehabilitation, perceived behavioral control and intentions toward physical activity increased, as did social norms and perceived behavioral control toward sedentary behavior; implicit attitudes were also more positive toward physical activity. Implicit attitudes at the end of PR (Time 2) were significantly associated with postrehabilitation physical activity (Time 3). ***Conclusions:*** TPB variables toward physical activity and sedentary behavior as well as implicit attitudes were enhanced during PR. At 6 months, implicit attitudes were significantly associated with physical activity. These results suggest that motivation, particularly implicit attitudes, should be targeted in future behavioral interventions in order to optimize the effects of rehabilitation on physical activity maintenance.

Impact and Implications

Understanding the maintenance of an active lifestyle after pulmonary rehabilitation is challenging. This study is the first to explore the role of both implicit and explicit motivational variables as outcomes of pulmonary rehabilitation and predictors of postrehabilitation behaviors. The study highlighted that certain, but not all, explicit and implicit motivational variables could be enhanced during pulmonary rehabilitation. However, only implicit motivational factors were significantly associated with postrehabilitation physical activity in this study. Results suggest to consider both explicit and implicit motivation as an important outcome in pulmonary rehabilitation context. Implicit motivational processes could be a relevant determinant to target in future experimental studies and behavioral interventions.

Keywords: Theory of Planned Behavior, implicit attitudes, respiratory disease, dual processes model, automatic processes

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Introduction

Patients with chronic respiratory disease are less physically active than age-matched healthy individuals (Pitta et al., 2005). Yet reduced physical activity in this population predicts poor health-related outcomes (Waschki et al., 2011). Compared with other therapies, Pulmonary Rehabilitation (PR) has arguably the most powerful effect on patients' physical and psychological health (McCarthy et al., 2015). PR is a comprehensive intervention that focuses on exercise training and education with the twofold aim of improving the physical and psychological condition of patients and promoting long-term adherence to health-enhancing behaviors (Spruit et al., 2013). One of the main PR outcomes is increased exercise capacity that will carry over into more active behaviors in postrehabilitation daily living (Spruit, Pitta, McAuley, ZuWallack, & Nici, 2015). Unfortunately, the transition from supervised exercise during PR to autonomous active behavior after the program does not systematically occur.

A recent review of 11 studies noted that only three of them reported a significant increase in physical activity after PR compared with preenrolment levels, three reported an increase in only some of the physical activity indicators, and five found no significant increase in physical activity (Spruit et al., 2015). In addition, a longitudinal study investigating trajectories in self-reported physical activity 1 year after PR found that only 30% of the patients were sufficiently active in the postrehabilitation period, whereas 15% started with a sufficient active level post-PR but significantly declined over time, and 55% were insufficiently active both at the end of the PR program and in the postrehabilitation period (Soicher et al., 2012). Given these findings, a call was made for interdisciplinary studies, especially combining the rehabilitation and behavioral sciences, in order to gain an in-depth understanding of behavior change during and after PR (Spruit et al., 2015).

To date, very little information is available on the components that may be missing from PR programs that would ensure long-term postrehabilitation behavioral modification. Previous studies have mainly focused on the clinical variables traditionally measured in PR as potential determinants of patients' physical activity (Yu, Frei, Ter Riet, & Puhan, 2016). For example, patients who are more active after PR are usually those who exhibit higher exercise tolerance at the end of the program (Saunders et al., 2015; Soicher et al., 2012). However, in addition to the usual physiological variables studied in respiratory medicine, there is a strong need to consider behavioral determinants which explain a significant part of postrehabilitation behaviors. For example, over the past three decades, studies have demonstrated that health behaviors are consistently associated with individuals' motivational characteristics (Gourlan et al., 2016; Rebar et al., 2016; Sheeran, Gollwitzer, & Bargh, 2013). Contemporary theories of motivation like the reflective impulsive model (Strack & Deutsch, 2004) assume that two categories of psychological determinants shape individual behavior: explicit and implicit processes (Gawronski & Payne, 2011), and this assumption is shared by researchers in health psychology (Hofmann, Friese, & Wiers, 2008).

Explicit processes are generally included in sociocognitive models that assume that health behaviors result from conscious cognitions, such as goals and intentions (Sheeran et al., 2016). One of the most cited theories dealing with explicit motivation is the Theory of Planned Behavior (TPB; Ajzen, 1991). In this model, the conscious *intention* to act is considered the most proximal precursor of behavior. This construct is enhanced by positive *explicit attitudes* (i.e., subjective evaluation of the (un)likable and useful/less characteristics of the behavior), encouraging *social norms* (i.e., positive opinion and behaviors of members of the social environment), and high *perceived behavioral control* (i.e., perception of one's ability to perform the behavior and control it). Intentions are thus mediators in the relationship between explicit attitudes, social norms, and perceived behavioral control (i.e., also conceptualized as a direct determinant of behavior) and behavior.

The predictive validity of this model in the health field has been supported by several meta-analyses (McEachan et al., 2016; McEachan, Conner, Taylor, & Lawton, 2011; Hagger, Chatzisarantis, & Biddle, 2002), and two studies carried out in rehabilitation (i.e., cardiac) have also provided support for the tenets of the TPB (Blanchard et al., 2003; Blanchard, Courneya, Rodgers, Daub, & Knapik, 2002). In these studies, explicit attitudes, subjective norms, and perceived behavioral control were independent predictors of exercise intentions, which in turn significantly predicted exercise adherence during rehabilitation and follow-up. However, little is known about the change of explicit motivation during PR. Rodgers, Murray, Selzler, and Norman (2013) found that task self-efficacy was significantly improved during cardiac rehabilitation, whereas barrier self-efficacy and scheduled self-efficacy were not. Moreover, in lung cancer survivors, the only TPB variable enhanced during a 10-week exercise program was perceived behavioral control (Peddle-McIntyre, Bell, Fenton, McCargar, & Courneya, 2013). These findings suggest that the TPB variables may not be modified in the same way during a PR program, and further investigation into how each of them changes is thus needed.

In parallel to conscious cognitive processes, such as the TPB variables, one recent review highlighted that physical activity also depends on less conscious cognitions (Rebar et al., 2016). Accordingly, it is increasingly recognized in health psychology that behavioral determinants should be described both in terms of explicit and implicit processes (Sheeran et al., 2013). In contrast to explicit processes, which refer to conscious thoughts, implicit processes refer to cognitive, affective, and motivational processes that influence health decisions and behaviors with little awareness of their influence (Sheeran et al., 2013, 2016). Methodologically, implicit psychological processes therefore need to be assessed indirectly. The measures are generally operationalized through computerized tasks with the reaction times (RTs) recorded to assess participants' implicit cognitions (i.e., in contrast to explicit processes, which are frequently measured with self-report questionnaires). Over the last decade, the study of these variables has received increasing attention in the physical activity field (Rebar et al., 2016), particularly implicit attitudes (i.e., automatic evaluations of an object as pleasant or unpleasant, which operate mostly outside of a person's awareness; Greenwald & Banaji, 1995). Indeed, evidence is increasing that implicit attitudes are significantly related to physical activity, whether self-reported (Berry, Spence, & Clark, 2011; Bluemke, Brand, Schweizer, & Kahlert, 2010; Calitri, Lowe, Eves, & Bennett, 2009; Eves, Scott, Hoppé, & French, 2007) or objectively measured (Conroy, Hyde, Doerksen, & Ribeiro, 2010; Rebar, Ram, & Conroy, 2015).

Moreover, implicit attitudes were found to be significantly associated with physical activity (Conroy et al., 2010), controlling for the effect of TPB variables, particularly in obese persons (Chevance, Caudroit, Romain, & Boiché, 2017). In addition, several quasiexperimental studies in the physical activity context have suggested that implicit attitudes are malleable (Antoniewicz & Brand, 2016; Berry, 2016; Hyde, Elavsky, Doerksen, & Conroy, 2012; Markland, Hall, Duncan, & Simatovic, 2015). Hence, the study of implicit attitudes in addition to TPB variables during PR might provide deeper insight into the role of motivation during rehabilitation and potentially inspire new interventional perspectives (Hollands, Marteau, & Fletcher, 2016; Papies, 2016; Rebar et al., 2016).

In this study, we thus focused on the motivation for both physical activity and sedentary behavior (i.e., time spent sitting) independently, a procedure that is currently considered necessary to provide an accurate picture of patient lifestyles (Sparling, Howard, Dunstan, & Owen, 2015). Indeed, previous studies have shown that (a) sedentary behavior is partially independent of the physical activity level (Mansoubi, Pearson, Biddle, & Clemes, 2014), (b) high levels of both behaviors can be displayed by certain individuals (Omorou, Coste, Escalon, & Vuillemin, 2016), and (c) the adverse health effects of sitting time are in part independent of physical activity level (Biswas et al., 2015). Some authors have therefore argued that sedentary behavior is a valid outcome to be considered apart from physical activity in the context of PR (Spruit et al., 2015). Currently, little is known about the motivational determinants of sedentary behavior. Theoretically, this behavior may depend on the same types of motivational processes as physical activity (Maher & Conroy, 2016), but the motivations for both categories may be impacted differently by an intervention (Biddle, Mutrie, & Gorely, 2015).

Research on motivation for physical activity and sedentary behavior is crucial to achieve a better understanding of how PR affects behavior in postrehabilitation. Such studies thus potentially offer a way to refine the current rehabilitation programs. The aims of this study were therefore (a) to assess the changes in TPB variables and implicit attitudes toward physical activity and sedentary behavior during PR, and (b) to examine the relationships between these variables and both physical activity and sedentary behavior at 6 months postrehabilitation.

Method

Participants

All potential study participants had a medical indication for pulmonary rehabilitation to manage respiratory disease. They were eligible for study enrollment if they were between 18 and 75 years old and had health care coverage. They were not included in the study if they had needed acute care (e.g., exacerbation requiring hospitalization) in the previous month, had a medical contraindication to exercise or health problems that precluded program completion, were unable to respond to paper-based questionnaires or perform computerized tests, or were under psychiatric treatment that might affect their judgment. During the program, participants were excluded from the study if they did not participate in the entire program (e.g., due to injury or other incapacity). Six months after the end of PR, participants were excluded from the analyses if they failed to report their level of physical activity and sedentary behavior in postrehabilitation period. No intervention or incentive was provided to encourage maintained participation in the study. The recruitment phase of the study (inclusion evaluations and Time 1 measures) took place in France between March and October 2015. All participants gave written consent. Procedures were in accordance with the principles of the Declaration of Helsinki of 1975, as revised in 2000.

Pulmonary Rehabilitation Program

The inpatient PR program lasted 5 weeks and primarily focused on exercise, with 13–24 hours per week of Adapted Physical Activities including treadmill walking, outdoor walking, aqua-aerobics, strengthening exercises, and stretching. The education sessions included lectures on nutrition, tobacco, stress, and general disease management. Psychologists and nutritionists were available to meet with patients in individual sessions. None of the health professionals were trained in behavior change theories and techniques, and the program was not specifically designed to enhance patient motivation.

Measures

Demographic and clinical characteristics. Age, gender, marital and current employment status as well as the number of previous stays in previous inpatient rehabilitation programs were self-reported. Indications concerning psychiatric antecedents (i.e., presence vs. absence of a psychiatric antecedent), declarative regular physical activity (i.e., practicing at least 30 min of physical activity 5 times per week vs. no regular practice) and tobacco consumption (i.e., never, abstainer or weaned, smoker) were recorded during an interview with a physician. Body mass index and symptom-limited $\dot{V}O_2$ peak % theoretical (Wasserman, Hansen, Sue, Casaburi, & Whipp, 1999), were measured at the beginning of the program by a physician.

Variables of the Theory of Planned Behavior for physical activity. The questionnaires assessing the TPB variables were formulated following the recommendations of Ajzen (2006). Participants were first informed of the definition of regular physical activity according to the French national plan for nutrition and health (i.e., doing at least 30 min per day of moderate to vigorous physical activity, 5 days per week). We assessed explicit attitudes through 7-point semantic differentiation scales, for which the instructions were: "For you, practicing a regular physical activity after your rehabilitation program would be. . . ." Six pairs of positive (e.g., pleasant, beneficial, useful) and negative (e.g., unpleasant, harmful, unnecessary) adjectives were used (α = .78). Intentions (e.g., "I intend to practice a regular physical activity after my rehabilitation program"; α = .88), perceived behavioral control (e.g., "I feel able to practice a regular physical activity after my rehabilitation program"; α = .67) and social norms (e.g., "People who are important to me encourage me to practice a regular physical activity after my rehabilitation program"; α = .88) were each measured through three items with a 7-point Likert scale ranging from (1) *do not at all agree* to (7) *totally agree*.

Mean scores were computed for each variable between 1 (lowest score) and 7 (highest score).

Variables of the Theory of Planned Behavior for sedentary activities. The questionnaire assessing the TPB variables regarding sedentary behavior started with a definition of these activities (i.e., time spent by a person sitting or lying down, Sedentary Behaviour Research Network, 2012). In line with recent research (Maher & Conroy, 2016), items were formulated regarding the absence of sedentary behavior: "For you, limiting the time spent in sedentary activities after your rehabilitation program would be. . . ." Similar to physical activity, six items were used for explicit attitudes ($\alpha = .74$) and three for intentions (e.g., "I intend to limit my sedentary activities after my rehabilitation program"; $\alpha = .85$), perceived behavioral control (e.g., "I feel able to limit my sedentary activities after my rehabilitation program"; $\alpha = .67$) and social norms (e.g., "People who are important to me encourage me to limit my sedentary activities after my rehabilitation program"; $\alpha = .89$). Mean scores between 1 and 7 were computed for each variable.

Implicit attitudes toward physical activity versus sedentary behavior. Implicit attitudes were measured with a computerized Implicit Association Test and by analyzing participant's RTs throughout the test (IAT; Greenwald, McGhee, & Schwartz, 1998). This test evaluates the strength of a person's mentally held automatic associations between two attributes (e.g., positive and negative) and two conceptual targets (e.g., physical activity vs. sedentary behavior). During the IAT, participants are required to sort stimuli (i.e., words or images) representing four categories with only two response keys, each assigned to two of the four categories (e.g., physical activity + positive vs. sedentary behavior + negative; physical activity + negative vs. sedentary behavior + positive). If two categories are highly associated mentally for that person, the sorting task is expected to be easier when they share the same response key than when they do not. Hence, ease of sorting can be estimated by the speed of responding (Greenwald, Nosek, & Banaji, 2003).

The IAT procedure comprised seven blocks. In Block 1, the two conceptual categories "physical activity" and "sedentary behavior" were displayed on the left and right sides of the window. Participants were asked to sort words into either category, physical activity or sedentary behavior. Each trial consisted of a stimulus appearing in the center of the computer screen and had to be classified into the correct category. The word remained on the screen until the participant made a categorization choice. Participants used the letter *Q* on the left side on the keyboard, and the number *5* on the right side on the numeric keypad to select their category choice for each stimulus. If a word was incorrectly categorized (e.g., the word *run* in the category sedentary behavior), an indication (X) appeared on the screen, and the participant had to fix his or her error by pressing the correct response key before going on with the test. In Block 2, participants were asked to sort words corresponding to the attributes "positive" or "negative", displayed in the left and right side of the screen, and following the same procedure as in Block 1. In Blocks 3 (i.e., practice block) and 4 (i.e., test block), participants were asked to sort the stimuli corresponding to the four categories combined (e.g., physical activity + positive in the right side of the screen vs. sedentary behavior + negative in the left side of the screen). Block 5 was similar to Block 1 but the categories were reversed in position (i.e., if physical activity was displayed on the right side, the category is placed on the left side and vice versa). In Blocks 6 (i.e., practice block) and 7 (i.e., test block), participants were asked to sort stimuli in the four categories combined in a reversed version (e.g., physical activity + negative in the right side of the screen vs. sedentary behavior + positive in the left side of the screen). Following the recommendation from Greenwald et al. (2003), practice blocks comprised 20 trials and test blocks comprised 40 trials. Before starting, participants were told that they would be making a series of category classifications. The instructions were to sort the stimuli as quickly as possible and to make as few mistakes as possible, insisting on the fact that these two parameters were equally important.

The data were prepared according to Richetin, Costantini, Perugini, and Schönbrodt (2015): (a) for each participant, the 10% fastest and slowest latencies were replaced by the last untrimmed latencies, for both error and correct responses, (b) the difference between the average latencies of the two critical blocks was divided by the pooled *SD* of all the latencies, and (c) the score was computed based on practice and critical trials together. The score was between −2 (implicit attitudes in favor of sedentary behavior compared with physical activity) to +2 (implicit attitudes in favor of physical activity compared with sedentary behavior), 0 being a neutral score suggesting no distinct treatment between concepts. The IAT and this scoring algorithm were preferred to other methods due to stronger test–retest reliability [$ICC_{(2,1)\ \text{Time 1-Time 2}} = 0.78$] and internal consistency [$\alpha_{\text{Time 1}} = 0.97$ and $\alpha_{\text{Time 2}} = 0.96$] demonstrated in a sample of patients admitted for PR (Chevance, Héraud, Guerrieri, Rebar, & Boiché, 2016).

Physical activity behavior. Physical activity in the postrehabilitation period was measured with the Phone-Fitt Questionnaire (Gill, Jones, Zou, & Speechley, 2008). This questionnaire was first validated in older adults and provides information about the nature of activities (i.e., household and recreational activities: "In a typical week in the last month, did you engage in the activity . . ."), their frequency (i.e., from 0 to 7 times per week; "How many times/week?") and duration (i.e., "About how much time on each occasion?"). The score was computed following recommendations (Gill et al., 2008): the sum of the frequency (i.e., from 0 to 7 times per week) and the duration code (i.e., 0 = *1–15 min*, 1 = *16–30 min*, 2 = *31–60 min*, and 4 = *more than 60 min*), summed across all recreational activities (i.e., 14 items including walking, lifting weight, swimming, and others).

Sedentary behavior. Sedentary behaviors in the postrehabilitation period were measured with the Sedentary Behavior Questionnaire for adults (Rosenberg et al., 2010). This questionnaire assesses the time spent in different sedentary activities per day during the week and weekend separately. Questions were formulated as follows: "On a typical week day/weekend day, how much time do you spend (from the moment you wake up until you go to bed) doing the following activities?" In the present study, the score was computed using four items corresponding to screen-based leisure-time activities (e.g., the time spent watching TV and using a computer for leisure) for weekdays and weekend days. The mean time spent on screen-based leisure activities was computed based on these four items.

Procedures

Variables from the TPB and implicit attitudes were first measured in one of the first 2 days of the program (Time 1), and again 5 weeks later at the end of PR (Time 2). Physical activity and sedentary behaviors were recorded 6 months after the end of the program (Time 3). The physical activity and sedentary behavior questionnaires were delivered by regular mail. If patients did not respond within 2 weeks, they were reached by phone. After three missed calls, they were excluded from follow-up analyses. All the motivational and behavioral data were collected by the same experimenter (first author).

Statistical Analysis

We calculated the sample size needed to determine a change in implicit attitudes between Time 1 and Time 2, taking into account potential attrition in the rehabilitation context. Regarding implicit attitudes, Hyde et al. (2012) highlighted an effect size of .20 (Cohen's *d*, Cohen, 1988) at 1 week among students. Furthermore, Markland et al. (2015) showed a difference of .40 in implicit attitudes between participants from an intervention versus control group. Accordingly, we considered an effect size of .30 for this study. A priori analyses carried out in G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) showed that a sample of 122 patients would be sufficient to detect an effect size of at least .30 with 95% power at the 5% significance level. Assuming a 20% attrition rate, we planned to recruit 140 participants. Regarding follow-up analyses at Time 3, post hoc power (1-β) analyses were conducted using standard formulas (Cohen, Cohen, West, & Aiken, 2003).

Means and standard deviations were computed for continuous variables, and frequencies were calculated for categorical variables. Next, to test for potential attrition biases, independent sample *t* tests and chi-square tests were performed to compare the baseline characteristics (i.e., age, BMI, sex, motivation) of participants who completed the program (Time 2) with those who only participated at Time 1.

To examine change in the TPB variables and implicit attitudes during the program, we performed one-tailed paired sample *t* tests, and Cohen's *d* was used as the indicator of effect size. Multiple regression models were performed to assess whether motivation were significantly associated with physical activity and sedentary behaviors 6 months after PR (Time 3). In a first model (Model 1), independent variables measured at Time 1 were regressed on physical activity and sedentary behavior at Time 3. In a second model (Model 2), independent variables measured at Time 2 were regressed on follow-up behavior at Time 3. In both models, exercise tolerance (i.e., best distance covered in walking tests performed both at Time 1 and Time 2, and expressed in percentage of theoretical value; Troosters, Gosselink, & Decramer, 1999; Singh, Morgan, Scott, Walters, & Hardman, 1992) was entered as an independent variable in models to control for the potential impact of this variable on physical activity maintenance after PR (Saunders et al., 2015; Soicher et al., 2012). All the analyses were performed with JASP 0.7.1.12 software (JASP, 2016).

Results

Participant Characteristics and Descriptive Statistics

One hundred and 42 patients were included in this study, and 119 completed the PR program and evaluations at Time 2. Of the 23 who did not provide data at Time 2, almost half experienced injury or exacerbation during the program ($n = 11$), 10 did not complete the program for other reasons, and some were not interested in completing the Time 2 measures ($n = 2$). Regarding attrition biases, independent sample *t* tests and chi-square tests yielded no significant differences in the Time 1 characteristics between those who participated at Time 2 and those who did not. The scores of these two groups of participants at Time 1 are presented in Table 1. At Time 3 (i.e., 6 months after PR), 62 patients provided self-reported measures of physical activity and sedentary behavior. Among the 57 patients who did not provide behavioral measures, a majority did not respond to the questionnaires and were not available by phone ($n = 38$), others were hospitalized during the postrehabilitation phase ($n = 9$), some sent in their questionnaire responses but after the 6-month cutoff ($n = 8$), one participant declined, and one participant died during the follow-up period.

Change in Theory of Planned Behavior Variables and Implicit Attitudes During the Program

Change in TPB variables and implicit attitudes between the start (Time 1) and the end of the program (Time 2) are provided in Table 2. Regarding the TPB variables toward physical activity, there was a significant increase between Time 1 and Time 2 for

Table 1
Demographic Characteristics at Time 1

	Mean (***SD***) or %	
Demographic and clinical variables	Participants ($N = 119$)	Drop-outs ($N = 23$)
Age (years)	61.73 ± 8.7	62.41 ± 8.5
Previous rehabilitation programs	1.8 ± 1.1	2.1 ± 1.6
BMI (kg/m^2)	28.6 ± 6.5	30.8 ± 12.0
$\dot{V}O_2$ peak (% theo.)	64.3 ± 23.1	62.6 ± 19
Sex		
Female	47%	44%
Male	53%	56%
Marital status		
Married	66%	62%
Single	34%	38%
Professional status		
Workers	20%	21%
Retired	55%	53%
Unemployed	25%	26%
Self-reported physical activity	39%	40%
Psychiatric antecedents	9%	17%
Tobacco		
Never	28%	40%
Abstainer or weaned	41%	35%
Smoker	31%	25%

Note. BMI = body mass index; Participants = patients who completed the Time 2 survey; Drop-outs = patients who did not complete the Time 2 evaluations.

Table 2
Differences in TPB Variables and Implicit Attitudes Between Time 1 and Time 2 (N = 119)

Psychological variables	Time 1 *M* (*SD*)	Time 2 *M* (*SD*)	*t*	*p*	*d*
TPB Physical activity					
Intentions	5.8 (1.03)	6.0 (.90)	1.83	**.035**	.17
Explicit attitudes	6.2 (.88)	6.3 (.77)	1.56	.060	.15
Social norms	5.5 (1.42)	5.6 (1.49)	1.27	.104	.12
Perceived behavioral control	5.4 (1.13)	5.7 (.90)	2.28	**.012**	.22
TPB Sedentary behavior					
Intentions	5.4 (1.26)	5.6 (1.15)	1.20	.117	.11
Explicit attitudes	5.8 (.95)	5.9 (.95)	.48	.316	.05
Social norms	4.8 (1.81)	5.1 (1.70)	1.86	**.033**	.18
Perceived behavioral control	5.2 (1.20)	5.5 (.96)	1.96	**.026**	.19
Implicit attitudes	.56 (.85)	.73 (.81)	2.36	**.010**	.22

Note. TPB = Theory of Planned Behavior; *M* = mean; *SD* = standard deviation; *d* = effect size according to Cohen's *d*.

intentions ($p = .035$, $d = .17$) and perceived behavioral control ($p = .012$, $d = .22$). Explicit attitudes and social norms did not change significantly. Regarding the TPB variables toward sedentary behavior, social norms and perceived behavioral control were significantly higher at Time 2 compared with Time 1 ($p = .033$, $d = .18$; $p = .026$, $d = .19$), but intentions and explicit attitudes did not change significantly. Implicit attitudes significantly improved in favor of physical activity compared with sedentary behavior during the program ($p = .01$, $d = .20$). Effect sizes were between [.17–.22], which indicates small effects, according to Cohen's *d* (Cohen, 1988).

Association Between Theory of Planned Behavior Variables, Implicit Attitudes and Behaviors in Postrehabilitation

Multiple regression analyses were performed to examine whether motivation significantly predicted physical activity and sedentary behavior 6 months after PR. Exercise tolerance, intentions and implicit attitudes measured at Time 1 (i.e., start of PR, Model 1) or Time 2 (i.e., end of PR, Model 2) were entered as independent variables. Physical activity and sedentary behavior at Time 3 were entered as dependent variables. Intentions toward physical activity were entered when the dependent variable was physical activity behavior, and sedentary behavior intentions were entered when the dependent variable was sedentary behavior. Results of the regression analyses are displayed in Table 3.

Regarding Model 1 for physical activity, the equation was statistically significant: $F(3, 53) = 5.11$; adjusted $R^2 = .18$; $p =$ 004, 1-β = .49. Exercise tolerance ($\beta = .39$; $p = .003$) was significantly and positively associated with physical activity, whereas implicit attitudes ($\beta = .17$; $p = .169$) and intentions were not ($\beta = .10$; $p = .416$). Regarding Model 1 for sedentary behavior, the equation was statistically significant $F(3, 52) = 5.79$; adjusted $R^2 = .21$; $p = .002$, 1-β = .51. Exercise tolerance was significantly and negatively associated to sedentary behavior ($\beta = -.42$; $p < .001$). Implicit attitudes ($\beta = -.16$; $p = .195$), and intentions ($\beta = -.13$; $p = .283$) were not associated with sedentary behavior.

Regarding Model 2 for physical activity, the equation was statistically significant: $F(3, 50) = 7.13$; adjusted $R^2 = .26$; $p <$ .001, 1-β = .59;. Exercise tolerance ($\beta = .43$; $p < .001$) and implicit attitudes ($\beta = .29$; $p = .020$) were significantly associated with physical activity, whereas intentions were not ($\beta = .10$; $p =$ .416). Regarding Model 2 for sedentary behavior, the equation was statistically significant $F(3, 48) = 5.98$; adjusted $R^2 = .23$; $p =$ .002, 1-β = .53. Exercise tolerance was significantly and negatively associated to sedentary behavior ($\beta = -.45$; $p < .001$). Implicit attitudes ($\beta = -.21$; $p = .097$), and intentions were not associated with sedentary behavior ($\beta = .15$; $p = .247$).

For both regression models, standardized residuals as well as variance inflation factors were examined, revealing no problem of nonlinearity, heteroscedasticity or multicollinearity.[1]

Discussion

The two objectives of this study were to assess (a) the change in TPB variables and implicit attitudes toward physical activity and sedentary behaviors during PR, and (b) to examine whether explicit and/or implicit motivation was significantly associated with patients' behaviors at 6 months postrehabilitation. First, the results indicated that both explicit and implicit motivational processes may be sensitive to PR. Intentions and perceived behavioral control toward physical activity, as well as social norms and perceived behavioral control toward sedentary behavior, increased during the PR period. Implicit attitudes also became more in favor of physical activity compared with sedentary behavior. Second, implicit attitudes at the end of the PR program were a significant predictor of physical activity but not sedentary behavior. No independent association of intentions with physical or sedentary behavior was observed.

Change in Explicit and Implicit Motivational Processes

Regarding the TPB variables, perceived behavioral control toward both behaviors increased during PR, whereas explicit attitudes did not change for either of them. Social norms for sedentary behavior significantly increased, but not those for physical activity; and intentions toward physical activity were higher at the end of PR, but not toward sedentary behavior. These results highlight the interest of studying these motivational processes independently, given that they were modified in different ways over the course of the PR. Previous research noted the independence of some of the TPB variables toward physical activity and sedentary behavior in students (Rhodes & Blanchard, 2008), and the results of our study extend this literature. In the present study, solely perceived behavioral control toward the two behaviors was consistently enhanced, which is in accordance with previous study conducted among cancer survivors (Peddle-McIntyre et al., 2013).

[1] Intentions have been entered as an independent variable in both models because they theoretically mediate the relationships between explicit attitudes, social norms and perceived behavioral control on the one hand, and behavior on the other. In complementary analyses, the other TPB variables were not significantly associated with behaviors in postrehabilitation, and implicit attitudes at Time 2 remained significantly associated with physical activity but not with sedentary behavior.

Table 3
Multiple Regression Analyses Displaying the Associations Between Motivation (Time 1 and Time 2) and Behaviors (Time 3)

Predictors	Physical activity Time 3			Sedentary behavior Time 3		
	B (*SE*)	β	R^2	*B* (*SE*)	β	R^2
Model 1						
Exercise tolerance Time 1	.11 (.03)	.39**	.18	−.04 (.01)	−.42***	.21
Intentions Time 1	−.62 (.85)	−.10		−.27 (.25)	−.13	
Implicit attitudes Time1	1.48 (1.07)	.17		−.48 (37)	−.16	
Model 2						
Exercise tolerance Time 2	.11 (.03)	.43***	.26	−.04 (.01)	−.45***	.23
Intentions Time 2	−.81 (.98)	.10		−.66 (.39)	.15	
Implicit attitudes Time 2	2.5 (1.03)	.29*		.35 (.30)	−.21	

Note. *B* = unstandardized; *SE* = Standard error; β = standardized; R^2 = Adjusted; Due to missing data on exercise tolerance, $N = 57$ for physical activity Model 1, $N = 56$ for sedentary behavior Model 1, $N = 54$ for physical activity Model 2, and $N = 52$ for sedentary behavior Model 2.
* $p < .05$. ** $p < .01$. *** $p < .001$.

This result appears logic in a rehabilitation context where daily structured exercise courses are proposed to patients, and could reinforce their perceptions of control toward the behaviors. Regarding intentions, the significant enhancement of physical activity intentions compared to sedentary behavior could be explained by the fact that exercise and health professionals do not systematically know the differences between physical activity and sedentary behaviors. It could be hypothesized that their discourses focus more on physical activity participation than on the reduction of sedentary behavior, which could have differently impacted these two variables in this study. Regarding explicit attitudes, the lack of significant change during the program could be explained by strong attitudes from the start of the program. Indeed, means for these variables at Time 1 were higher than the other TPB variables, which may have statistically limited their increase during PR. Finally, regarding the lack of studies investigating change in social norms, it is challenging in the present study to explain a change of this variable toward sedentary behavior but not toward physical activity. Experimental studies specifically targeting the TPB variables are needed to more fully elucidate the nature of the changes that occur (Chatzisarantis & Hagger, 2005; Sniehotta, 2009). It is also important to note that the effect sizes concerning the changes in these variables were small in the present study. This could be due to high scores on the TPB variables at the start of program, which may have limited their increase during PR. Future studies might therefore specifically pay attention to patients characterized by low levels of explicit motivation and who could be more likely not to engage in PR programs.

Regarding implicit attitudes, our results showed a significant change in favor of physical activity compared with sedentary behavior during the program. This result indicates that the patients automatically evaluated the concept of physical activity more positively and/or the concept of sedentary behavior more negatively at the end of the program compared with the start. To date, only a handful of studies have explored the malleability of physical activity implicit attitudes (Antoniewicz & Brand, 2016; Berry, 2016; Hyde et al., 2012; Markland et al., 2015), and none were conducted in a rehabilitation context. Importantly, the results of the current study confirm that implicit attitudes can change in PR without specific interventions targeting these processes. Nevertheless, as noted, the effect size was small, suggesting that an additional intervention would be required to observe a larger modification of this variable. In this aim, several frameworks have recently been proposed to target implicit processes (Hollands et al., 2016; Papies, 2016). These interventions focus on behavior change techniques supposed to have a significant impact without participants' awareness, such as health goal priming or evaluative conditioning. In future studies, it would be interesting to examine the complementary impact of this kind of intervention during PR in parallel to more traditional intervention content (e.g., patient education and counseling). Last, implicit attitudes were significantly enhanced during PR in this study, contrary to explicit attitudes. This pattern of results were observed in another experimental study (Hollands, Prestwich, & Marteau, 2011), supporting the assumption that these two constructs are independent (Hyde, Doerksen, Ribeiro, & Conroy, 2010).

Association Between Explicit and Implicit Motivation and Behaviors During Postrehabilitation

When exercise tolerance at the end of PR and implicit attitudes were controlled for, intentions were not significantly associated with either physical activity or sedentary behavior. In the literature, this phenomenon has been referred to as the *intention–behavior gap* (Webb & Sheeran, 2006). In the physical activity field, research has indicated that more than one third of the people who intend to be physically active fail to translate their intentions into actual behavior (Rhodes & de Bruijn, 2013). Several moderators of this relationship have been investigated, and intention stability (i.e., the degree to which a person's intentions are stable over time) appears to be the most consistent one to date (Rhodes & Dickau, 2012). This may explain why intentions were not related to behaviors in the current study. Indeed, the time between the measure of intentions and the assessment of behaviors (i.e., 6 months) was longer than in previous research in rehabilitation (e.g., 14 weeks, Blanchard et al., 2002). Given that intentions are likely to fluctuate over time—due to disease symptoms, tiredness, or even weather—additional studies are needed to identify which techniques or health care organizations effectively sustain intention stability in postrehabilitation (Michie et al., 2011). For example, self-regulatory strategies, such as implementation intentions (Gollwitzer & Brandstätter, 1997), may be of particular interest to support the transition between intentions and behaviors in chronic disease patients, at least in the short term (Rodgers et al., 2014).

With exercise tolerance and intention level controlled for, we observed that implicit attitudes measured at the end of the program, but not at the start, played a significant role in physical activity reported 6 months postrehabilitation. These results mean that automatic evaluations in favor of physical activity compared to sedentary behavior lead to higher level of physical activity participation 6 months after PR. Interestingly, PR seems to have significantly impacted the relationship between implicit attitudes and behavior. Indeed, only Time 2 implicit attitudes are significantly associated with physical activity, while this was not the case of baseline scores. Prospective studies have already shown significant associations between implicit attitudes and physical activity, but only with short-term follow-up (i.e., 1–2 weeks, Conroy et al., 2010; Rebar et al., 2015). The current study thus contributes to the literature by demonstrating the long-term associations between implicit motivational processes and behaviors in the physical activity context (Rebar et al., 2016). Post hoc analyses revealed that implicit attitudes explained 12% of the additional variance in physical activity behavior, controlling for exercise tolerance and intentions. Although this result may appear modest, physical activity behaviors depend on multiple processes (Bauman et al., 2012), and it is encouraging that a motivational variable was associated with physical activity measured at 6 months. Thus, implicit attitudes could be a relevant target to promote physical activity after PR. Experimental studies specifically targeting implicit motivational processes are now required to confirm their role in behavior change. In this study, the association between implicit attitudes and sedentary behavior did not reach a statistical significance threshold. Further investigations would be required to describe the role of implicit attitudes in long-term sedentary behavior after PR.

Implications for Pulmonary Rehabilitation

Researchers in respiratory medicine have argued that PR needs to be optimized to foster meaningful and sustainable behavior change (Spruit et al., 2013) and that future studies would do well to combine the knowledge gained in both the rehabilitation and behavioral sciences to better understand how to achieve this goal (Spruit et al., 2015). Unfortunately, the field of PR currently suffers from a lack of interdisciplinary research, which has impeded the accumulation of knowledge regarding physical activity and sedentary behavior change (see Cavalheri, Straker, Gucciardi, Gardiner, & Hill, 2016). For example, although recommendations in respiratory medicine have called for the design of behavioral interventions based on theoretical models of health psychology, these recommendations have failed to consider the variables of these models as crucial intervention outcomes (Leidy et al., 2014). This oversight has limited knowledge building and insight into why and for whom a behavioral intervention may be (in)effective (see Peters, de Bruin, & Crutzen, 2015). In the future, more research is needed to identify modifiable mediators of physical activity and sedentary behavior in various PR contexts, particularly when postrehabilitation services are not available. After that, behavioral determinants could be targeted in improved PR programs with an appropriate use of behavior change techniques (see Michie et al., 2016).

Strengths and Limitations of the Study

The strengths of this research reside in the study of both explicit and implicit motivational processes in PR, because no previous study has investigated motivation as both an outcome of PR and a predictor of behavior following PR. This study is also one of the first to consider both physical activity and sedentary behavior motivation in a rehabilitation context. The present study has also limitations that need to be addressed. A first limitation concerns the sample size displayed for the test of the associations between motivational factors and behavior. Indeed, dropout rate between Time 2 ($n = 119$) and Time 3 ($n = 62$) was high in the present study (50%) compared to previous research in similar context (Saunders et al., 2015; Soicher et al., 2012). Consequently, statistical power concerning the regression models in this study was comprised between .49 and .59, indicating moderate Type II error risks. A second limitation concerns the use of self-report measure of behaviors in postrehabilitation. Self-report methods are known to provide less accurate measures than activity monitors like accelerometers (Pitta et al., 2005; Van Remoortel et al., 2012). According to these two limitations, the associations observed in this study between motivation and behaviors in postrehabilitation need to be replicated with an objective measure of behaviors and larger sample size. Last, it should be noted that different patterns of results might be expected in other programs, depending, for example, on their duration, context (e.g., inpatient vs. outpatient) and content (e.g., behavior change techniques included, Bourbeau et al., 2016).

Conclusion

To conclude, this study makes an important contribution to the field of PR by showing that motivation may be sensitive to a rehabilitation program and may have an impact on self-reported physical activity in postrehabilitation. In this study, TPB variables for physical activity and sedentary behavior increased in different ways during PR. Implicit attitudes were significantly more in favor of physical activity compared with sedentary behavior at the end of PR. At 6 months postrehabilitation, solely implicit attitudes were significantly associated with physical activity. This suggests that implicit attitudes might be a fruitful target for researchers and clinicians aiming at enhanced physical activity maintenance after PR.

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