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Implicit attitudes and the improvement of exercise capacity during pulmonary rehabilitation

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ABSTRACT
The aim of this study was to examine the role of explicit and implicit attitudes in the improvement of exercise capacity during a 5-week pulmonary rehabilitation (PR). A total of 105 patients performed walking tests at baseline and at the end of PR. Change between performances was computed at the end of PR, and Minimal-Clinically-Important-Difference (MCID) were used to categorize patients as *responders* (i.e. change above MCID, $N = 54$) or *non-responders* (i.e. change below MCID, $N = 51$). At baseline, implicit attitudes were measured through a physical activity versus sedentary behavior *Implicit Association Test*; explicit attitudes toward physical activity and sedentary behavior were measured by questionnaires. Only implicit attitudes significantly differed between the two groups ($p = .015$), responders displaying implicit attitudes significantly more in favor of physical activity ($M = .91$, $SD = .54$) than non-responders ($M = .60$, $SD = .71$) at baseline. Measuring implicit attitudes in PR could help to accurately estimate patients' motivation, and design more individualized rehabilitation programs.

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Among patients living with chronic respiratory diseases, functional exercise capacity, defined as the amount of physical exertion that a patient can sustain, is strongly associated with quality of life, risk of hospitalizations and mortality (Polkey et al., 2013); thus, the improvement of this parameter is a critical issue in respiratory medicine. Among different strategies, Pulmonary Rehabilitation (PR) is arguably the most efficient technique to restore or improve exercise capacity (McCarthy et al., 2015). PR is an intervention that includes exercise training, education, and disease management with the objectives to improve the physical and psychological condition of individuals living with respiratory disease (Spruit et al., 2013). If on average PR has significant favorable effect on exercise tolerance (McCarthy et al., 2015), the improvement of this outcome could be variable between patients (Troosters, Gosselink, & Decramer, 2001). Specifically, between half and one third of participants to PR program would not display clinically significant improvement of exercise capacity at the end of the intervention (Fischer et al., 2012; Stoilkova-Hartmann, Janssen, Franssen, & Wouters, 2015). Apart from physiological mechanisms, psychological processes, and

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especially motivation toward exercise, are likely to influence patients' behavior during PR, and indirectly, the improvement of their exercise capacity (Scott, Baltzan, Fox, & Wolkove, 2010).

Currently, this hypothesis has already received support in the literature. Fischer et al. (2012) found that concerns about physical activity (i.e. perceived costs and risks associated with the behavior) measured at the start of the program were negatively associated with patients' responses to PR (i.e. increase in exercise tolerance, measured with walking tests, above or below 10% of their baseline values). Selzler, Rodgers, Berry, and Stickland (2016) found that baseline coping self-efficacy toward physical activity (i.e. confidence in one's ability to exercise under challenging conditions) positively predicted change in exercise tolerance (i.e. distance covered on a walking test) at the end of a PR program. If these studies bring important information concerning the potential role of motivational processes in PR, no research has yet examined the contribution of unconscious/implicit processes regarding exercise capacity. Indeed, according to contemporary dual-processes models (e.g. Reflective-Impulsive Models, Hofmann, Friese, & Wiers, 2008), health-related behaviors are driven by both explicit (i.e. intentional, rational) and implicit (i.e. automatic) motivational processes. Compare to explicit processes, implicit processes are cognitive, affective and motivational processes that influence behaviors without a fully conscious perception of this influence by individuals (Sheeran et al., 2016). For example, implicit attitudes correspond to automatic evaluations of an object (i.e. physical activity) as pleasant or unpleasant, that occur partly outside of awareness (Greenwald & Banaji, 1995). During PR, implicit motivational processes, such as implicit attitudes, are likely to influence patients' involvement in daily exercise sessions and thus, could indirectly affect his/her improvement in terms of exercise tolerance. Accordingly, baseline implicit attitudes could partly explain physical improvement at the end of PR.

In line with the aforementioned research (Fischer et al., 2012; Selzler et al., 2016), this study sought to examine whether baseline implicit attitudes, toward physical activity versus sedentary behaviors, differed between patient who displayed a clinical improvement of their functional exercise capacity at the end of a PR program, and those who did not. To control the role of explicit processes in the present study, the contribution of explicit attitudes toward physical activity and sedentary behavior was also investigated. We expect that patient who displayed a clinical improvement of their functional exercise capacity at the end of a PR program display more favorable implicit and explicit attitudes toward physical activity compared to sedentary behaviors at the start of the program[1].

Method

Participants and procedure

Participants were enrolled in rehabilitation following a prescription by a medical doctor and for the purpose of chronic respiratory disease management. Patients were recruited during a 5-week inpatient PR program composed of daily exercise courses and lectures on various health-related behaviors and disease management strategies (for more details see, Chevance et al., 2017a).

Study participants were eligible for study enrolment if they had a medical indication for PR, were between 18 and 75 years old and had healthcare 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 contra-indication to exercise, or presented 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 present study if they did not participate in the entire program or does not perform exercise capacity assessments at start and at the end (e.g. due to injury or other incapacity).

All eligible participants included in rehabilitation were approached in one of the first 2 days of the program to participate in a study on 'motivation in rehabilitation context'. Of the 142 patients included in this study, 105 displayed an accurate evaluation of their exercise capacity both at start and at the end of the program. Of the 37 who did not provide data at Time 2, 16 did not performed exercise tolerance assessment at the end of the program (i.e. due to incapacities, such as joint pain, or missed appointments), 11 experienced injury or exacerbation during the program and thus were excluded from the study, and 10 did not complete the rehabilitation program for other reasons (e.g. family or personal problems). All participants gave written consent. Procedures were in accordance with the principles of the Declaration of Helsinki of 1975, as revised in 2000 and approved by local ethic committee.

Measures

Functional exercise capacity and responses to PR

At baseline and at the end of the PR program, exercise capacity was estimated with the *six-minute walking test* or the *shuttle-walking test* when ceiling effects were encountered on the six-minute walking test at baseline (i.e. distance ≥ 500 meters or 80% of the theoretical value, Troosters, Gosselink, & Decramer, 1999). In this case, the test were performed the following day. These tests have been performed in accordance with current recommendations (Puente-Maestu et al., 2016). The same test was performed twice both at baseline and the end of the program. Change in exercise capacity was computed using the best performance at each occasion. Patients were classified as *responders* to the program according to the Minimal Clinically Important Difference (MCID) available in the literature for these tests and as *non-responders* otherwise (Singh, Morgan, Scott, Walters, & Hardman, 1992; Troosters et al., 1999).

Implicit attitudes

At baseline, implicit attitudes toward physical activity versus sedentary behaviors were estimated with a computerized Implicit Association Test (IAT, Greenwald et al., 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; for details see Chevance, Héraud, Guerrieri, Rebar, & Boiché, 2017b). The score of the IAT was computed using a winsorized score processed with the statistical software R using the package *IAT.Score* (Richetin, Costantini, Perugini, & Schönbrodt, 2015). This score was comprised between −2 and +2, 0 representing a neutral score, and positive scores revealed favorable implicit attitudes toward physical activity behavior compared to sedentary behavior. Stimuli for the category 'positive' and 'negative' were: pleasant/unpleasant; happy/sad; favorable/unfavorable; beneficial/harmful. Stimuli selected to represent the conceptual category 'physical activity' were: run, walk, hiking, dancing, stairs, swimming, bike, lift, gardening, effort. Stimuli selected to represent the conceptual category 'sedentary behavior' were: sitting, armchair, chair, television, reading, computer, couch, lying, desk, read.

Explicit attitudes

At baseline, explicit attitudes for both physical activity and sedentary behavior were measured through 7-point semantic differentiation scales according the recommendations (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); and sedentray behaviors according to the Sedentary Behaviour Research Network (2012; i.e. time spent by a person sitting or lying down). The question for physical activity was 'For you, practising a regular physical activity after your rehabilitation program would be….'; and for sedentary behavior: 'For you, limiting the time spent in sedentary activities 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 for both behaviors. Mean scores were computed for each variable between 1 (lowest score) and 7 (highest score).

Socio-demographic and clinical characteristics

At baseline, participants' age, gender, marital and professional statutes were self-reported. A physician estimated body Mass Index (BMI). Exercise capacity was expressed in percentage of theoretical values (Singh et al., 1992; Troosters et al., 1999).

Data analysis

Independent sample *t*-tests and chi-squared analyses were firstly performed to examine potential baseline differences between responder and non-responder patients regarding their socio-demographic or clinical characteristics. In case of significant differences on these variables between groups, one-way analyses of co-variance (ANCOVAs) were used to examine motivational differences controlling for identified covariates. Otherwise, independent sample *t*-tests were conducted to examine differences in implicit and explicit attitudes between groups.

Results

Regarding the clinical improvement of exercise capacity over the course of the program, 51 patients were categorized as responders (49%), and 54 as non-responders (51%). Descriptive statistics for the entire sample, and each group are presented in Table 1. Responder and non-responder patients did not differed on their socio-demographic and clinical baseline characteristics (see Table 1).

Independent sample *t*-tests were performed to compare baseline implicit attitudes and explicit attitudes toward physical activity and sedentary behavior in responder and non-responder conditions. Regarding implicit attitudes, a significant difference was found between conditions, $t(103) = 2.47$, $p = .015$. Responders displayed implicit attitudes significantly more in favor of physical activity compared to sedentary behavior at baseline ($M = .91$, $SD = .54$) than non-responder patients ($M = .60$, $SD = .71$). Effect size was medium (Cohen's $d = .48$).

Table 1. Demographic and clinical characteristics at baseline.

	All group (*N* = 105)	Responders (*N* = 54)	Non-responders (*N* = 51)	*p-value*
Age (years)	62.3 (7.6)	62.6 (6.8)	61.9 (8.5)	.65
BMI (kg/m²)	28.4 (6.5)	28.4 (6.1)	28.1 (6.7)	.83
Gender (M/F)	64%/46%	45%/55%	56%/44%	.26
Married	66%	65%	61%	.60
Retired or unemployed	79%	85%	69%	.50
Walking tests (% pred)	76.9 (25)	79.6 (21)	74.5 (29)	.30

Note: Data are presented as mean and standard deviation or percentage; *p-value* referred to independent *t*-tests or Chi-squared analyses performed between responder and non-responder conditions; M = Male; F = Female; % pred = % of theoretical values.

No significant difference was found between groups regarding physical activity explicit attitudes [$M_{\text{responders}} = 6.3$, $SD = .08$ versus $M_{\text{non-responders}} = 6.1 \pm .08$; $t(103) = .81$, $p = .161$], or sedentary behavior explicit attitudes [$M_{\text{responders}} = 6.0 \pm .95$ versus $M_{\text{non-responders}} = 5.9 \pm .90$; $t(103)=-1.38$, $p = .270$].

Ancillary analyses were conducted to examine differences in implicit attitudes between responders and non-responders controlling for explicit attitudes. ANCOVA indicated that implicit attitudes still significantly differed between the two conditions after controlling explicit attitudes toward physical activity and sedentary behaviors, F (1, 101) = 7.623, $p = .007$, $\eta^2 = .067$ (results remained similar when other Theory of Planned Variables toward the two behaviors -social norms, perceived behavioral control, intentions- were controlled for).

Discussion

The aim of this study was to investigate baseline differences in implicit attitudes between patients who displayed a clinical improvement of their functional exercise capacity and those who did not over the course of a PR program. Results highlighted that patients who clinically improved their exercise functional capacity at the end of the program were characterized by higher implicit attitudes at baseline compared to other patients. In other words, compared to non-responders, responders automatically evaluated stimuli representing physical activity more favorably than those representing sedentary behaviors on a computerized IAT administrated at the beginning of the program. In the current study, the two groups were not significantly different regarding their baseline explicit attitudes toward physical activity and sedentary behavior measured by questionnaires.

In past literature, it was shown that implicit attitudes toward physical activity significantly predict physical activity behavior (Rebar et al., 2016). More interestingly, these associations have been observed controlling for explicit motivational variables, such as barriers self-efficacy and intentions (Conroy, Hyde, Doerksen, & Ribeiro, 2010), perceived behavioral control and explicit attitudes (Chevance, Caudroit, Romain, & Boiché, 2017c), and in post-rehabilitation context, behavioral intentions (Chevance et al., 2017a). Accordingly, it may be that patients reporting implicit attitudes in favor of physical activity were more physically active during their exercise sessions all along the program, ultimately resulting in a better improvement of their exercise capacity (independently from their explicit attitudes; i.e. see ancillary analyse). This hypothesis has received support in the literature. Indeed, a study pointed out that students who received a brief training (i.e. evaluative conditioning) aiming to enhance their implicit attitudes toward exercise selected significantly higher intensities of exercise during a subsequent ergo-bicycle task, compared to students from the control group (Antoniewicz & Brand, 2016a). Moreover, baseline implicit attitudes toward exercise were shown to be stronger among adults from the general population with high adherence rate during a 14-week exercise course, compared to those who dropped out (Antoniewicz & Brand, 2016b). Accordingly, in the PR context, the next step would be to test the extent to which the relationship between implicit attitudes and exercise tolerance improvement is mediated by a stronger adherence to exercise prescription and higher physical activity levels during the program.

In the current study, no significant differences in explicit attitudes toward both physical activity and sedentary behavior were observed between responder and non-responder participants. Explicit attitudes are known to be associated with physical activity behavior (Rhodes & Courneya, 2003), however in the current study participants from both groups reported very high levels of explicit attitudes toward 'more physical activity' and 'less sedentary behavior' from the start of the program. This could be explained by the context in which this study has been performed. Indeed, at the start of an intervention participants could report artificially high level of explicit motivation, which could be attenuated after several days and experiences with the behavior (Blanchard, Arthur, & Gunn, 2015). Other measurement methods (e.g. ecological momentary assessment), offering a more dynamical view of explicit attitudes, could help to better understand their role in exercise tolerance improvement in PR. In the same line, other explicit processes could be associated with exercise tolerance. For example, it would be interesting to examine the contribution of volitional factors, such as action planning (Fleigs et al., 2017), in the improvement of exercise tolerance; interactions between explicit and implicit processes could also be expected in the prediction of exercise tolerance improvement (see Cheval, Sarrazin, Isoard-Gautheur, Radel, & Friese, 2015).

Finally, social desirability is known to be salient in the physical activity context (Adams et al., 2005). This phenomenon has possibly impacted patients' self-reported motivation at baseline, which could have generated a lack of sensibility in the estimation of explicit attitudes, in comparison to the scores obtained with the IAT, less likely to be controlled by participants. This hypothesis supported the use of the IAT in clinical setting to complete self-report measurement and accurately estimate patients' motivation.

To our knowledge, this study is the first to highlight the role of implicit attitudes in the clinical improvement of functional exercise capacity during PR. This study thus contributes to highlight the role of motivation in rehabilitation context as (*i*) an important outcome, (*ii*) a potential predictor of patients' behaviors over the course of a program, and (*iii*) a potential important element of baseline diagnostic in PR (Chevance et al., 2017a). Indeed, given the importance of functional exercise capacity in the prognostic of patients with respiratory diseases (Polkey et al., 2013), the identification of psychological factors that could contribute to the clinical improvement of this variable in PR is crucial. Nonetheless, this study has also limitations that should be noted. First, implicit attitudes measured through an IAT are not representative to all implicit processes. Hence, it could be relevant to examine the associations between implicit processes and exercise tolerance through other implicit processes (e.g. attentional bias) and other implicit measures (e.g. dot-probe task). Secondly, MCIDs have a strong clinical interest, however they could be imperfect to accurately describe patient's evolution over the course of a PR program. For example, other studies have keep exercise tolerance as a continuous variable (Selzler et al., 2016), categorized patients in more groups, or took into account indicators of subjective health to characterize patients' responses to the program (Stoilkova-Hartmann et al., 2015). Future researches investigating the role of other motivational processes in other PR's outcomes are thus needed to generalize the results obtained in this study.

Human rights and informed consent

The ethical committee of the group *5 Santé* approved this study. All procedures were in accordance with Helsinki declaration of 1975, as revised in 2000. Informed consent was obtained from all participants before being included in the study.

Note

1. This study is based on a larger dataset aiming at investigating the role of motivation in different PR's outcomes. Changes in implicit and explicit motivational processes during PR, and their role in 6-month post-rehabilitation physical activity and sedentary behaviors were examined in a first study (Chevance, Héraud, Varray, & Boiché, 2017a). The present study completes these previous results by examining the associations between baseline implicit and explicit attitudes and the improvement of exercise tolerance during a PR program. These results are presenting in two separate studies because physical activity maintenance post-rehabilitation and the improvement of exercise tolerance at the end of a PR program are two different and specific outcomes (see Zwerink, Palen, Valk, Brusse-Keizer, & Effing, 2013).

Disclosure statement

The authors declare that they have no conflicts of interest in the present research.

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