Coping Versus Mastery Modeling Intervention to Enhance Self-efficacy for Exercise in Patients with COPD

Anne-Marie Selzler, Wendy M. Rodgers, Tanya R. Berry, and Michael K. Stickland

Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of death, and is predominantly caused by a substantial smoking history. Physical activity is a strong predictor of mortality in patients with COPD, although many patients are inactive, with activity decreasing and sedentary time increasing as disease severity and dyspnea progress. Pulmonary rehabilitation (PR) is a thorough intervention including patient assessment, exercise training, and self-management education designed to improve the physical and psychological condition of people with COPD and promote long-term adherence to health behaviors, such as physical activity. Physical activity comprises all types of body movement, including exercise, sport, play, and activities of daily living. In PR, structured exercise is recommended to improve exercise capacity in addition to physical activity. While PR improves exercise capacity, it is less effective for improving and sustaining daily physical activity. To improve the long-term effectiveness of PR and health outcomes in people with COPD, more research examining predictors of physical activity is needed. Self-efficacy has been found to be a determinant of physical activity in people with COPD, yet few interventions have been developed to enhance self-efficacy in this population. This study contributes to the literature by testing the effects of mastery and coping model interventions on self-efficacy during an exercise experience in PR, and examines the relationship of exercise specific self-efficacy to physical activity.

Self-efficacy is defined as “one’s beliefs in their capabilities to organize and execute the courses of action required to produce given attainments.” People with strong beliefs in their capabilities strive...
toward goals and persist when encountering barriers.\textsuperscript{9} Capability beliefs are contingent on the behavioral and social contexts in which they occur. According to Maddux,\textsuperscript{10} there are two capability beliefs for any given behavior: task and coping. Task self-efficacy is confidence for performing elemental aspects of behavior, whereas coping self-efficacy is confidence for performing the behavior under challenging circumstances. For exercise self-efficacy, Rodgers and colleagues\textsuperscript{11} further specified scheduling self-efficacy, a subtype of coping self-efficacy that is specific to coping with time-related barriers to exercise.

The importance of each self-efficacy sub-type varies according to behavioral outcomes. In COPD patients, task self-efficacy has been found to predict PR attendance and coping self-efficacy to predict functional exercise capacity improvement.\textsuperscript{12} It seems confidence for performing a task supports COPD patients’ attendance at PR, but confidence for persisting in the face of challenges supports improvement of functional abilities. It might also be important to assess self-efficacy for disease-specific factors that might influence physical activity. In COPD, managing breathlessness during exertion is a salient challenge. The COPD Self-efficacy Scale (CSES)\textsuperscript{13} assesses confidence for managing breathlessness, but it is composed of a composite score that conflates the circumstances and behaviors for which breathing difficulties occur. For example, confidence is rated for managing or avoiding breathing difficulties in many situations, such as when it is humid, when feeling frustrated, and when going up stairs. It may be useful to simultaneously assess items from the CSES\textsuperscript{13} that pertain to managing breathlessness during physical exertion, along with coping self-efficacy items of the MSES\textsuperscript{11} to further understand the distinct relationships between different targets of self-efficacy and behavior.

Walking self-efficacy has been shown to predict functional exercise capacity,\textsuperscript{14,15} and survival\textsuperscript{16} in COPD patients. If each self-efficacy type has a unique relationship to behavioral outcomes, and the relationship between self-efficacy and behavior are reciprocal as outlined in Social Cognitive Theory,\textsuperscript{9} behavioral experiences may impact each self-efficacy type differently. Therefore, this study assessed multiple types of self-efficacy outcomes outlined in Table 1, including exercise self-efficacy subtypes from the MSES\textsuperscript{11} (task, coping for exercise, coping for breathing, scheduling) and walking self-efficacy. The independent effect of each self-efficacy sub-type on physical activity after researcher contact was also examined.

Mastery experiences—one’s own successful behavioral experiences, are the strongest source of self-efficacy followed by vicarious experiences—estimates of one’s own capabilities based on observations of others.\textsuperscript{9} When individuals have limited behavioral experience, they tend to draw on observation of others’ performances to judge their own capabilities.\textsuperscript{9} Vicarious experiences can be real or imagined, and imagery of task performance is an important form of vicarious experience that has been shown to enhance self-efficacy and improve exercise performance (see review by Ross-Stewart and colleagues\textsuperscript{17}). Model performance and attributes can influence observer self-efficacy. The greater the model-observer similarity, the more strongly self-efficacy is impacted.\textsuperscript{7} For behavior initiates, Bandura\textsuperscript{9} postulated that observing a coping model (one who begins unsure of themselves but through persistent effort improves performance) is thought to have more positive effects on self-efficacy than observing a mastery model (one who performs the behavior competently without error). Coping models display strategies for overcoming obstacles accompanied by declining distress. Coping models progressively improve until they achieve performance mastery,\textsuperscript{18} which is conveyed through physical performance and verbal statements that highlight increased confidence and ease of performance with persistent effort.\textsuperscript{19} In contrast, mastery models consistently demonstrate impeccable physical performance and verbalize strong confidence and low task difficulty.\textsuperscript{19} Behavioral initiates may find coping models more like themselves than mastery models. Coping models may also display strategies for performance improvement that are useful to behavioral initiates, and by demonstrating success through persistence, coping models can reduce the negative effects of setbacks and better sustain motivation.\textsuperscript{9}

The limited empirical research suggests that mastery and coping models have similar impacts on

<table>
<thead>
<tr>
<th>Self-efficacy type</th>
<th>Definition</th>
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<tr>
<td>Task</td>
<td>Confidence for performing elemental aspects of exercise.</td>
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<tr>
<td>Coping with exercise</td>
<td>Confidence for exercising under challenging circumstances.</td>
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<tr>
<td>Coping with breathing</td>
<td>Confidence for managing breathing during physical exertion.</td>
</tr>
<tr>
<td>Scheduling</td>
<td>Confidence for exercising regularly.</td>
</tr>
<tr>
<td>Walking</td>
<td>Confidence for walking at a moderate pace at incremental intervals.</td>
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</table>
be more beneficial than mastery models. So far, studies have examined coping versus mastery models in the context of swimming performance, diving, and balance on a stability task in young healthy participants. However, there may be circumstances that moderate the effects of coping and mastery models on observer self-efficacy. When learners observe difficult tasks or tasks that require a great amount of persistence for success, coping models may be more beneficial than mastery models. Alternatively, coping models may not be necessary when people are confident in their abilities to learn quickly and manage problems effectively. To date, no studies have examined potential moderator effects of coping and mastery models on observer self-efficacy, such as previous experience, gender, perceived difficulty of task, and learning self-efficacy. Further, the effect of coping and mastery models on exercise self-efficacy has not been studied in COPD patients, and it is unclear whether coping or mastery models are superior for improving physical activity levels.

The primary purpose of this study was to test the effects of two vicarious experience interventions, coping and mastery video-modeling, on COPD patients' self-efficacy levels within the context of a usual-care, pre-PR cardiopulmonary exercise test (CPET). The CPET was chosen because it is a highly controlled situation and therefore ideal for preliminary experimental testing before proceeding to more complex environments. It was hypothesized that coping models would enhance observer self-efficacy more than mastery models. Potential moderators of this effect were explored, including gender, perceived difficulty, response efficacy, and learning self-efficacy. Not all self-efficacy types were expected to be impacted similarly. Given that the video interventions portrayed patients' physical experiences of CPET tests and did not include actions related to scheduling exercise, it was hypothesized that task, walking, and coping self-efficacy for exercise and breathing would be impacted more than scheduling self-efficacy.

The secondary purpose of this study was to determine the self-efficacy subtype that had the strongest predictive relationship to physical activity the week following the CPET. It was hypothesized that coping self-efficacy for exercise and breathing would have the strongest relationships to physical activity, followed by task and walking self-efficacy. Elemental aspects of exercise tasks and overcoming challenging circumstances are considered the most important to COPD patient persistence with physical activity behaviors.

Methods
Participants and procedures
Ethical approval was obtained from university and hospital research ethics boards. Eligibility requirements for the study were a physician diagnosis of COPD, airflow obstruction (post-bronchodilator forced expiratory volume in 1 second/forced vital capacity (FEV1/FVC) ratio of less than 0.7), and capability to provide written informed consent in English. Potential participants were excluded if they had a respiratory exacerbation within the previous month, unstable cardiac disease, talc granulomatosis, interstitial lung disease, or cognitive impairments. Patients with comorbidities or requiring supplemental oxygen could participate.

Participants were recruited from the waiting area prior to a usual care pre-PR assessment at an outpatient PR clinic. When specifying a medium effect (f = 0.25), power = 0.80, α = 0.05 the a priori sample size calculation for the primary hypothesis in G*Power 3.1.9.2 was 33 participants per group (99 total). A medium effect was anticipated based on previous coping and mastery model interventions that had medium to large effects on self-efficacy. Based on experience, it was estimated that 20% of participants would be non-compliant to Fitbit instructions. Therefore, 120 participants, 40 per group (50% female), were recruited to permit sufficient power for the secondary analysis. The power calculation for the primary hypothesis at this sample size was 0.88.

Participants were randomized with equal allocation to one of three conditions (coping, mastery, control) within each gender using a random numbers table. First, participants completed assessments of exercise self-efficacy, walking self-efficacy, learning self-efficacy, perceived difficulty, response efficacy, and past exercise experience. Next participants watched the video associated with their intervention condition (or received verbal instructions in control condition), followed by assessments of exercise self-efficacy, walking self-efficacy, perceived difficulty, and model-observer similarity for those in the mastery and coping conditions. Participants then completed a usual-care physician supervised CPET, followed by an assessment of exercise self-efficacy, walking self-efficacy, and perceived difficulty. Last, participants wore Fitbits to measure physical activity in steps per day during the subsequent week.

The following comorbidities and systemic manifestations were present in this sample: 53% (n = 64) musculoskeletal impairment, 48% (n = 58) hypertension, 42% (n = 50) dyslipidemia, 32% (n = 38) mental health problems.
illness, 21% (n = 25) diabetes, 16% (n = 19) coronary artery disease, 19% (n = 23) cancer, 16% (n = 19) asthma, 7% (n = 8) valvular heart disease, 7% (n = 8) renal disease, 4% (n = 5) obstructive sleep apnea, 4% (n = 5) cerebrovascular, and 4% (n = 5) liver disease. The comorbidities and systemic manifestations of this sample are in line with the extant literature on COPD.23 Additional participant characteristics are displayed in Table 2.

### Development of video interventions

Two pilot studies were conducted to support the development of the interventions. In the first pilot study, 30 COPD patients attending PR (15 males, 15 females) orally listed the people they compared themselves to when deciding if they were good at exercise. A cumulative list of possible comparators and characteristics was constructed from participant responses (e.g., males/females in PR-class, spouse, male/female children). Next, 30 new COPD patients attending PR (15 male, 15 female) rated on a brief oral questionnaire (1) how well (better, the same, worse), and (2) how often (never, rarely, sometimes, often, frequently) they compared themselves to the people on the list generated by the previous sample. Participants reported comparing similarly and most frequently to people the same age and gender. As a result, separate videos of male and female models close in age to the average COPD patient were created.

In the second pilot study, oral questionnaires were conducted with 20 COPD patients (10 males, 10 females) before and after performing a CPET, and three health care practitioners (HCPs) who conduct CPETs, to gather information about patient experiences of the CPET. The findings indicated that patients expect the CPET to be difficult, although many perform either the same or better than they thought they would. Aspects of the CPET patients found difficult were getting used to the mouth piece and nose plug, adjusting to different speeds (both fast and slow), the feeling of walking on a treadmill, the feeling of being ‘tested’, and the number of people in the room (i.e., two staff members, one physician—sometimes two if a resident was training). HCPs identified the most common errors made by patients on the treadmill: taking short unnatural strides, shoulders raised and close to their ears, gripping onto railings, and legs and hips behind body and not underneath shoulders. These results informed patient experiences to be portrayed by the models in the videos, including the types of errors the coping models acted out.

### Video modeling interventions

One female and one male graduate of the PR program who regularly exercised were recruited as models for the intervention videos. They were recruited because they had adequate stamina for taking multiple shots, were able to act out different scenarios, and appeared similar in age to many COPD patients. The videos were recorded in the designated exercise testing room at the PR center and were developed with assistance from a videographer. Four videos were created that were between 5 and 7 minutes in length: female coping, female mastery, male coping, and male mastery. The same female and male models were in each video.

Both coping and mastery videos began with the same footage of a HCP explaining the CPET procedures, equipment, and measures, followed by the attachment of equipment to the model’s body, and usual care spirometry assessments and breathing maneuvers. Next, models acted out a CPET but did not achieve their maximum exercise capacity as they were higher in ability and fitness than typical COPD patients. The models’ performances during the CPET differed in the coping and mastery videos. In the coping model video, the models began the CPET acting out common errors identified in the pilot studies: (1) taking short strides, (2) walking with legs and hips behind body instead of underneath shoulders, and (3) tensing shoulders and gripping the support railings. HCPs provided the models with instruction to overcome these errors. As the CPET continued, the models’ performance improved as a result of the instruction, and by the end of the video, the models performed competently and without error. In the mastery model video, the models’ appeared competent and did not make any errors throughout. The models demonstrated

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**Table 2. Descriptive statistics.**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Control M ± SD</th>
<th>Mastery M ± SD</th>
<th>Coping M ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years</td>
<td>63.67 ± 10.65</td>
<td>68.00 ± 7.67</td>
<td>67.16 ± 7.08</td>
</tr>
<tr>
<td>BMI, kg/m²</td>
<td>30.87 ± 6.98</td>
<td>28.18 ± 6.79</td>
<td>31.26 ± 6.64</td>
</tr>
<tr>
<td>mMRC, 1-5</td>
<td>3.00 ± 1.08</td>
<td>2.92 ± 1.15</td>
<td>3.00 ± 1.00</td>
</tr>
<tr>
<td>Smoking history, pack years</td>
<td>39.07 ± 20.41</td>
<td>40.03 ± 21.67</td>
<td>36.36 ± 24.97</td>
</tr>
<tr>
<td>FEV₁, % predicted</td>
<td>68.43 ± 23.89</td>
<td>64.31 ± 20.02</td>
<td>59.00 ± 20.14</td>
</tr>
<tr>
<td>FVC/FVC, % predicted</td>
<td>65.81 ± 19.20</td>
<td>63.25 ± 19.83</td>
<td>63.71 ± 20.13</td>
</tr>
</tbody>
</table>

Note. BMI = body mass index, mMRC = modified Medical Research Council Dyspnea Scale, FEV₁ = forced expiratory volume in one second, FVC = forced vital capacity. Gold Stage = classification of disease severity by lung function impairment: I/mild = FEV₁ ≥ 80% predicted; II/moderate = 50% ≤ FEV₁ < 80% predicted; III/severe = 30% ≤ FEV₁ < 50% predicted; IV/very severe = FEV₁ < 30% predicted.
ideal form, with hips directly underneath shoulders, long and natural strides, and a stable but loose grip on the support bars. The HCPs did not give mastery models instructions as it was not required. In both coping and mastery videos, the models appeared to terminate the CPET as a result of maximal effort. Commentary was provided by the models after the CPET. The coping models stated the CPET was difficult at first, but with the instruction from the staff and through their persistent effort, they were able to grasp the task. The mastery models stated it was a relatively easy and straightforward task for them to do.

Participants in the intervention conditions watched the video associated with their condition and gender: coping (male/female) or mastery (male/female). Participants in the control condition only received standardized verbal instruction from a HCP about the CPET test.

Cardiopulmonary exercise testing

Participants were given standardized information about CPET procedures, equipment, and measures before beginning. Participants were encouraged to walk for as long as possible but informed they could end the test when they felt they could not continue. Participants pointed to the appropriate value on the modified Borg exertion scale when prompted at baseline, every two minutes, immediately post-exercise, and 2 minutes post-exercise to rate their breathing and leg discomfort. Once the exercise test began the workload increased by adjustments of speed and/or grade every minute or two up until a maximum duration of 8–12 minutes. The specific protocol was determined on an individual basis by the supervising physician. Gripping or leaning onto treadmill handrails was discouraged. Participants could rest hands on handrails when balance was sought. Standardized general encouragements were given to all participants during the test, such as “good job,” and “you are doing well.” Baseline spirometry, as well as inspiratory capacity, minute ventilation, oxygen update, and carbon dioxide production were collected throughout the test by a metabolic cart (Vmax Spectra V29 System, SensorMedics, Yorba Linda, CA). Physicians monitored a 12-lead electrocardiogram (Cardiosoft; SensorMedics, Yorba Linda, CA, during the test to ensure there were no exercise-induced ECG changes.

Materials

Demographics
Age, gender, BMI, and smoking history (pack years) were obtained from PR records.

Modified medical research council (mMRC) dyspnea scale
This routine measure collected by the PR program was obtained through program records and assessed patients’ self-reported breathlessness from 1 (not troubled by breathlessness except with strenuous exercise) to 5 (too breathless to leave the house or breathless when dressing).

Spirometry
Standard spirometry assessments were performed on all patients prior to the pre-program assessment. Patients were stratified according to Global initiative for Chronic Obstructive Lung Disease (GOLD) forced expiratory volume in 1 second (FEV1) criteria.

Leisure score index (LSI) from the Godin-Leisure-Time exercise Questionnaire
Participants recalled average weekly frequency and duration of light (minimal effort, no perspiration), moderate (not exhausting, light perspiration), and vigorous (heart beats rapidly, sweating) exercise that lasted at least 10 minutes during the past month. Total energy expenditure expressed as metabolic equivalents was calculated using a standard algorithm. This instrument has been found to be reliable and valid.

Multidimensional Self-Efficacy for Exercise Scale
A modified version of the Multidimensional Self-Efficacy for Exercise Scale (MSES) assessed exercise self-efficacy. This version assesses task, coping for exercise, and scheduling with three items each from the original version; and a new fourth sub-type, coping for breathing, using three additional items from the COPD Self-efficacy Scale that pertain to managing breathlessness during exercise or exertion. Confidence for each question is rated from 0 (no confidence) to 100 (complete confidence). The mean of each self-efficacy subtype was calculated and used for analysis. The MSES has been found to be reliable and valid, and has been used in many populations, including patients with COPD. The internal consistency values across all time points for the subtypes ranged from 0.83 to 0.91.

Modified Self-Efficacy for Walking Scale
Participants responded to 9 items following the prompt, “How confident are you that you can walk every day at a moderate pace for …”, on a 100% confident scale, from 0 (no confidence) to 100 (complete confidence). Each item increases in consecutive 5-minute increments, from 5 to 45 minutes. The mean
of the nine items was calculated used for analysis. The internal consistency values for this scale across all time points were between 0.96 and 0.97.

**Self-efficacy for learning**
Four items assessed self-efficacy for learning exercise tasks from 0 (no confidence) to 100 (complete confidence). The items correspond with Rodgers and colleagues’ MSES task self-efficacy items. For example, one task self-efficacy item from Rodgers and colleagues’ scale is “how confident are you that you can perform all of the movements required for your exercises”, and a corresponding learning self-efficacy item is “how confident are you that you can learn new movements required for your exercises.” The mean of the items was calculated and used for analysis. The internal consistency value for this scale was 0.99.

**Perceived difficulty**
Perceived difficulty of treadmill walking was assessed with three items on a 1–7 Likert-type scale, from 1 (extremely easy) to 7 (extremely difficult). Each item assessed a different exercise intensity (i.e., light, moderate, strenuous). Participants responded to items following the prompt, “How difficult would it be for you to walk on a treadmill at a ______intensity (intensity description) for at least 10 minutes?” The mean of the items was calculated and used for analysis. The internal consistency value for this scale was 0.82.

**Model-observer similarity**
Participants rated their similarity to the model in the video with a single item, from 1 (completely dissimilar) to 7 (exactly like me).

**Response efficacy**
Participants indicated the extent to which they agree from 1 (strongly disagree) to 7 (strongly agree), with the following two statements, “Increasing my exercise will improve my physical capabilities” and “Increasing my exercise will improve my well-being.” The mean of the items was used for analysis. The internal consistency value was 0.94.

**Objective physical activity**
Physical activity was assessed by recording step count in 15-minute intervals using the Fitbit Flex or Fitbit Flex 2. Participants were instructed to wear the device on their nondominant wrist during all waking hours for one week following their CPET. Data were downloaded onto a secured laboratory computer in order to evaluate patients’ average step count. Data analysis was based on the first 10 hours of data recorded averaged across 5 consecutive days.

**Analysis and results**

**Data screening**
All statistical analyses were performed using IBM SPSS Statistics 24. Assumptions of statistical tests were tested and tenable unless otherwise stated. Minor deviations from normality were found for learning self-efficacy and response efficacy at baseline (kurtosis = 2.92 and 4.55, respectively), and task self-efficacy post-exercise test (skewness = −2.13, kurtosis = 5.72). Given the few and minor deviations from normality no data transformations were performed.

**Preliminary analyses**
MANOVAs were conducted with continuous variables and chi square statistics with categorical variables to determine if coping model, mastery model, and control groups differed on baseline levels of (1) demographic and clinical data (age, gender, BMI, FEV1% predicted, FEV1/FVC %, mMRC dyspnea, and smoking history in pack years), and (2) psychosocial and behavioral data (modified MSES, SEW, learning self-efficacy, perceived difficulty, LSI). None of these tests were statistically significant.

**Manipulation check**
A one-way ANOVA compared participants’ ratings of the number of model errors in the video across intervention groups. The test was statistically significant, $F(1, 78) = 316.38, p < 0.001, \eta^2_p = 0.80$, $M_{mastery} = 0$, $M_{coping} = 3$, indicating that the manipulation was successful.

**Primary analysis**
To test the effects of coping versus mastery model interventions on COPD patients’ self-efficacy a 3(condition: coping, mastery, control) by 5(self-efficacy: task, coping for exercise, coping for breathing, scheduling, walking) by 3(time: pre-video, post-video, post-exercise test) mixed MANOVA with repeated measures on the last two factors was conducted. Multivariate tests are reported as the assumption of sphericity (Mauchly’s test) was violated for the main effect of time, $\chi^2 = 28.88, p < 0.001$, self-efficacy, $\chi^2 = 89.03, p < 0.001$, and the time and self-efficacy
interaction, $\chi^2 = 199.23, p < 0.001$. There was a statistically significant interaction between time, self-efficacy type, and group, $F(16, 222) = 1.70, p = 0.049, \eta^2_p = .11$; time and group, $F(4, 234) = 6.93, p < 0.001, \eta^2_p = 0.10$, and time and self-efficacy type, $F(8, 110) = 6.30, p < 0.001, \eta^2_p = 0.31$. There were main effects of time, $F(2, 116) = 46.38, p < 0.001, \eta^2_p = 0.44$, and self-efficacy, $F(4, 114) = 94.79, p < 0.001, \eta^2_p = 0.77$. Consistent with the significant interactions, the planned simple contrasts for group were not statistically significant. Follow-up time by group repeated measures ANOVAs showed significant interactions for task and group, $F(4, 234) = 5.00, p = 0.001, \eta^2_p = 0.08$; coping for exercise and group, $F(4, 234) = 7.83, p < 0.001, \eta^2_p = 0.12$; and coping for breathing and group, $F(4, 234) = 2.79, p = 0.027, \eta^2_p = 0.05$.

**Figures 1.** A–E) Self-efficacy sub-types over time by intervention condition. Note. Intv = intervention, ET = exercise test. Figures 1a, 1b, and 1d have statistically significant interaction effects.

Figures 1a–e display the interactions between time and group for each self-efficacy subtype. The figures show positive effects of the intervention conditions, such that all the self-efficacy sub-types were strengthened from baseline to post-video in the coping and mastery conditions. The figures show there was no change in any of the self-efficacy subtypes from baseline to post-verbal instructions in the control
condition. Interestingly, the rate of increase for exercise self-efficacy was greater in the coping condition than the mastery condition. Across all three groups, the self-efficacy sub-types were strengthened from post-intervention to post-exercise test, with one exception. In the coping group, walking self-efficacy did not improve from post-intervention to post-exercise test. In the control group, there was a greater increase in the self-efficacy types from post-intervention to post-exercise test compared to the coping and mastery groups, such that all groups had similar levels of self-efficacy post-exercise test.

**Exploratory moderator analyses**

Learning self-efficacy, response efficacy, perceived difficulty, and LSI were recoded into dummy variables to test the moderating effects of these variables on the relationship between the interventions and self-efficacy. Learning self-efficacy, response efficacy, and perceived difficulty were split into quantiles at the median of each scale, and the LSI was split into quantiles at the mean, which was 10. The means of the high and low categories for perceived difficulty were 5.00 and 1.33, respectively, and the point-biserial correlation coefficients to the self-efficacy subtypes across all time points ranged from 0.07 to 0.36. The means of the high and low categories for LSI were 35.61 and 1.39, respectively, and the point-biserial correlation coefficients to the self-efficacy sub-types across all time points ranged from 0.00 to 0.32. Learning self-efficacy and response efficacy were not tested as moderators as less than 10% of the sample fell into the “low” categories. The mean and median scores for learning self-efficacy were 85 and 100 (out of 100), respectively, and for response efficacy were 6.10 and 6.50 (out of 7), respectively. Perceived difficulty and the LSI were also split into tertiles with the middle group removed for a second moderator analysis.

To determine whether gender, perceived difficulty, and LSI moderated the effects of the intervention, these variables were added one at a time to the main ANOVA analysis. None of the interaction terms containing group with perceived difficulty, LSI, or gender (quantiles or tertiles) were statistically significant, p’s between .07 and .98, respectively. Therefore, perceived difficulty, LSI, and gender were not retained as moderators in the primary analysis.

**Model observer similarity**

To determine whether model-observer similarity impacted the intervention effects, a time by self-efficacy type by intervention group (coping, mastery) repeated measures ANOVA was conducted to test the moderating effects of these variables on the relationship between the interventions and self-efficacy. Learning self-efficacy, response efficacy, and perceived difficulty were split into quantiles at the mean, and the LSI was split into tertiles with the middle group removed for a second moderator analysis. None of the relationships were statistically significant; therefore, no demographic/clinical indicators were controlled for in the subsequent analysis.

**Impact of the self-efficacy intervention on physical activity and CPET performance**

There were no statistically significant differences between groups on steps per day F(2, 99) = 1.06, p = .350, η²p = 0.02, Mcontrol = 3967 SDcontrol = 2185, Mmastery = 4781 SDmastery = 2919, Mcoping = 4076 SDcoping = 2779; peak VO2, F(2, 90) = 0.04, p = .959, η²p < .01, and peak heart rate, F(2, 106) = 0.23, p = .796, η²p < .01, indicating that the intervention conditions did not impact physical activity, exercise tolerance, or effort. Cardiopulmonary data from the exercise test are included in Supplementary Table 1.

**Secondary analyses**

Remaining analyses were conducted on 102 participants that returned Fitbits and provided 10 hours of data for 5 consecutive days. To determine if any demographic/clinical variables influenced the self-efficacy – physical activity relationship, partial correlations were computed between demographic/clinical indicators (age, gender, BMI, smoking history, mMRC dyspnea, season, FEV1% predicted, and FEV1/FVC %) and steps per day while controlling for self-efficacy sub-types. None of the relationships were statistically significant; therefore, no demographic/clinical indicators were controlled for in the subsequent analysis.

Multiple regression was conducted to determine if post-intervention self-efficacy predicted average steps per day in the subsequent week. Bias in the regression model was examined by plots and diagnostic statistics to test assumptions and identify unusual cases. The assumptions of multiple regression were tenable. Several cases had Mahalanobis distances and leverage values greater than the recommended cutoffs. However, all cases were well below the cutoff of 1 for Cook’s distance, indicating there was no need to delete these cases since they did not have a large effect on the regression analysis.

The multiple regression model predicting average steps per day from the self-efficacy variables was statistically significant, F(5, 97) = 3.26, p = .009, M = 4,231, SD = 2,637, range = 473–11,417. The predictors accounted for 10% (adjusted) of the variance in steps per day. Table 3 displays the coefficients for
the regression model. Coping for exercise and breathing were statistically significant predictors of steps per day, such that greater coping for exercise and lower coping for breathing were significantly associated with greater steps per day. The beta weights of scheduling self-efficacy and coping for breathing related self-efficacy to steps per day were substantially larger than the zero-order correlations to steps per day, suggesting suppression was present. To identify the variable responsible, the variables with congruent beta weights and correlations were systematically left out of the regression equation (i.e., task, coping for exercise, and walking self-efficacy) and then the changes in the beta weights for the independent variables with incongruent beta weight and correlations were examined. Results of this procedure indicated that coping for exercise self-efficacy enhanced the relationship of scheduling self-efficacy to physical activity, and walking self-efficacy enhanced the importance of coping for breathing self-efficacy to physical activity by suppressing irrelevant variance.

**Discussion**

This is the first study to test the effects of mastery and coping model interventions on observer self-efficacy in COPD patients. Both mastery and coping model interventions positively impacted self-efficacy, whereas verbal instructions alone did not change self-efficacy. Compared to the coping models, the mastery models had a similar impact on the self-efficacy subtypes, except for coping for exercise self-efficacy, which was the type of self-efficacy most strongly associated with post-exposure physical activity. For this type of self-efficacy, the coping models had a greater impact on observer self-efficacy than the mastery models. The models in the coping video portrayed common errors that COPD patients make on CPETs and how to correct them. Therefore, the coping models may have provided participants with more information specific to overcoming exercise challenges than the mastery models, which could explain the greater increase of coping for exercise self-efficacy in the coping group compared to the mastery group. The similar changes across the other self-efficacy sub-types suggest that vicarious experience can have a generalized effect on self-efficacy. However, the greater increase in coping for exercise self-efficacy in the coping condition points to the specificity needed in the design of behavioral interventions to get the strongest possible impact on the desired outcome.

Given the context of the intervention was a physical exercise task, it was hypothesized that task, coping (both types), and walking self-efficacy would be more strongly impacted than scheduling self-efficacy. This hypothesis was partially supported. Task and coping self-efficacy (both types) were most strongly impacted by the interventions, followed by scheduling self-efficacy. The increase in scheduling self-efficacy may have occurred by virtue of its relationship to task self-efficacy. Confidence for elemental aspects of tasks is a prerequisite for confidence for performing the task under challenging situations. COPD patients may not be confident that they can schedule exercise tasks if they are not sure if they can perform the task itself. Through gaining confidence to perform a physical exercise task, patients with COPD may also gain confidence to arrange their schedule to do the task itself, particularly if time demands are not a pressing issue, which may be the case in a predominantly retired population group.

Contrary to our hypothesis, there was limited change in walking self-efficacy across conditions. The lack of change may be explained by the intensity of the activity specified in the scale. The modified SEW\(^3\) assesses perceptions of walking endurance at a moderate pace. However, the CPET is a maximal test where the intensity steadily increases until the patient or supervising physician terminates the test. Observing a model perform a CPET may not provide the observer with much relevant information about walking endurance at a moderate pace.

Cumulating research suggests that mastery and coping models have similar effects on observer self-efficacy,\(^3\) although several moderators of this relationship have been suggested. Some researchers have suggested that coping models may be more beneficial than mastery models when learners observe difficult tasks, or tasks require great persistence for success. In this study, perceived difficulty and past exercise experience did not moderate the intervention and self-efficacy relationship. However, the greater impact on coping self-efficacy in the coping intervention

**Table 3. Multiple regression analysis predicting 10 hour step count average one week post contact.**

<table>
<thead>
<tr>
<th>SE Predictor</th>
<th>(Adj)(R^2)</th>
<th>Unst. B (95% CI)</th>
<th>SE</th>
<th>St. B</th>
<th>p-value</th>
<th>(r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task</td>
<td>23.15 (–21.22, 67.52)</td>
<td>22.36 .12 .30 .21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coping with exercise</td>
<td>37.87 (7.845, 67.90)</td>
<td>15.13 .35 .01 .29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scheduling</td>
<td>–27.34 (–57.92, 3.23)</td>
<td>15.41 –.22 .08 .00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coping with breathing</td>
<td>–25.16 (–49.24, –1.08)</td>
<td>12.13 –.25 .04 –.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking</td>
<td>15.15 (–4.20, 34.49)</td>
<td>9.75 .18 .12 .19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. SE = self-efficacy; Unst. = unstandardized; St. = standardized.
compared to the mastery intervention, coupled with similar impact on task self-efficacy across the mastery and coping conditions suggests that coping models may be more beneficial than mastery models when the complexity of the task is great. During elemental and basic tasks, both mastery and coping models can improve observer capability beliefs. However, when the task is a composite of multiple smaller behaviors and more information is required by the observer, coping models seem better than mastery models at improving capability beliefs.

This study also examined the effects of mastery experience on self-efficacy. In the coping and mastery conditions, there was an increase in self-efficacy with the vicarious experience interventions and then a further small increase in self-efficacy after participants performed their own CPET (i.e., mastery experience). In the control condition, there was no change in self-efficacy with verbal instructions only, but an increase in self-efficacy with the CPET that brought self-efficacy levels up to those of the coping and mastery model intervention conditions. This finding is in line with theoretical expectations that mastery experiences are the strongest source of self-efficacy, although it does not negate the importance of vicarious experiences. Vicarious experiences are useful for instructional purposes and may be important for supporting the initiation of new behaviors when individuals are unsure of how to begin, the task is complex, or when support from an expert is absent. Further, observation of others is inevitable in social environments. Additionally, the cumulative value of vicarious and mastery experiences across time and under differing circumstances might encourage better adherence and achievement and warrants further study. Understanding the impact people’s behavior has on others is necessary for creating situations that will support development of confidence and behavior.

The intervention conditions did not have statistically significant impacts on exercise tolerance, effort, or physical activity. The protocol of a CPET is designed to facilitate patient achievement of maximal exercise tolerance and effort, so it is not surprising that the intervention conditions did not translate into better CPET performance. Similarly, the intervention was not expected to impact physical activity levels given that it was delivered one time only and in the context of a very specific exercise experience that was prior to the PR program. Also, the CPET is not, strictly speaking, an intervention – but is a capability assessment. It is likely that a more intensive and explicit intervention would be required to impact physical activity levels. However, the results of this study are promising, given that the type of self-efficacy most strongly impacted by the coping model intervention was the type of self-efficacy most strongly related to physical activity the week following contact. Repeated exposures in modeling interventions would likely be required to impact and sustain long-term physical activity.

This study was the first to examine which type of exercise-self-efficacy is most strongly related to objective physical activity in COPD patients. Physical activity is a key component of optimal disease management in COPD patients, and physical activity has been shown to be related to acute exacerbations (flare-up of disease symptoms) and mortality in patients with COPD. While the development of self-efficacy is considered fundamental to long-term physical activity and is a key component to COPD management protocols, no previous research has examined the relationship of exercise-specific self-efficacy to physical activity in COPD patients and few studies have empirically tested how to enhance self-efficacy in this population. This study demonstrated that self-efficacy for coping with exercise barriers was the type of self-efficacy most strongly related to objectively measured physical activity. This was also the type of self-efficacy most strongly impacted by the coping model intervention. In previous research, coping for exercise self-efficacy predicted functional exercise capacity improvement in COPD patients over and above demographic and clinical indicators. Cumulatively, these studies suggest targeting coping with exercise self-efficacy in future interventions to improve functional capabilities and physical activity levels in COPD patients, and that vicarious experiences using coping models may be a useful intervention technique to achieve these behavioral goals.

An important contribution of this research is the inclusion of self-efficacy for coping with breathing barriers and exercise barriers. Given that dyspnea (i.e., breathlessness) is a primary symptom of COPD and that physical activity will naturally induce dyspnea, it is reasonable to assume that self-efficacy for coping with breathing barriers would be important to physical activity participation in this group. However, this research tentatively suggests that self-efficacy for coping with exercise barriers may be more important to physical activity than coping with breathing barriers. Future research statistically distinguishing the two constructs in COPD patients is needed. The results of that research will have implications for the design of
future interventions to improve physical activity adherence in COPD patients.

There are several applications of this research for PR settings. First, PR could use peers to demonstrate exercise tasks and solutions for overcoming common pitfalls. Demonstration could occur in vivo or through prerecorded videos. In previous research, low task self-efficacy was associated with poor attendance at PR. Videos illustrating exercise training components by a peer may facilitate the enhancement of self-efficacy prior to attending PR, which may facilitate attendance at PR among COPD patients. The second application of this research to PR settings is that while demonstration of an ideal situation is helpful, demonstration of a situation in which one has to cope, may be better. This point applies to the performance of physical exercise tasks, such as form while walking on a treadmill, but it may also apply to other exercise tasks, such as overcoming motivational, environmental, and social challenges. While the former challenges have implications for performance of exercise in the PR setting, the latter challenges have implications for the performance of long-term physical activity after PR has concluded.

Limitations

This study demonstrated that observation of similar others perform exercise tasks can enhance self-efficacy in COPD patients. The patient CPET experience was ideal to preliminarily test vicarious experience effects as the setting was highly controlled. However, it is unknown if vicarious experiences in less controlled environments, such as a PR exercise class, would have similar impacts on self-efficacy. In less controlled environments, more information is available for individuals to interpret and it is unclear what information will ultimately impact confidence. Facilitating opportunities for beneficial mastery and vicarious experiences may help to ensure that patients’ confidence is positively impacted. Further, the results of the multiple regression should be interpreted with caution. Although coping with exercise self-efficacy statistically predicted steps per day, the confidence intervals were large. Also, the coping with breathing sub-scale was preliminary and requires psychometric testing, and the unavailability of socio-economic status and ethnicity data limits the ability to generalize the results.

Conclusions

This research tested the effects of mastery and coping vicarious experiences on multiple types of observer self-efficacy within the context of usual care CPET in COPD patients. While both mastery and coping models had beneficial effects on observer self-efficacy, coping models had a stronger effect on self-efficacy for coping with exercise barriers, which was the type of self-efficacy most strongly related to physical activity. This research suggests that vicarious experience is a useful intervention technique to enhance self-efficacy, and that future interventions with COPD patients should target coping with exercise self-efficacy. Further, this research highlights the importance of detailed, population-specific interventions to have the greatest possible impact on outcomes. Future research examining the generalizability of coping self-efficacy will be useful for understanding the theoretical and applied limits of this variable.

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References


