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"I'm just too busy to exercise": Reframing the negative thoughts associated with exercise-related cognitive errors

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ABSTRACT

Objectives: Exercise-related cognitive errors (ECEs) represent a negative lens that distorts individuals' view of exercise. Such thinking can inhibit individuals' behaviour change efforts. Reframing is an evidence-based counselling strategy used to help individuals evaluate the evidence for and against their biased thoughts. Reframing is commonly used within the clinical counselling domain, however, there is no systematic evidence base for its use in an exercise setting for a sample of non-clinical individuals. Two proof-of-concept studies examined whether reframing could attenuate ECEs in the exercise context.

Design: Study 1 ($N = 22$) used a one-group pre-post design to examine cognitive error reframing (REF) in a sample of university staff and students. Study 2 ($N = 28$) used a randomized design (REF vs. attention control [AC]) to examine ECEs and exercise changes in a sample of individuals with prediabetes.

Methods: Those receiving REF were prompted to identify, challenge, and reframe their negative exercise thoughts.

Results: Both studies demonstrated ECE reductions following reframing. Changes in self-regulatory social cognitions were observed in Study 1. Those receiving REF in Study 2 reported greater increases in their self-reported exercise four weeks following the diabetes program compared to those in AC.

Conclusions: REF may help individuals to reduce their biased exercise thoughts when making behaviour change efforts. While findings should be viewed as preliminary given the early research stage and sample sizes, we hope they spark future reframing research within the exercise context.

One of the most commonly cited perceived barriers to exercise is the lack of time or being "too busy" to exercise (Booth, Bauman, Owen, & Gore, 1997). Usually this thought has truth to it, but individuals may come to that conclusion without fully thinking through whether they are *actually* too busy to exercise. Some may feel busier than they actually are and only evaluate information that confirms their busy feeling. In these situations, has the decision to exercise been accurately evaluated? The cognitive errors model would suggest that, for some, perceived exercise barriers result from a biased evaluation of one's situation. Cognitive errors provide a framework that may aid our understanding and modification of these biased perceptions.

1. The biasing influence of cognitive errors

Cognitive errors have been predominantly studied in relation to depression and anxiety as the psychological mechanism causing maladaptive and negative thoughts (Beck, 1976; Lefebvre, 1981). Recently, the cognitive errors framework has been used to understand the psychology of biased exercise perceptions (e.g., Locke & Brawley, 2018). *Exercise-related cognitive errors* (ECEs) represent a biased view of exercise-relevant information that distorts how individuals perceive and make decisions about their exercise participation (Locke & Brawley, 2016, 2017; Milman & Drapeau, 2012). Catastrophizing is one example of a cognitive error. Catastrophizing occurs when "one predicts that a future outcome of some situation will be negative without giving consideration to more likely outcomes, which may be less negative" (Drapeau & Perry, 2010, p. 18). The following is an example of a catastrophizing reaction to a typical exercise situation that might be encountered: you have just come off holidays and have not exercised in two weeks. When it comes time to exercise, you think to yourself, "It's been so long since I've exercised that I'm going to be painfully sore for days."

Recent research has demonstrated that ECEs may be one cognitive mechanism that is detrimental to regular physical activity engagement,

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particularly for those who are insufficiently or irregularly active. For example, those reporting higher and lower levels of ECEs differentially processed information about an exercise decision-making vignette (Locke & Brawley, 2017). Those viewing exercise through an ECE predominantly paid attention to the challenging aspects of exercise, while ignoring or discounting the positive aspects. ECEs have been associated with lower levels of physical activity and lower intentions to be physically active (Locke & Brawley, 2016). ECEs impact the aspects of a situation that to which individuals pay attention and evaluate. They can cause individuals to perceive that they are too busy to exercise when, in reality, they are forming their conclusion based on the feeling of being too busy rather than the time constraints of their actual schedules. Modifying the cognitive errors may be one fruitful means to help individuals form more accurate perceptions about their exercise engagement.

2. The impact of cognitive errors on self-regulatory exercise cognitions

Regular exercise engagement is complex and requires self-regulation (e.g., scheduling, regulating motivation, managing thoughts and feelings; Carver & Schier, 2011). Social cognitive theory maintains that self-regulatory efficacy, the confidence to self-regulate exercise, is a prerequisite for regular exercise participation (Bandura, 1986). Self-regulatory efficacy beliefs are one of the most consistent determinants of physical activity participation (Ashford, Edmunds, & French, 2010) and may be one of the best targets to promote continued participation (Bandura, 2004). ECEs may have the capacity to negatively impact individuals' self-regulatory efficacy for exercise. For example, biased thoughts such as, "I'm just too busy to exercise" may thwart motivation and confidence to develop, schedule, and follow through with exercise plans. Past research has demonstrated that high ECE scores were strongly associated with less adaptive self-regulatory cognitions related to physical activity adherence (e.g., lower self-regulatory efficacy, more struggle in deciding to exercise, less persistence to self-manage exercise; Locke & Brawley, 2018).

An individual's self-regulatory efficacy beliefs are typically strengthened by their experiences of success and diminished by experiencing failure. Exercise initiates or low-active populations may not have personal experiences to draw on to form self-efficacy beliefs requiring them to draw on other sources of information that may not be as accurate (Bandura, 1997). Evaluating self-efficacy through a cognitive error may cause an individual to perceive partial success (e.g., attending three out of four scheduled exercise classes) as a complete failure and internalize it as being less capable to self-manage their exercise. Enhancing self-regulatory efficacy beliefs by modifying cognitive errors may be an important outcome to promote exercise for people who are affected by ECEs and view previous experience with exercise through a negative and one-sided perspective.

3. Understanding the impact of cognitive errors through a dual-process model

The importance of self-regulatory cognitions in understanding exercise adherence cannot be understated. However, there is increasing recognition that automatic processes impact motivational aspects of exercise engagement (Conroy & Berry, 2017). Dual-process models can help to position the impact of cognitive errors on exercise self-regulation. Dual-process models suggest that two systems operate in parallel to regulate our feelings, decisions, and actions (Hagger, 2016; Kahneman, 2011). System 1 is characterised as being a relatively fast process that reflects learned associations that automatically come to mind. System 2 is characterised as being a deliberative or reflective process that reflects controlled reasoning. In this way, the activation of a perceived barrier may be characteristic of the automatic associations described in system 1. They may involuntarily arise when the idea of exercise is brought to a person's mind. The biased evaluation through which cognitive errors can impact decision making may represent the deliberative processes described in system 2. Understanding the system through which cognitive errors function can guide intervention efforts.

4. Modifying cognitive errors through reframing

Reframing is a system 2 approach for modifying the thoughts associated with cognitive errors. Cognitive error reframing is a common technique used within clinical counselling settings (Leahy, 2017). This technique is effective in modifying biased thoughts in the treatment of posttraumatic stress disorder (Mueser, Rosenberg, & Rosenberg, 2009) and depression (Leahy, 2017). Reframing represents a flexible set of techniques aimed at identifying core thoughts and cognitive errors that contribute to biased and negative thinking then systematically evaluating the evidence for and against those negative thoughts (Mueser et al., 2009). Cognitive errors are targeted in reframing counselling because they are the hypothesized mechanism in forming biased perceptions (Beck, 1976; Leahy, 2017). Reframing is typically the first strategy used in counselling to help individuals to challenge their biased thoughts (Mueser et al., 2009). Once individuals form a balanced perspective, self-regulatory behavioural techniques are then employed to help individuals modify their behaviours (e.g., self-monitoring, goal setting). As such, the purpose of reframing is to modify biased cognitions. On its own, reframing may indirectly impact behaviour through the change in cognitions (Leahy, 2017).

Cognitive errors have been demonstrated as occurring in the exercise context with resulting biased perceptions in a non-clinical sample (Locke & Brawley, 2018). While reframing may hold promise in modifying biased exercise perceptions in the physical activity context, it has not been systematically examined. Reframing may also help individuals to more accurately perceive exercise self-management (e.g., dealing with partial success), which may be an important step prior to teaching individuals how to self-monitor and set exercise goals.

5. Purpose

The goal of reframing is to modify biased *cognitions*. Since this research represents the first examination of an exercise-specific reframing in attenuating ECEs, the broad purpose was to examine whether a one-off reframing session could shift participants' cognitions in the immediate and short-term. Two experimental studies were conducted to examine the capacity of reframing to help individuals to challenge the biased exercise perceptions associated with their ECEs.

6. Study 1

6.1. Purpose

The purpose of Study 1 was to pilot test reframing as a means to change biased exercise cognitions in a sample of university staff and students. Participants also provided feedback on the reframing session, which provided context to the quantitative findings.

Hypothesis 1. Participants will decrease their level of ECE and level of struggle in making the decision to exercise following reframing.

Hypothesis 2. Participants will increase their intention to exercise and their self-regulatory efficacy to manage their biased exercise thoughts following reframing.

Hypothesis 3. Following reframing, participants will anticipate feeling less negative about their decision to either exercise or NOT exercise.

7. Method

7.1. Participants and procedure

A sample of adults was recruited via printed posters from a Canadian university, which included both students and staff. Participants consented and completed an online pre-test and eligibility questionnaire. Inclusion criteria included being over 18 years old, not currently in an uncontrolled mood disorder, must have reported that they have struggled with making the decision to exercise in the past month, and must have an ECE score above a 3 (out of 9). A minimum ECE cut-off score was set to ensure that participants reported some level of bias that could be reframed. This rationale parallels the evaluation of mood-disorder treatments; that is, an intervention for depression is examined with individuals who report depressive symptoms. Eligible participants were contacted and scheduled for their reframing within one week of the pre-test. Participants completed a post-test questionnaire immediately following the reframing session.

7.2. Measures

Exercise-specific cognitive errors. The Exercise-Related Cognitive Errors Questionnaire (E-CEQ; Locke & Brawley, 2016) assesses cognitive errors that occur within an exercise context. The 16-item E-CEQ represents the degree to which individuals believe that their thoughts are consistent with ECEs, which are based on a model of cognitive errors described by Drapeau and Perry (2010). Items took the form of very short vignettes (i.e., depicting a cognitively errored response to a variety of exercise situations). An example item reads, "You consider starting an exercise routine, but think to yourself, 'I'm not good at sticking with anything. I'll probably quit after a month so why start'". Participants responded to items on a nine-point Likert scale ranging from 1 (not at all like I would think) to 9 (exactly like I would think). The overall scale mean was calculated and demonstrated good reliability (Cronbach's $\alpha s > 0.88$). Please refer to Locke and Brawley (2016) for additional information on the E-CEQ and its psychometric properties.

Exercise intention. Cognitive errors should affect intentions (i.e., proximal goals), during the exercise decision-making process. Participants were asked a single item question, "how many 30-min or more bouts of moderate or strenuous exercise do you intend on doing in the next 7 days?" This one-item measure has demonstrated predictive utility in previous research (e.g., Bloomquist, Gyurcsik, Brawley, Spink, & Bray, 2008; Locke & Brawley, 2016).

Self-regulatory efficacy for managing cognitive errors (SRE). Four SRE items were used to assess participants' confidence in their ability to regulate their exercise when they were thinking in a manner consistent with cognitive errors (e.g., similar to facing a challenge/obstacle; Locke & Brawley, 2018). In responding to the SRE items, participants were asked to reflect on their responses on the E-CEQ, and the unhelpful exercise thoughts and situations that they struggled with most. On a scale ranging from 0 (not at all confident) to 100 (completely confident) participants were asked, "how confident are you that you can": (1) Prevent your unhelpful thoughts from interfering with deciding to exercise as planned; (2) Manage your unhelpful thoughts about exercise so that they do not make you indecisive about engaging in exercise?; (3) Maintain your motivation to exercise despite having unhelpful thoughts about exercising?; (4) Focus solely on the positive outcomes of exercise important to you instead of the negative outcomes you think about? The 4-item SRE measure had good internal consistency (Cronbach's $\alpha s > 0.92$).

Decisional struggle. Participants were first asked to write a thought or situation that they struggle with most (or most often) when thinking about exercising (e.g., "I'm too busy to exercise"). They were then asked, "in the past week how much struggle did this thought cause you": (1) when deciding whether or not you wanted to exercise, (2) when deciding how many times you wanted to exercise, (3) when planning your exercise, and (4) when following through with your planned exercise. Items were rated on a scale ranging from 1 (*no struggle*) to 9 (*tremendous struggle*). The scale is an expanded operationalization of a one-item decisional struggle item used in previous cognitive error research (Locke & Brawley, 2018). The overall scale means were calculated and demonstrated low reliability ($\alpha s > 0.64$).

Anticipated affect for action and inaction. Two measures (3 items each) were used to assess how participants would feel (a) if they decided to exercise, and (b) if they decided NOT to exercise. Participants were asked how much they would, "regret it", "feel proud of myself" (reverse coded), and "feel worried and tense" if they decided to exercise and if they decided NOT to exercise today by responding on a scale ranging from 1 (*unlikely*) to 9 (*likely*). This exercise version of the scale was based on Ajzen and Sheikh (2013), who hypothesized that anticipated affect of engaging in an action and or not engaging in an action would predict behaviour, particularly in circumstances of decisional struggle. The overall scale means were calculated and demonstrated low reliability ($\alpha s > 0.61$).

Reframing session feedback. After completing the reframing session, participants were asked to respond to and explain four online, open-ended session feedback questions. They were asked, (1) did today's reframing session help you to reframe how you think about exercise?; (2) what parts of the session did you find useful?; (4) what parts of the session did you find not useful?; (4) would you use this reframing strategy in the future? Participants were also given the opportunity to provide additional comments.

7.3. Reframing procedure

The reframing sessions consisted of three key steps: (1) identifying the main biased thought; (2) evaluating the evidence for and against the thought; and (3) reframing the thought (Leahy, 2017). Participants received one-on-one counselling sessions lasting approximately 15 min. Participants were given a handout outlining the session and were given the option of either recording their thoughts or follow along as they talked through the handout (see supplementary file 1 for the handout). In the first step, participants were asked to identify the thought they struggled with most when making the decision to exercise. The researcher continued to ask follow-up questions until both participant and researcher had a clear view of the problem. For example, participants were asked to carefully describe their past exercise efforts and the last time that they struggled in deciding to exercise.

In the second step, participants were prompted to ask themselves two general questions aimed at evaluating the evidence for and against their biased thought, "am I exaggerating part of this situation," and "am I seeing both sides of this situation." The following is an example of what the researcher might have said,

> "You had mentioned that you're too busy to exercise. Sometimes we get home from work all we can focus on is how busy we are. Sometimes we are actually too busy but other times we aren't too busy, we just feel that we are too busy. In this way, we exaggerate how busy we are. Do you think this has ever happened to you? If so, please tell me about it."

Participants then received a second hand-out describing four common ECEs (see supplementary file 1). ECEs included all-or-nothing thinking (i.e., views a situation as fitting into only two extreme categories), mental filter (i.e., pays undue attention to only one aspect of a situation), catastrophizing (i.e., predicts future negative outcomes without considering more likely positive outcomes) and emotional reasoning (i.e., infers truth based on belief while ignoring evidence to the contrary). Participants were asked to identify the ECE(s) influencing their view of exercise and how they were influencing their view. After challenging their biased exercise thought, participants were asked to reframe their unhelpful view of exercise by proposing a more balanced

Table 1
Participant characteristics for Study 1 and 2.

Demographics	Study 1	Study 2
Age		
18-25 years old	11	0
26-34 years old	6	0
35-44 years old	1	1
45-54 years old	1	7
55-65 years old	4	18
Unknown	0	2
Gender		
Male	8	3
Female	14	25
Transgendered	0	0
Education		
High School Diploma	4	5
College Diploma or Trade Certificate	3	10
Some University	7	2
University Degree or higher	8	9
Not Provided	0	2
Employment Status		
Full-Time	7	9
Part-Time or Contract	1	6
Student	14	0
Retired	0	11
Other/Unknown	0	2
Relationship Status		
Single	16	6
Married	5	16
Widowed/Divorced	1	6
Ethnicity		
Caucasian	14	27
Aboriginal/Metis/First Nations	2	0
Asian	5	0
African	0	1
Other/Unknown	1	0

Note: Study 1 (N = 22), Study 2 (N = 28).

response to the situation they were struggling with.

7.4. Analytic plan

There were no *a priori* power calculations used in Study 1 as this was the first study examining the impact of reframing cognitive errors in the exercise context and relevant literature was lacking. Paired-samples t-tests were used to examine pre-post changes in ECEs, decisional struggle, exercise intentions, SRE, and anticipated affect. The magnitude of pre-post change was examined using Cohen's d (Cohen's d effect size conventions: small = 0.2, medium = 0.5, large = 0.8; Cohen, 1988). Participant feedback provided context to the quantitative data.

8. Results

See Table 1 for participant demographic information. Participants (N = 22) were eight university staff and 14 university students, with an average age of 31 years old (SD = 14), with eight males and 14 females participating in the study. Figure 1 presents individual-level data depicting pre-post ECE change. All of the following results are with regards to change following reframing. Participants significantly decreased their level of ECE from M = 4.81 (out of 9; SD = 1.39) to M = 3.94 (SD = 1.66, t = 2.75, df = 21, p = .012, Cohen's d = 0.57). Seventeen participants decreased their ECE score, while 5 increased their score. Participants significantly decreased their struggle from M = 5.60 (out of 9; SD = 1.61) to M = 2.89 (SD = 1.23, t = 5.95, df = 21, p < .001, Cohen's d = 1.90). Seventeen participants decreased their decisional struggle, while 3 increased their struggle, and 2 did not change. Participants significantly increased their intentions from M = 2.76 (SD = 1.90) bouts of physical activity over the next week to M = 4.86 (SD = 3.49, t = 3.74, df = 20, p < .001, Cohen's d = 0.76). Six participants did not change their physical activity

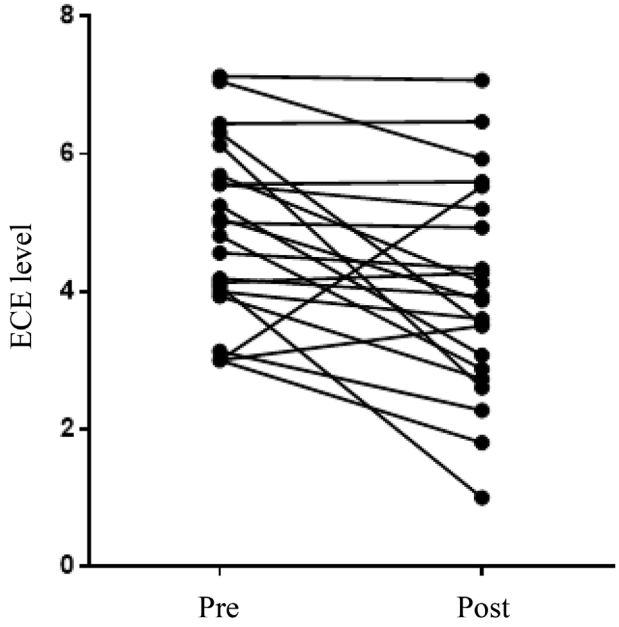

Figure 1. Study 1 data depicting the individual-level change in exercise-related cognitive error (ECE) scores from pre-reframing (M = 4.81, SD = 1.39; out of 9) to post-reframing (M = 3.94, SD = 1.66).

intentions, while 16 increased them. Participants significantly increased their self-regulatory efficacy to manage their unhelpful thoughts from M = 36.67 (out of 100; SD = 31.16) to M = 63.19 (SD = 22.20, t = 5.95, df = 21, p < .001, Cohen's d = 0.98). Sixteen participants increased their self-regulatory efficacy, while 6 decreased their self-regulatory efficacy. There was no change between participants' anticipated negative affect if they did NOT exercise ($Mpre$ = 6.23, SD = 1.33, $Mpost$ = 6.12, SD = 1.71, t = 0.32, df = 21, p = .75). However, there was a significant decrease in participants' anticipated negative affect if they did exercise from $Mpre$ = 3.47 (SD = 1.58) to $Mpost$ = 2.62 (SD = 1.17, t = 2.75, df = 21, p = .012, Cohen's d = 0.61). In other words, participants anticipated being less likely to feel regret/negatively if they ended up deciding to exercise. Finally, 18 participants decreased their anticipated negative affect, while 2 increased, and 1 remained unchanged.

8.1. Participant feedback

The following are illustrative examples of participants reframing experiences. Participant feedback in the post-session survey corroborated the quantitative findings. For example, when asked how the reframing session helped to reframe their view of exercise, one participant suggested that "*it helped me take a step back and look at the whole picture of my situation. As I already know all the major benefits to exercise, looking at the whole picture allowed me to focus on all these positive things and not just the one aspect that was holding me back.*" This individual was able to identify an ECE that was biasing her exercise thoughts (i.e., mental filter) and challenge their biased thoughts. When asked if they would use reframing in the future, one participant agreed and said, "*I often have negative thoughts about exercising but like exercising, I know it has great benefits and I know I will feel better afterwards. I like that this is a tool I can use to help motivate me to get out the door to a class or out running because once I am exercising I don't have any more negative thoughts.*" This statement also suggested that this participant was able to gain a more balanced view of exercise and perhaps use reframing strategies to manage their decisional struggle.

Participant feedback on the reframing sessions was predominantly positive, and some reported on various strategies they may employ to gain a more balanced view of exercise. One participant explained, "*I can*

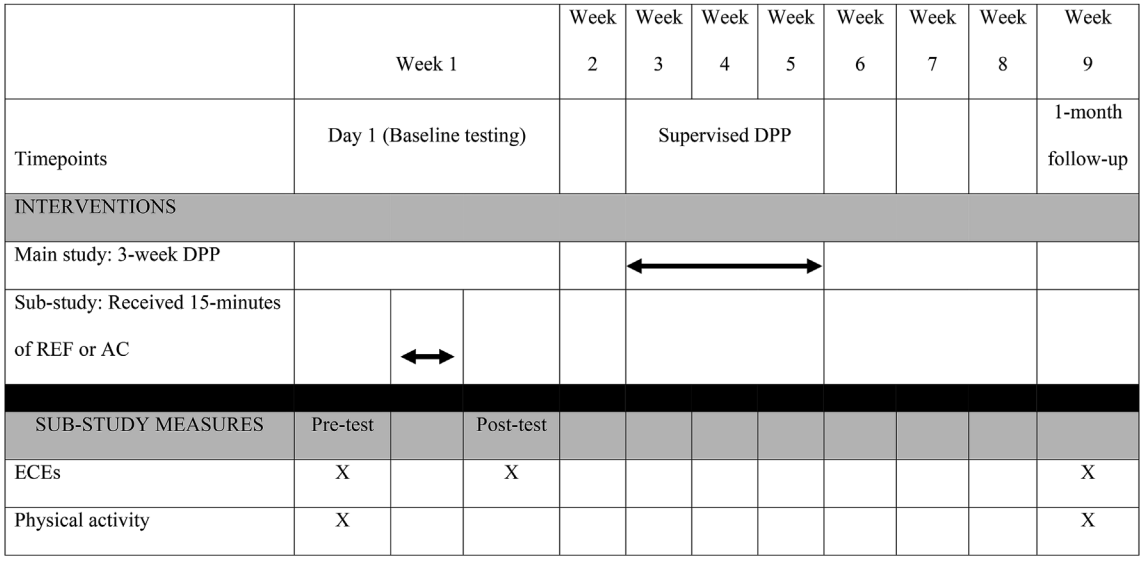

Figure 2. Timeline for Study 2 schedule of the main intervention, reframing sub-study, and measures.
Note: DPP = diabetes prevention program; REF = reframing; AC = attention control; ECEs = exercise-related cognitive errors.

more honestly evaluate my thoughts and feelings and challenge the thoughts that may be negative and hinder my desire to exercise." This comment demonstrated that reframing sessions enabled participants to more accurately evaluate their biased thoughts and develop more balanced thoughts that may lead them to exercise in the future. Conversely, some participants became aware of their biased thinking, and as such, their social cognitions were not in the hypothesized direction. One participant explained, "*there were several things I did not consider until now and this has opened my eyes to the way I have been thinking in the past*". In this instance, reframing brought the pattern of biased thinking to the participant's awareness.

9. Conclusion

Study 1 represented the first pre-post test of cognitive reframing in a non-clinical sample within the exercise context. It demonstrated the proof-of-concept for a brief 15-min reframing session to help individuals reduce their biased exercise perceptions. Study 2 builds on these findings by examining exercise perceptions and behaviour four weeks following reframing in a community-based chronic disease sample. This iterative process is consistent with recommendations by Rothman, Klein, and Cameron (2013) regarding the importance of conducting experiments outside of the lab in community settings.

10. Study 2

10.1. Purpose

Often, there is a gap between translating lab-based health research and real-world contexts where health problems are managed. A call was put out for researchers to conduct controlled experiments in applied health settings (Mermelstein & Revenson, 2013; Rothman et al., 2013). Early-stage research examining psychological mechanisms within existing health programs can produce ecologically valid theoretical experiments that are poised to have a greater potential real-world impact compared to tests in student or asymptomatic populations. The purpose of Study 2 was to experimentally test cognitive reframing in a sample of low-active individuals with prediabetes to ready them to begin a community-based diabetes prevention program.

Hypothesis A. Compared to attention control, those receiving reframing will report greater decreases in their level of ECE from pre-experiment to immediately post-experiment and four weeks post diabetes prevention program.

Hypothesis B. Compared to attention control, those receiving reframing will report greater increases in their self-report level of exercise from pre-experiment to four weeks post diabetes prevention program.

Hypothesis C. Compared to attention control, those receiving reframing will report a greater readiness to make behavioural changes immediately-post experiment.

11. Method

11.1. Participants and procedure

Study 2 is a randomized experimental sub-study within an ongoing community-based diabetes prevention program. Briefly, the three-week diabetes prevention program employed social cognitive theory and behaviour change techniques aimed to help individuals at high risk of developing type 2 diabetes to change their exercise and dietary behaviours (Jung, Bourne, Beauchamp, Robinson, & Little, 2015). Participants were asked to perform either moderate-intensity exercise at a continuous pace or high-intensity interval exercise. Individuals undergoing annual bloodwork whose HbA1c values were in the prediabetes range were invited to participate (HbA1C between 5.7% and 6.4%; American Diabetes Association, 2012). Other recruitment strategies included: 1) online ads (i.e. castanet.net or kijiji.ca), 2) pamphlets distributed in doctor's offices, and 3) program website traffic. Data were collected between July and December 2017. Participant eligibility for the diabetes prevention program included adults aged 18–65 years old who were classified as having prediabetes and had no contraindications to exercise.

The sub-study included one additional eligibility criteria: participants must report an ECE score above a 3 (out of 9). Adults with prediabetes who joined the diabetes prevention program were randomly assigned to either receive reframing counselling or attention control at their pre-program testing, which took place two weeks before participants began the three-week program. Participants were emailed a questionnaire four weeks following the diabetes prevention program, which occurred nine weeks post-reframing. See Figure 2 for the timeline of the main study, sub-study, and measurement schedule.

11.2. Measures

Exercise-specific cognitive errors. See Study 1 measures for description. The E-CEQ was assessed at three points: pre-test, immediately post-test, and nine weeks later (i.e. four weeks following the program). The overall scale mean was calculated and demonstrated good reliability (Cronbach's αs > 0.94).

Self-report exercise (Metabolic equivalents [METs]). Participants reported the number of 30-min bouts of moderate and vigorous exercise in which they engaged during the past week using the modified Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985). The validity of the alteration to the scale (30-min bouts) has been demonstrated (Amireault & Godin, 2012). MET scores were calculated from participants' self-reported moderate and vigorous exercise using Godin and Shephard's (1985) scoring system. MET scores were chosen as an outcome to appropriately credit exertion level for participants who were prescribed either vigorous or moderate intensity exercise in the diabetes prevention program. The GLTEQ was assessed pre-test and four weeks following the program.

Readiness to start the program. Participants were asked about their readiness to start the diabetes prevention program. Participants rated their level of agreement on four items ranging from 1 (*completely disagree*) to 5 (*completely agree*) on four items: (1) I am ready to start …, (2) I am hesitant to start …, (3) I am willing to make exercise changes during …, and (4) I am willing to challenge negative exercise thoughts during … the diabetes prevention program. Items were examined individually and were compared between intervention and control groups post-reframing. The four items were created for this study to operationalize readiness as described by Meichenbaum and Turk (1987) to begin the Small Steps for Big Changes diabetes prevention program.

11.3. Reframing procedure

Study 2 added supplementary probing questions to the first two steps of the previously described reframing protocol (Study 1). The additions were based on: participant feedback from Study 1, review of session recordings, and examination of in-session counsellor notes. The counsellor used the probing questions to help participants—especially those struggling to identify or evaluate their thoughts—reflect more deeply. In the first step, error identification and description, probing questions helped participants to fully think through the context and typical reactions to exercise. Examples of probing questions included, "*Describe when this thought typically occurs.*"; "*Describe what happens when you think about exercising.*"; and "*Think back to the last time you planned to exercise, what do you think and immediately decide to do?*". Probing questions were written in a general form and were made participant-specific in the sessions. To make the last probing participant-specific, the reframing counsellor could have said, "*last week you just got home from a long day at work and hadn't eaten dinner yet, the thought of exercise went through your mind. What did you think at that moment?"*

In the second step, evidence evaluation, probing questions helped participants to more critically examine the validity of their exercise perceptions. Examples included, "*What if I told you that when you get home from work tomorrow you had to exercise. How would you do it?*"; "*You mentioned a lot of your colleagues regularly exercise. How do you think they are able to fit their exercise in? What strategies help them become successful?*"; and "*You mentioned you were too busy to exercise. What do you think would happen if you did end up exercising?*". By the time participants reached the third step, reframing, they had a clearer perspective of their response to exercise, and additional probing questions were not required. The reframing session lasted approximately 15 min.

11.4. Attention control

Those randomized to the attention control group received information about foot care associated with diabetes management. Foot issues are salient to individuals with prediabetes because they are one of the most common symptoms associated with the progression of type 2 diabetes (Abbott et al., 2002). Participants were asked about any foot issues they were currently experiencing or recently had, and then discussed proper foot care practices recommended by Diabetes Canada (2018). The discussion lasted approximately 15 min.

11.5. Analytic plan

Using G*Power 3.1.9.2, a minimum sample size of 22 was calculated to detect a significant within-between ECE interaction effect between reframing and control groups across three repeated measures. This calculation was based on the observed pre-post treatment-only effect from Study 1 (Cohen's $d = 0.57$) and no hypothesized change for those receiving attention control (Cohen's d converted to effect size $f = 0.285$; Cohen, 1988), $\alpha = 0.05$, Power = .8, 2 groups, and 3 repeated measurements. Given that reframing seeks to directly modify cognitive errors as the mechanism causing negative exercise thoughts, it is very reasonable to suspect a larger magnitude change in ECEs, requiring a smaller sample. Mixed-design ANOVAs using group as the between- and time as the within-subject factor were run to examine changes in ECEs and physical activity between reframing and control groups across time using SPSS version 25. Follow-up contrasts were run to examine whether the magnitude of ECE change significantly differed between groups from (1) pre-to immediate post-reframing and (2) from pre-to four weeks post-program. Four Bonferroni-adjusted between-groups t-tests ($\alpha = 0.0125$) were run to examine post-test only difference in readiness to start the diabetes prevention program following the receipt of reframing or attention control. The magnitude change was examined using Cohen's d to compare the magnitude change between groups between pre- and immediately post-experiment and from pre-to four weeks post-program.

11.6. Results

Participant characteristics. See Table 1 for participant demographic information. Participants' ($N = 28$) average age was 56 years old (SD = 6.5), with three men and twenty-five women participating in the study.

Change in cognitive errors. See Table 2 for group means and standard deviations across the study. There was not a statistically significant difference in ECE score between groups at baseline ($t = 1.21$, $df = 26$, $p = .235$) suggesting the equivalency of the two randomized groups. There was a statistically significant main effect for ECEs ($F[2, 25] = 17.17$, $p < .001$, *partial* $\eta^2 = 0.34$) and a significant interaction effect ($F[2, 25] = 3.85$, $p = .028$, *partial* $\eta^2 = 0.13$). Using a planned contrast, there was a statistically significant difference in pre-post ECE change between reframing and control groups ($F[1, 26] = 5.79$, $p = .023$; Cohen's $d = 1.03$, 95% *CI*: 0.23–1.82). Those receiving reframing reported significantly greater decreases in their level of ECE post-reframing compared to those receiving control who did not

Table 2
Study 2 descriptive statistics.

	Pre *Mean* (*SD*)	Post *Mean* (*SD*)	4 weeks post program *Mean* (*SD*)
ECEs			
Reframing	5.39 (1.44)	4.51 (1.66)	3.36 (1.35)
Attention control	4.72 (1.38)	4.76 (1.37)	4.00 (0.97)
Exercise (METs)			
Reframing	23.23 (16.79)	–	49.85 (22.67)
Attention control	20.54 (9.12)	–	30.00 (20.79)

Note: Table 2 depicts the strength of exercise-related cognitive error across Study 2 ($N = 28$), reframing ($n = 16$), and attention control ($n = 12$). ECE = exercise-related cognitive error; METs = metabolic equivalents.

change. Using a planned contrast, there was a statistically significant difference in pre-to four-weeks post-experiment ECE change between reframing and control groups ($F[1, 26] = 23.15$, $p < .001$; Cohen's $d = 0.90$, 95% *CI*: 0.11–1.60). Both groups reduced their level of ECE from pre to the 4-week post program follow-up. However, those in the reframing group reported significantly greater decreases.

Change in exercise. There was a statistically significant main effect for exercise ($F[1, 22] = 28.59$, $p < .001$, *partial* $\eta^2 = 0.57$) and a significant interaction effect ($F[1, 22] = 6.47$, $p = .019$, *partial* $\eta^2 = 0.23$). Both reframing (Cohen's $d = 1.33$) and control (Cohen's $d = 0.59$) groups increased their exercise level from pre to the 4-week post program follow-up, however, those in the reframing group observed a significantly greater exercise increase (Cohen's $d = 1.09$, 95% *CI*: 0.23–1.95).

Change in readiness. Following reframing, there were no significant between-group differences in readiness to begin the program for all four variables: (1) ready to start ($M_{reframing} = 4.72$, $SD = 0.21$, $M_{control} = 4.96$, $SD = 0.48$; $t = 2.00$, $df = 26$, $p = .057$), (2) hesitant to start ($M_{reframing} = 2.00$, $SD = 1.04$, $M_{control} = 1.48$, $SD = 1.37$; $t = 1.36$, $df = 26$, $p = .181$), (3) willing to make exercise changes ($M_{reframing} = 4.78$, $SD = 0.29$, $M_{control} = 4.96$, $SD = 0.42$; $t = 1.63$, $df = 26$, $p = .117$), and (4) willing to challenge negative exercise thoughts ($M_{reframing} = 4.65$, $SD = 0.52$, $M_{control} = 4.87$, $SD = 0.50$; $t = 1.60$, $df = 26$, $p = .122$). All participants reported readiness values close to the scale basement or ceiling.

12. Discussion

Two reframing studies were undertaken to examine whether reframing could be effectively tailored and applied in an exercise context to help individuals to challenge their biased thoughts and gain a more balanced view of their exercise efforts. Some individuals report biased thoughts about exercise leading them to focus exclusively on the challenging aspects of exercise. Biased thoughts can exacerbate individuals' struggle in making the decision to exercise and can ultimately lead them to choose not to exercise (Locke & Brawley, 2018). The findings from these first two preliminary studies represent first-generation research (Zanna & Fazio, 1982) demonstrating proof-of-concept for a reframing counselling intervention in an exercise setting.

Study 1 represented the first examination of a reframing intervention to modify exercise-related adherence cognitions. The findings demonstrated the immediate pre-post effects of a short 15-min reframing session. Participants successfully challenged and reframed their biased exercise thoughts. Following the reframing session, most participants decreased their level of ECE and decisional struggle, and anticipated feeling less negatively if they ended up deciding to exercise. Additionally, most participants increased their exercise intentions and self-regulatory efficacy to manage their unhelpful thoughts. These self-regulatory social cognitions are important for regular adherence to exercise (Bandura, 2004; Schwarzer & Luszczynska, 2015). Findings suggest that reframing may improve self-regulatory cognitions that allow an individual to manage their exercise participation more effectively.

While most of the 22 participants in Study 1 reported changes in ECEs, decisional struggle and self-regulatory efficacy in the hypothesized direction, 6 did not. One tenable explanation for the findings for these individuals is that reframing resulted in some participants becoming aware of their biased thinking, which was corroborated by participant feedback. For these participants, initially high confidence and low level of ECEs may have been inaccurately estimated. As such, reframing may have illuminated biased thinking for some individuals and may have resulted in mentally recalibrating their cognition strength. These reframing outcomes are congruent with what might be expected in the clinical setting, where individuals with a certain pathology may be initially unaware of their biased thought processes (Leahy, 2017). It is noteworthy that no participants decreased their intention to exercise following reframing. Study 1 represented the first pilot-test of reframing in the exercise context in an asymptomatic sample.

Study 2 examined pre-intervention reframing in a sample of individuals with prediabetes about to start a diabetes prevention program which targeted exercise and diet change. Those receiving reframing reported significant decreases in their level of ECE following reframing, supporting the Study 1 findings. Four weeks following the diabetes prevention program, individuals in both groups lowered their ECE levels and reported greater levels of exercise. Those receiving reframing reported greater ECE decreases compared to attention control.

To put the observed magnitude of effects in context, the decrease in ECE following reframing aligns with annual analytic reviews suggesting cognitive behavioural counselling typically yields large effects (Butler, Chapman, Forman, & Beck, 2006). They are of a similar magnitude to the effects reported in systematic reviews of other physical activity intervention strategies such as action planning (Carraro & Gaudreau, 2014), enhancing barrier self-efficacy (Higgins, Middleton, Winner, & Janelle, 2014), and self-monitoring (Michie, Abraham, Whittington, McAteer, & Gupta, 2009). The ECE decline observed in both groups from post-experiment to four weeks following the diabetes prevention program can be understood through social cognitive theory (Bandura, 1986). Participants were initiate exercisers who may not have sufficient exercise experience to form accurate perceptions about exercise or their capabilities to exercise. Without experience, initial perceptions have the potential to be inaccurate or biased, which may be the case for those reporting high ECEs. According to Bandura (1986), the successful performance of exercise increases individuals' self-efficacy. These mastery experiences might also provide individuals with sufficient information to form more accurate perceptions about exercise such that they were less negatively biased. The ECE decline observed in the control group one month following the program aligns with this supposition.

An alternative explanation for the observed ECE decreases in both groups could be, in part, due to the receipt of behaviour change counselling throughout the diabetes prevention program. The successful implementation of strategies like self-monitoring and goal feedback may have increased the accuracy of individuals' exercise perceptions, providing a possible explanation for the decreased ECE levels. Cognitive strategies like reframing are hypothesized to have a synergistic effect with behavioural strategies (e.g., with problem solving; D'Zurilla & Nezu, 2007). For example, reframing may help individuals to more effectively process information about their unsuccessful exercise experiences and improve their future ability to set and follow through with exercise goals. The greater declines in ECEs observed for those receiving reframing could be the result of the interaction between reframing and the behavioural counselling intervention in the diabetes prevention program.

Dual-process models purport that automatic associations about exercise are learned over time and through experience (Conroy & Berry, 2017). Individuals who regularly struggle with exercise may have learned maladaptive patterns of rationalizing the decision not to exercise (i.e., system 2 evaluations). Reframing may be a system 2 approach that helps individuals to more carefully and accurately think through inconsistencies in their mental associations and evaluations about exercise. Future conceptual research examining cognitive errors relative to dual-process models would provide a stronger foundation for understanding the impact of reframing.

All participants increased their self-report exercise four-weeks following the diabetes prevention program. However, those receiving reframing reported significantly greater increases in exercise. Recall that reframing is hypothesized to have a smaller and indirect impact on behaviour through a change in cognitions (Leahy, 2017). The between-groups differences in exercise levels were greater than anticipated. Future research is needed to corroborate these findings using a design that is powered to detect changes in exercise since Study 2 was powered to detect changes in ECEs, not exercise. The use of accelerometer-

measured exercise or behavioural measures of exercise frequency should be considered in future research.

Treatment adherence experts have suggested that readiness to engage in behaviour change efforts is necessary and facilitates treatment adherence (Meichenbaum & Turk, 1987; Rejeski, Brawley, McAuley, & Rapp, 2000). There were no differences in readiness to start the program between groups. Both groups reported scores at the ceiling of the scale, and therefore, group differences could not be detected. While pre-post measures of readiness would have been a stronger design, we were mindful of participant burden and limited the number of questions asked as part of this sub-study. Those participants who enrolled in the program were the highly motivated 20% who contacted the program after receiving a study invitation. Reframing may have a stronger impact on readiness for those individuals who have low motivation and did not join the program. Future reframing efforts examining readiness should target those individuals with low motivation or who are hesitant to join behaviour change programs.

One major strength of the research was the strong evidence base from which reframing was drawn. Established and effective protocols developed by Leahy (2017) within the clinical setting provided a strong foundation for the tailored application of reframing to the exercise context. A second strength was the use of findings from Study 1 to enhance the reframing protocol for Study 2. A third strength was the experimental test of reframing within an existing community-based diabetes prevention program, which answered calls by Rothman et al. (2013).

Study limitations include small sample size which may have limited the power to detect changes in our outcomes. The small sample size may have also limited the generalizability of our findings. The self-report nature of the exercise measure was also a study limitation as it may be subject to recall bias and overestimation (Prince et al., 2008). Regarding the internal consistency of our measures, the study was limited by low alphas for the decisional struggle and anticipated affect which increased measurement error. Another potential limitation was that outcomes were measured immediately following reframing, which could be subject to a form of mere exposure method bias (Zajonc, 2001). While study 2 included a third follow-up timepoint, future research should seek to measure post-reframing effects either one- or seven-days post-reframing. Including these time points would also enhance the interpretability of measures like decisional struggle which ask individuals about their perceptions of struggle over the past seven days.

There are many advantages to conducting experiments within existing community health programs. However, one disadvantage was our inability to manipulate the behaviour strategies received by participants in Study 2. Future research should experimentally examine the synergistic effect of delivering reframing with behavioural strategies. Another limitation was the use of an arbitrary minimum ECE cut-off score. A minimum score was necessary to prevent baseline effects in ECE change. Future research should seek to determine an empirically-driven cut-off score and examine whether reframing is beneficial to individuals with low ECE scores. Research should also examine reframing delivered across multiple sessions and with a longer follow-up period. The treatment of depression or anxiety is rarely accomplished in a single session. Similarly, reframing negative exercise thoughts may require practice and feedback over multiple sessions. In this way, dose-response could be examined to find the optimal number of required sessions.

These two studies were the first to demonstrate that reframing could be tailored to the exercise context to help individuals challenge the biased thoughts associated with their ECEs. Together, these findings provide preliminary evidence that we hope sparks future reframing research within the exercise context.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.psychsport.2019.03.011.

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