

Subjective experiences of physical activity and forecasting bias during behavioral weight loss

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Abstract

Introduction: Engagement in physical activity (PA) is a critical component of behavioral weight loss (BWL) treatment. Subjective experiences surrounding PA may shape exercise decisions and need to be further understood within a BWL sample.

Methods: Participants in this study were adults with overweight/obesity enrolled in an 18-month BWL program. At baseline, six, and 18 months, participants ($N = 320$) predicted how they would feel during a lab-based walking task and rated their experiences mid-walk and post-walk. They also completed self-report questionnaires assessing depressive symptoms and discomfort intolerance.

Results and Discussion: Results indicated that exercise experience and expectations were more positive at later treatment points than at baseline. At each assessment point, post-walk ratings were more positive than mid-walk ratings, but pre-walk ratings did not differ from mid-walk ratings, suggesting BWL participants were relatively accurate in predicting their PA experience. These results suggest treatment-seeking adults with overweight/obesity feel most positive upon completion of PA, may not experience a forecasting bias as hypothesized and seem to have increasingly positive PA expectations and experiences as they proceed through treatment and lose weight. Lower discomfort intolerance and depressive symptoms were associated with more positive PA expectations and experiences. Understanding these individual differences in PA experience can inform intervention strategies.

KEYWORDS

affective response, forecasting, obesity, physical activity

1 | INTRODUCTION

Regular engagement in physical activity (PA) is a key component of behavioral weight loss (BWL) interventions and successful weight loss maintenance.¹ Yet, most BWL participants find it challenging to

adhere to PA recommendations (150–250 min/week) during and after lifestyle modification programs.² To facilitate and support adherence to a PA regimen, a better understanding of PA decision making in treatment-seeking adults with overweight or obesity (OW/OB) is needed. Subjective experiences surrounding PA, defined by

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how one feels both physically and mentally, have been shown to predict future exercise behavior: more positive experiences, particularly during PA, foster increased motivation and likelihood of engaging in that activity in the future.³⁻⁷

In addition to in-the-moment experiences, anticipated emotions are integral in decision-making and planned behavior,⁸ as individuals contemplate the likelihood of pleasure and choose the option that is more likely to be pleasurable.⁹ Within PA decision making, anticipated affective response has been conceptualized as a key pathway in determining exercise intentions, behavior, and adherence.¹⁰⁻¹² Individuals who predict PA will be aversive will be less likely to choose that activity, particularly if it is being weighed against an option they perceive as being more pleasurable (e.g., watching TV, sleeping in). Importantly, people tend to exhibit a forecasting bias, where their anticipated experience of PA is more negative than their subjective experience. This forecasting bias surrounding exercise has been shown among healthy weight adults across a variety of exercise settings (e.g., group classes, weight training)¹³ and in a laboratory walking task.¹⁴ These negative PA expectations have been shown to decrease motivation and intention to engage in PA.^{13,14} Thus, exercise expectations, and the extent to which these differ from actual experiences (i.e., bias), are a relevant component of the PA decision-making framework.

Despite their role in exercise choice, PA experience, expectations, and bias have not been sufficiently explored among BWL participants, who likely have unique barriers and feelings about exercise. For example, individuals with OW/OB may experience weight stigma and self-consciousness while engaging in exercise, which can foster PA avoidance and decrease intentions to engage in exercise.^{15,16} Additionally, previous research has shown that individuals with a body mass index (BMI) in the OW/OB range find PA less enjoyable than those with normal weight.¹⁷⁻¹⁹ Other work has explored negative affective responses to PA among sedentary individuals.^{20,21} Yet, to our knowledge, there are no prior studies examining exercise experience among adults with OW/OB during BWL, as they attempt to adopt lifestyle modifications. Exercise anticipations and experiences have been found to vary across stages of PA behavior change (e.g., contemplation, action) and negative affective responses may decrease as individuals enter the maintenance phase of an exercise regimen.^{12,22} However, this work was conducted among normal weight adults, so further work is needed to understand the dynamics of subjective experiences of PA throughout BWL. Forecasting bias in exercise has mainly been studied in healthy adults¹⁴ who exercise regularly.¹³ Only one study to our knowledge has explored forecasting bias among sedentary individuals, with findings suggesting that inactive participants may exhibit a larger forecasting bias surrounding PA than active participants.²³ No prior studies have explored forecasting bias among adults with OW/OB or those enrolled in BWL. Examining participants' exercise predictions, experiences, and the discrepancy between the two as they proceed through their weight loss efforts can improve our understanding of PA decision making within a group for whom exercise engagement is critical.

Given the established relationships between positive PA experiences and increased PA engagement, there also is clinical utility in understanding what characteristics distinguish BWL participants who

have more positive versus more negative PA experiences. Those individuals at risk for negative PA experiences could be targeted with interventions to improve PA expectancies, which in turn could improve PA experience and engagement. Theoretical models and research in other populations point to two constructs that could be related to how adults with OW/OB experience or anticipate PA. First, a reciprocal relationship between PA engagement and depressive symptoms is supported in previous literature, where levels of PA impact subsequent depression and intensity of depressive symptomology predicts frequency of PA behavior.²⁴ Higher anhedonia is associated with decreased PA and this relationship was partially mediated by decreased PA enjoyment.²⁵ Lack of exercise enjoyment has also been cited as a major barrier to exercise among those experiencing depression symptoms.²⁶ These studies point to an important relationship between depression severity and subjective exercise experience, yet the dynamics of these constructs have not been explored within the context of BWL, where rates of depression are higher than in the general population.²⁷

Second, subjective PA experience also may be related to individual differences in BWL participants' ability to tolerate distressing experiences, a concept known as discomfort intolerance.²⁸ PA can be accompanied by various uncomfortable sensations, including exertion, fatigue, and boredom. Those with higher discomfort intolerance may be more sensitive to perceiving these sensations as particularly aversive, contributing to pessimistic exercise expectations or experiences, which then may decrease their PA engagement. Previous work has shown affective responses to exercise among women of varying fitness levels were influenced by awareness of bodily cues and perception of the physiological state of the body,²⁹ and improvements in discomfort intolerance during BWL have been associated with greater PA engagement.³⁰ However, it is not yet known how discomfort intolerance relates to predicted or experienced subjective PA sensations among adults with OW/OB.

Aim 1 of this study was to examine the subjective experiences associated with PA in treatment-seeking adults with OW/OB throughout BWL and explore how these experiences change during treatment. Given that exercise tends to be a more positive experience among individuals who are active and/or at a lower weight, it was predicted that PA experiences would become more positive as treatment progressed and participants adopted lifestyle modifications. Aim 2 was to test whether a forecasting bias occurred among BWL participants by comparing participants' anticipated experiences to their actual experiences during PA. Aim 2 also explored how PA experiences change for adults with OW/OB throughout a bout of exercise to see if participants felt more positive during or after PA. Participants were hypothesized to anticipate PA to be more aversive than they actually experienced (i.e., exhibit a forecasting bias), and to feel more positively after versus during PA, both of which are evident in prior literature.^{13,31} Aim 3 was to explore how PA expectations and experience, and the discrepancy between those two, was related to depressive symptoms and discomfort intolerance. The hypotheses were that lower depressive symptoms and discomfort intolerance would be associated with more positive PA experiences and lower

discrepancy between exercise predictions and experience (i.e., decreased forecasting bias).

2 | MATERIALS AND METHODS

2.1 | Participants

This project was a secondary analysis of a randomized controlled trial³² (Clinical Trials Identifier: NCT02363010) assessing the long-term efficacy of three different versions of behavioral treatment for weight loss. Participants were recruited from the community between 2014 and 2016. Inclusion criteria included age 18–70 years, BMI 27–45 kg/m², ability to engage in PA (i.e., can walk at least two blocks without stopping for rest) and completion of the enrollment process. Exclusion criteria included medical or psychiatric conditions that pose a risk or would interfere with treatment; pregnant or planning to be pregnant in the next 3 years; planned move out of the study area in the next 3 years; recently began or changed dosage of medication that causes change in weight; current or planned participation in another weight loss treatment; history of bariatric surgery; weight loss $\geq 5\%$ in the previous 6 months; having an immediate family or household member participating in the study. The study was approved and monitored by the Drexel University institutional review board.

2.2 | Intervention

In Phase I of treatment (1–6 months), all participants received 16 sessions of standard, group BWL treatment. Skills taught included self-monitoring of dietary intake, PA, and weight; stimulus control; identifying triggers for overeating; goal-setting; problem-solving barriers to behavior change; and relapse prevention. Participants adopted tailored goals for calorie intake to produce 0.5–1.0 kg per week of weight loss and gradually increased MVPA with an ultimate goal of 250 min per week. In Phase II (7–18 months), participants received 12 months of weight loss maintenance treatment in which they were randomized to one of three intervention conditions: behavioral treatment, behavioral treatment with a primary focus on PA, and acceptance-based treatment with a primary focus on PA. Phase II interventions consisted of 14 group meetings and three 15-min coach phone calls. Treatment conditions were collapsed for this secondary analysis given that groups did not differ on ratings of subjective experiences throughout the treadmill task, or on weight loss and MVPA outcomes.³²

2.3 | Measures

2.3.1 | Height and weight

At each assessment point, participant weights were measured in-clinic using a Tanita® model WB-3000 digital scale. Height was

measured at baseline with a stadiometer and used to calculate baseline BMI. For both height and weight, two measurements were taken and averaged. Percent weight loss at 6 and 18 months from baseline was calculated, with higher positive values indicating greater percent weight loss and negative values indicating weight gain.

2.3.2 | MVPA

Participants received ActiGraph GT3X tri-axial, solid state accelerometers and were instructed to wear them during all waking hours for 7 consecutive days at each assessment point. MVPA data was considered valid for analysis if the device was worn for at least 10 h for 4 days. The metric of interest was the weekly average of time spent in bouts of MVPA of at least 10 min, based on previously defined cut points.³³

2.3.3 | Subjective experiences of exercise

At each assessment point, participants completed a lab-administered 0.5 miles walk on a treadmill. The distance of 0.5 miles was chosen because it has established validity as a protocol for measuring fitness³⁴ and is sufficiently brief to minimize participant burden. After a 30-s warm up period on the treadmill, participants were instructed “Next, I will ask you to walk half of a mile on a treadmill at a brisk pace. This is a measure of physical fitness, so please push yourself to walk as quickly as you can.” They controlled the treadmill speed and were instructed to walk as briskly as they could manage.

Participants completed an adapted version of the Feelings About Leisure Time Activities Questionnaire (FALTAQ)³² three times during the treadmill walk test: once immediately before the walk (i.e., pre-walk), once during the walk (i.e., mid-walk at 0.25 miles), and once at the end of the walk (i.e., immediately post-walk at the conclusion of 0.5 miles). The FALTAQ asks participants to rate how they feel from 0 to 100 on five subscales: exhausted to energetic, weak to strong, bored to enthusiastic, irritable to content, and in great pain to no pain at all. Higher ratings indicate more positive feelings. For the pre-walk measurement, participants were asked to rate their *anticipated* feelings (“Using these 0–100 scales, I'd like you to tell me how you think you will feel while walking half a mile at a brisk pace”). At mid- and post-walk, participants were asked about their *current* feelings (“Using the 0–100 ratings, I would like you to tell me how you feel right now”). A mean subjective experience value was calculated for pre-, mid- and post-walk by averaging the five-subscale ratings for that timepoint.

2.3.4 | Forecasting bias

Forecasting bias (i.e., the discrepancy between predicted and actual experience) was calculated as average mid-walk FALTAQ ratings minus average pre-walk FALTAQ ratings. Thus, a positive

discrepancy score reflected a bias towards overestimating negative experiences, while a negative score reflected a bias towards underestimating negative experiences. A discrepancy score equal to or close to 0 indicated relatively accurate expectations of exercise.

2.3.5 | Depressive symptomatology

The Center for Epidemiologic Studies Depression Scale (CES-D)³⁵ assessed depressive symptoms at each assessment point. This questionnaire includes 20 items describing symptoms and participants rate the frequency with which they occurred in the past week on a 4-point scale (0 = "rarely or none of the time [less than 1 day]" to 3 = "most or all of the time [5–7 days]"). Scores range from 0 to 60 with higher scores indicating more severe symptomatology.

2.3.6 | Discomfort intolerance

The Discomfort Intolerance Scale (DIS),²⁸ a self-report measure, was completed by participants at each assessment. It is a five-item questionnaire including statements about perceived intolerance and avoidance of physical discomfort (e.g., "I take measures to avoid feeling physically uncomfortable"). Participants rate the extent they agree with each statement on a seven-point scale (0 = "not at all like me" to 6 = "extremely like me"). Scores range from 0 to 30, with higher scores indicating greater inability to tolerate physical discomfort.

2.4 | Data analysis

Data analyses were done in SPSS Version 26. Distributions and assumptions were analyzed prior to statistical testing. Although FALTAQ ratings were negatively skewed, parametric models are robust to skewness.³⁶ Retention was 89.4% at 6 months and 70.0% at 18 months. Participants missing treadmill task or questionnaire data at any given assessment point were excluded from those analyses only. For repeated-measures ANOVAs, Mauchly's test assessed the assumption of sphericity and for any models that violated this assumption, degrees of freedom were corrected using Huynh-Feldt estimates. Bonferroni corrections were used for all ANOVA post hoc testing, which is the recommended correction for models violating the assumption of sphericity.³⁶

For Aim 1, repeated-measures ANOVAs assessed how average subjective experiences at pre-walk, mid-walk and post-walk changed across 0, 6, and 18 months. Separate models were run for pre-walk, mid-walk, and post-walk FALTAQ ratings. For Aim 2, repeated-measures ANOVAs compared subscale and average subjective experience ratings throughout the treadmill task (pre-walk, mid-walk, and post-walk). Planned contrasts compared pre-walk predictions to mid-walk ratings to assess for forecasting bias and compared mid-walk ratings to post-walk ratings to understand how post-exercise

experience compares to experiences during exercise. Separate models were run for 0, 6, and 18 months.

For Aim 3, a series of linear regression models were run to predict PA expectations (average pre-walk FALTAQ ratings), experiences (average mid- and post-walk FALTAQ ratings) and forecasting bias from concurrent depressive symptoms (CES-D) and discomfort intolerance (DIS) while controlling for baseline MVPA. Separate models were run for each predictor at each assessment point. Bonferroni correction was used to correct for multiple comparisons. Even though study variables did not significantly differ by condition, sensitivity analyses were run for all significant regression models with and without intervention condition as a covariate, given the plausible relationship between condition content and certain study constructs (e.g., acceptance-based treatment condition and discomfort intolerance).

3 | RESULTS

3.1 | Descriptive statistics

Participants ($N = 320$) were on average 52.6 years old ($SD = 10.7$) and 78.1% were female. At baseline, average BMI was 35.1 kg/m² ($SD = 4.6$) and average MVPA was 56.92 min/week ($SD = 83.21$). The sample was 3.8% Hispanic or Latino, 70.0% White or Caucasian, 25.0% Black or African American, 2.8% more than one race, 1.6% Asian, and 0.6% American Indian or Alaska Native. Descriptive statistics for all study variables can be seen in Table 1.

3.2 | Aim 1: Subjective ratings of PA throughout BWL

Results of repeated-measures ANOVA assessing how pre-walk, mid-walk, and post-walk ratings changed over time can be seen in Figure 1. Average pre-walk expectations significantly changed over time, $F(1.87, 418.27) = 12.54, p < 0.001, \eta^2_p = 0.05$. Bonferroni post hoc tests revealed that pre-walk predictions at 6 months ($M = 77.70, SD = 16.24, p < 0.001$) and 18 months ($M = 77.14, SD = 17.67, p = 0.001$) were significantly more positive than baseline ratings ($M = 72.83, SD = 17.61$). Average pre-walk predictions at 6 and 18 months were not significantly different from each other (p 's > 0.05). The pattern of results was similar for mid-walk ratings, where subjective experiences during the walk were significantly more positive at 6 ($M = 77.67, SD = 17.81, p < 0.001$) and 18 months ($M = 77.48, SD = 18.56, p < 0.001$) than at baseline ($M = 73.13, SD = 16.53$), $F(1.91, 423.78) = 12.65, p < 0.001, \eta^2_p = 0.05$. Average mid-walk ratings at 6 and 18 months did not significantly differ (p 's > 0.05). Post-walk ratings also significantly changed over assessment points, $F(1.96, 431.96) = 4.82, p = 0.009, \eta^2_p = 0.02$. Bonferroni post hoc tests showed that only baseline and 6-month post-walk ratings significantly differed. Post-walk ratings at 6 months ($M = 81.60, SD = 16.97$) were more positive than baseline post-walk ratings ($M = 78.83, SD = 16.77, p = 0.008$).

TABLE 1 Descriptive statistics of study variables

Variable	Baseline (N = 320) M (SD)	6 Months (N = 285) M (SD)	18 Months (N = 226) M (SD)
BMI	35.14 (4.76)	31.45 (4.46)	30.96 (5.01)
Weight	214.66 (37.69)	193.04 (35.10)	189.90 (36.55)
Percent weight loss	-	9.9 (5.19)	10.53 (10.75)
MVPA	56.92 (83.21)	119.68 (119.73)	96.29 (117.61)
CES-D	8.89 (7.49)	8.70 (7.71)	10.29 (8.16)
DIS	10.41 (5.20)	9.92 (5.28)	9.50 (5.40)
Pre-walk average	73.05 (17.61)	77.48 (16.03)	76.86 (17.61)
Mid-walk average	73.32 (16.64)	77.70 (17.19)	77.04 (18.64)
Post-walk average	78.78 (16.37)	81.55 (16.41)	80.78 (17.40)
Pre-walk energy	68.80 (21.69)	78.78 (17.43)	77.57 (19.92)
Mid-walk energy	70.96 (19.35)	77.83 (17.55)	77.96 (19.62)
Post-walk energy	75.06 (20.30)	81.19 (18.31)	79.17 (20.47)
Pre-walk strength	71.67 (21.63)	81.22 (16.74)	81.41 (18.31)
Mid-walk strength	72.79 (18.94)	80.20 (18.20)	80.11 (19.53)
Post-walk strength	77.62 (19.48)	83.76 (17.07)	82.36 (18.97)
Pre-walk enthusiasm	64.34 (27.10)	63.19 (29.45)	63.43 (30.55)
Mid-walk enthusiasm	60.74 (29.27)	62.64 (31.75)	64.12 (30.98)
Post-walk enthusiasm	68.98 (29.08)	68.13 (31.63)	71.29 (30.33)
Pre-walk contentment	77.62 (21.43)	78.30 (22.73)	79.70 (21.46)
Mid-walk contentment	77.93 (21.63)	79.62 (21.45)	78.85 (22.46)
Post-walk contentment	83.96 (19.46)	84.49 (19.78)	84.96 (19.19)
Pre-walk pain	82.83 (20.96)	85.89 (18.95)	82.20 (21.95)
Mid-walk pain	84.17 (20.14)	88.19 (18.35)	84.15 (21.64)
Post-walk pain	88.28 (17.84)	90.18 (17.77)	86.12 (21.43)
Forecasting bias	0.27 (12.57)	0.22 (9.31)	0.17 (9.04)

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale; DIS, Discomfort Intolerance Scale; MVPA, moderate-to-vigorous physical activity.

3.3 | Aim 2: Subjective ratings of PA throughout the treadmill task and exploration of forecasting bias

Results of repeated-measures ANOVAs for average subjective experiences throughout the treadmill task at each assessment point can be seen in Table 2. At baseline, 6 months, and 18 months, there was a significant main effect of time on subjective experience during the treadmill task. Planned contrasts revealed that post-walk ratings were significantly more positive than mid-walk ratings ($p < 0.001$) and that pre- and mid-walk ratings did not significantly differ ($p > 0.05$), suggesting pre-walk expectations were generally similar to mid-walk experiences. Repeated-measures ANOVA also compared the FALTAQ subscales (i.e., energy, strength, enthusiasm, contentment, pain) at pre-, mid-, and post-walk during each timepoint. Similar patterns emerged across most subscales and assessment points, as seen in

Table 2, where post-walk was significantly more positive than mid-walk, but pre-walk and mid-walk did not significantly differ.

3.4 | Aim 3: Correlates of PA experience and discrepancy

Results of regression analyses predicting PA expectations, experiences, and discrepancy scores can be seen in Table 3. Sensitivity analyses revealed that results were consistent with and without controlling for intervention condition, so results are reported for models that included that as a covariate. At baseline, 6, and 18 months, discomfort intolerance had a negative association with PA pre-walk expectations and mid- and post-walk experiences ($p < 0.01$). At 18 months, depressive symptomatology exhibited a

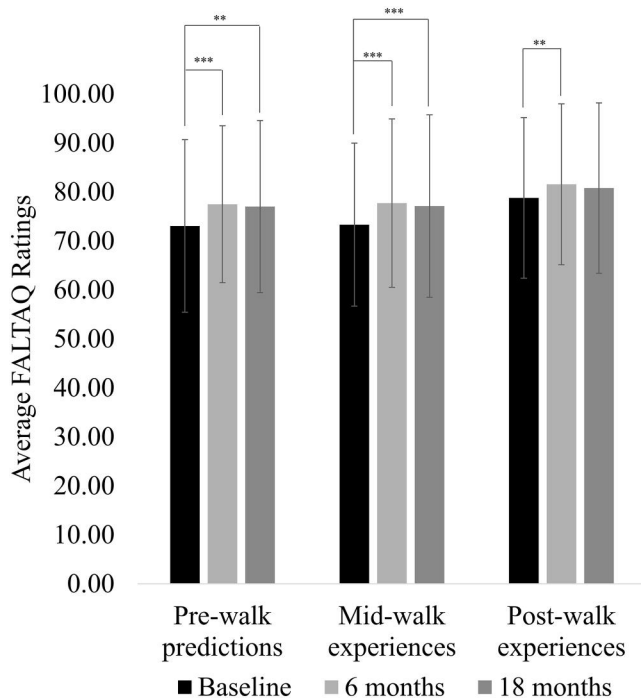


FIGURE 1 Average FALTAQ ratings for pre-walk predictions, mid-walk experiences, and post-walk experiences at each assessment point. Error bars represent standard deviation. ** $p < 0.01$, *** $p < 0.001$. FALTAQ, Feelings About Leisure Time Activities Questionnaire

negative relationship with PA expectations and experiences (p 's < 0.001). There were no significant predictors of forecasting bias at any assessment point.

4 | DISCUSSION

This study explored the subjective experiences associated with a lab-based exercise task among adults enrolled in BWL. Expectations and experiences of PA tended to be more positive at later assessment points (6 or 18 months) than at the start of treatment, suggesting that individuals enrolled in BWL develop more positive PA expectations and experiences as they progress through treatment, lose weight, and increase their activity levels. This mirrors prior work showing exercise is more pleasurable for those with a lower BMI¹⁷ and who have a regular, consistent PA regimen.^{21,22,37} As participants learn behavior change techniques to adopt a healthier, active lifestyle during BWL, it seems that they develop a more positive notion and experience of PA, perhaps due to increased fitness levels which can decrease the exertion, fatigue, or fear associated with exercise.³⁸

At all timepoints, subjective experiences at the end of the walk were, on average, more positive than mid-walk experiences and this was consistent across most subscales of subjective experience (i.e., energy, strength, enthusiasm, contentment, pain). The post-exercise peak in positive affect shown in this sample is consistent with

TABLE 2 Repeated-measures ANOVA and planned contrasts of subjective experience ratings throughout the treadmill task at each assessment point

	Baseline (N = 320)			6 Months (N = 285)			18 Months (N = 226)		
	F	p	η^2	F	p	η^2	F	p	η^2
Average	47.05***	<0.001	0.13	37.31***	<0.001	0.12	29.08***	<0.001	0.11
Energy	20.75***	<0.001	0.06	9.11***	<0.001	0.03	1.73	0.181	0.008
Strength	24.00***	<0.001	0.07	14.49***	<0.001	0.05	4.57*	0.014	0.02
Enthusiasm	29.38***	<0.001	0.08	18.94***	<0.001	0.06	33.55***	<0.001	0.13
Contentment	30.08***	<0.001	0.09	26.97***	<0.001	0.09	28.09***	<0.001	0.11
Pain	16.31***	<0.001	0.05	12.18***	<0.001	0.04	8.31**	0.001	0.04

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

TABLE 3 Linear regression analyses predicting baseline physical activity (PA) experience and discrepancy scores from Center for Epidemiologic Studies Depression Scale (CES-D) and Discomfort Intolerance Scale (DIS)

Predictors	Average pre-walk expectations			Average mid-walk experiences			Average post-walk experiences			Forecasting bias				
	B	SE	t	B	SE	t	B	SE	t	B	SE	t	p	
Baseline	-0.31	0.13	-2.32	0.021	0.13	-2.40	0.017	0.13	-2.13	0.034	0.005	0.10	0.05	0.959
Discomfort intolerance	-0.72	0.19	-3.85	<0.001*	0.18	-4.35	<0.001*	0.17	-4.44	<0.001*	-0.06	0.14	-0.41	0.685
6 months	-0.24	0.14	-1.72	0.086	0.15	-2.42	0.016	0.14	-1.65	0.101	-0.12	0.08	-1.51	0.131
Discomfort intolerance	-0.71	0.19	-3.82	<0.001*	0.20	-3.69	<0.001*	0.19	-3.17	0.002*	-0.03	0.11	-0.25	0.801
18 months	-0.67	0.16	-4.35	<0.001*	0.17	-3.91	<0.001*	0.16	-3.56	<0.001*	0.03	0.08	0.37	0.713
Discomfort intolerance	-1.01	0.22	-4.56	<0.001*	0.24	-4.74	<0.001*	0.22	-5.07	<0.001*	-0.10	0.11	-0.92	0.358

Note: Models controlled for baseline moderate-to-vigorous physical activity (MVPA) and intervention condition.

*Significant after correcting for multiple comparisons. Abbreviation: CES-D, Center for Epidemiologic Studies Depression Scale.

existing literature showing exercisers feel positively about PA immediately after completing it.³¹ Overall, pre-walk expectations were not significantly different from mid-walk experiences, suggesting a lack of forecasting bias within this BWL sample. Participants seem to be accurate predictors of their exercise experiences. The lack of forecasting bias surrounding exercise contradicts our hypothesis and prior research demonstrating a bias to underestimate positive feelings of PA in normal weight adults^{13,14} and inactive populations.²³ This is the first study of our knowledge to explore forecasting bias in adults during BWL and divergent findings prompts further questions about the dynamics of exercise experience among those attempting weight loss.

There are a few possible interpretations for the lack of forecasting bias within this sample of treatment-seeking adults with OW/OB. Our sample differed from prior samples exhibiting a PA forecasting bias in that it included adults with OW/OB (as opposed to young adults in a healthy BMI range). Thus, there could be real differences in how adults with OW/OB predict their PA experience and how accurate they are in doing so. It is also possible that adults enrolled in BWL have previously attempted weight loss several times, during which they may have tried and failed at numerous exercise regimens. These frequent exercise attempts may lead weight loss-seekers to be familiar with how exercise makes them feel, contributing to accurate predictions of their mid-walk experiences. Alternatively, it could be that adults with OW/OB generally find PA unpleasant and that is part of why they struggle to maintain sufficient exercise levels independently and seek out the support of a structured intervention. Thus, their aversive experience of PA leads them to not be “pleasantly surprised” or experience exercise as more positively than they anticipate. Finally, it could also be that the forecasting bias was not present during this lab-based, low-intensity bout of exercise. In the three prior studies documenting PA forecasting bias, two assessed exercise experience in a naturalistic setting and across a variety of workout types^{13,23} and the third utilized a treadmill task, but one that was longer than the task in this study (30 vs. 5 min).¹⁴ Perhaps a forecasting bias would emerge among adults in BWL during a bout of exercise that was longer or higher intensity, or in a more real-world setting.

This study also explored how PA expectations and experiences, and the discrepancy between the two, were related to depressive symptoms and discomfort intolerance. As hypothesized, lower discomfort intolerance was associated with more positive PA predictions and experiences. Individuals who can best manage the physical discomfort associated with exercise, and perceive it as less aversive, seem to feel more energetic, strong, enthusiastic, content, and in less pain during and after PA. They also appear to hold more positive preconceived notions (i.e., predictions) about how PA will make them feel. Lower discomfort intolerance, via decreased perceived aversiveness of PA, could lead individuals to anticipate the next bout of PA more positively. A relationship between PA expectations/experiences and discomfort intolerance corroborates previous work showing that, when anticipating how PA will make them

feel, individuals reflect on how manageable and/or intense previous exercise episodes were to predict their ability to manage the next one.³⁹

These findings add to a growing body of work implicating discomfort intolerance in PA engagement.³⁰ Providing participants skills in discomfort tolerance, shown to be modifiable during BWL,³⁰ may help them anticipate and experience PA more positively, which is a proven indicator of PA engagement.^{5,40} The utilization of acceptance-based approaches for PA engagement, which include skills on tolerating uncomfortable sensations in pursuit of goals, has growing empirical support.⁴¹⁻⁴³ However, it is worth noting that in the parent study of this secondary analysis, subjective PA experiences did not differ between those who received traditional lifestyle modification and those who received an acceptance-based behavioral treatment. Conditions also did not differ at post-treatment on PA engagement.³² It is possible that acceptance-based interventions have the potential to produce changes in PA discomfort tolerance and PA engagement, but aspects of intervention delivery need to be refined, such as timing or dose. The acceptance-based intervention in the parent study taught a range of acceptance-based skills, such as values clarity, willingness, and relating to internal experiences. The results of this analysis suggest that of these, tolerating and accepting distressing internal experiences may be the most crucial component to focus on. Perhaps the original intervention did not provide enough attention to these particular acceptance-based skills. An additional note is that the direction of the relationship between lower discomfort intolerance and more positive PA expectations and experiences cannot be concluded from the analyses executed in this study, which explored cross-sectional relationships amongst these variables. It is possible effects flow in the opposite direction, and that those who anticipate and find PA more enjoyable also view themselves as more likely to be able to tolerate PA discomfort. More nuanced longitudinal analyses that can establish temporal precedence could be a potential avenue for future research to clarify the nature of these relationships.

Depressive symptoms were only related to exercise experience at 18 months. At post-treatment, those with lower depression severity had more positive PA predictions and experiences, suggesting that depression's more global deficits in anhedonia may extend to the exercise experience as well.²⁵ Individuals with more depressive symptomology anticipate and experience PA as less pleasurable, which could influence PA engagement. Depressive symptoms, and their impact on PA decision making through diminished PA enjoyment, are important to consider, particularly for adults with OW/OB who have a higher likelihood of depressive symptoms.^{44,45} Depression symptoms also seem to be notably relevant for participants as they complete BWL and transition into weight loss maintenance. Interestingly, depression scores were also more elevated at 18 months than at earlier timepoints: a higher percentage of participants met the cutoff for clinically significant depressive symptoms (total score of ≥ 16 on the CES-D) at 18 months (16%) compared to the percent who met that criteria at 6 months (15.5%) or baseline (11.4%). This may influence the relationship between

CES-D scores and subjective PA experiences observed at the end of treatment. Proactive problem solving could be implemented during final treatment sessions to address mood and the presence of symptoms of depression as potential barriers to adherence to an exercise regimen, and these ideas could be incorporated into their post-treatment maintenance plan.

As mentioned above, depressive symptoms and discomfort intolerance were not related to forecasting bias at any timepoint. These variables do not seem to relate to the *accuracy or inaccuracy* of predictions relative to experiences, but rather only to the nature of the overall pre-, mid-, or post-walk ratings themselves. Thus, there is a need for future investigation into factors that may predict whether an individual is likely to overestimate versus underestimate the enjoyment they will experience from exercise, in an effort to better understand individual variability in the bias of PA expectations. Perhaps concepts known to be related to affective forecasting, such as emotional intelligence,⁴⁶ would explain some of these differences.

This study had several limitations of note, which point to important directions for future research. Exercise ratings were made during a single lab-administered treadmill task, so future research within a BWL sample could further explore PA expectations and experiences in more naturalistic PA settings, across several bouts of exercise, or at varying levels of intensity. During the treadmill task, all participants were prompted to walk at a "brisk" pace, but treadmill intensity was dictated by the participant and not held constant across individuals. Thus, it is possible that some participants reached higher exertion than others. Previous literature has shown that lower intensity exercise is more pleasurable for individuals with OW/OB¹⁷ thus PA experiences may have varied across individuals based on their self-selected intensity level. Future work could explore these relationships while controlling for perceived exertion or intensity, perhaps through objective measurements such as heart rate. In this sample, FALTAQ ratings were generally high from the start and changed only within that range (60-80 out of 100) so findings may not generalize to samples with lower (i.e., more negative) FALTAQ ratings or samples with more variability in FALTAQ ratings. Additional studies are needed to replicate results across a wider range of subjective PA experience scores. Additionally, discomfort intolerance and depressive symptomology were measured with single self-report measures, so replication of findings with more diverse assessment of these constructs would be helpful. Results reported here are also cross-sectional and more nuanced investigation into the temporal relationship amongst these variables should be explored. For example, future research could include longitudinal mediation analyses evaluating how early change in discomfort intolerance or depressive symptoms predict later improvements in the subjective experience of PA. Lastly, there are also theories in the literature about why a forecasting bias exists for exercise, including forecasting myopia: disproportionately focusing on the beginning of a workout which tends to be most aversive,¹³ and immune neglect: inaccurately accounting for one's ability to cope with unpleasant sensations.⁴⁷ Studies examining PA bias within BWL could assess for myopia and/or immune neglect to better characterize what may be driving bias.

In conclusion, the current study shows BWL participants do not exhibit a consistent forecasting bias when anticipating how they will feel during exercise but do seem to develop increasingly positive PA predictions and experiences as they proceed through treatment. Findings also suggest that post-exercise experiences among participants in BWL are notably positive relative to mid-exercise experiences. Lower discomfort intolerance was associated with more positive PA expectations and experiences throughout BWL, while fewer depressive symptoms was associated with more positive PA expectation and experiences at the end of treatment. These findings support the incorporation of content related to discomfort intolerance and depressive symptoms in BWL protocols for PA adherence and engagement.

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CONFLICT OF INTEREST

The authors do not have any conflict of interest to disclose.

AUTHOR CONTRIBUTIONS

Author contributions included the following: Nicole T. Crane, Meghan L. Butryn conceived research questions. Nicole T. Crane, Mary K. Martinelli, and Meghan L. Butryn finalized methodology. Nicole T. Crane conducted analyses, produced graphs/tables and wrote the original draft. All authors were involved in reviewing and editing the draft and had final approval of the submitted and published versions.

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