



Perfectly imperfect: The use of cognitive bias modification to reduce perfectionism

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ABSTRACT

Background and objectives: Perfectionism is a transdiagnostic risk and maintenance factor for psychopathology. The current study developed and evaluated a cognitive bias modification, interpretation retraining (CBM-I) intervention targeting maladaptive perfectionistic beliefs.

Methods: Participants were undergraduate students randomized to complete the perfectionism CBM-I ($n = 33$) or control condition task ($n = 36$) at two time points. Additionally, participants completed measures of perfectionistic interpretations and trait perfectionism, as well as an impossible anagram task designed to elicit perfectionistic concerns.

Results: Results indicated that after the intervention, participants who completed the perfectionism CBM-I endorsed fewer perfectionistic interpretations than participants in the control condition. Furthermore, although the study groups self-reported comparably low confidence in their anagram task performance, participants who completed the perfectionism CBM-I reported wanting to re-do significantly fewer anagrams than participants in the control condition, suggesting greater acceptance of imperfect performance following the intervention. Moreover, supporting a key hypothesized mechanism of effect in CBM-I, reductions in perfectionistic interpretations mediated the effect of condition on the desire to re-do anagram task items.

Limitations: The study results should be viewed in light of limitations, including the short time-span of the study, and the use of a relatively small, non-clinical, and demographically homogenous convenience sample.

Conclusions: Further research and development of the perfectionism CBM-I intervention are needed, but the present findings add to a nascent evidence base that suggests CBM-I holds promise as an accessible and transdiagnostic intervention for perfectionism.

Perfectionism—previously described as a “tyranny of the shoulds” (Horney, 1950; Shafran & Mansell, 2001)—is problematic for mental health and wellbeing. Perfectionism is inversely related to self-compassion and self-acceptance (Brown, 2010; Flett, Besser, Davis, & Hewitt, 2003; Neff, 2003) and is associated with a wide range of psychopathology (for a recent meta-analysis, see Limburg, Watson, Hagger, & Egan, 2017), making it a truly transdiagnostic factor in mental health. Moreover, beyond cross-sectional associations, prospective research finds that perfectionism predicts depression, anxiety, self-harm (Hewitt, Flett, & Ediger, 1996; O'Connor, Rasmussen, & Hawton, 2010), suicidal ideation (Beevers & Miller, 2004; Smith et al., 2018), and eating pathology (Bardone-Cone et al., 2007; Boone, Soenens, Vansteenkiste, & Braet, 2012; Fairburn, 2008; Shafran, Cooper, & Fairburn, 2002; Shafran, Lee, Payne, & Frost, Novara, & Rheaume, 2002; Stice, 2002;

Wade, O'Shea, & Shafran, 2016). It is therefore unsurprising that perfectionism is also associated with poor psychological treatment outcomes (Egan, Wade, & Shafran, 2011) and that treatment of perfectionism can lead to reductions in psychopathology, even when treatment focuses on perfectionism and not disorder-specific symptoms (Lloyd, Schmidt, Khondoker, & Tchanturia, 2015; Riley, Lee, Cooper, Fairburn, & Shafran, 2007; Steele & Wade, 2008). Of concern, not only is there a robust relation between perfectionism and psychopathology, but levels of perfectionism appear to be on the rise in recent decades (Curran & Hill, 2017). Thus, perfectionism seems to be an important, prevalent, and productive target for psychological intervention.

Despite evidence for the utility of treating perfectionism, few treatments specifically target perfectionism. Historically, the conceptualization, research, and treatment of psychological disorders

Abbreviations: CBM-I, cognitive bias modification, interpretation retraining

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largely revolved around the taxonomy provided by the Diagnostic and Statistical Manual of Mental Disorders, resulting in a preponderance of disorder-specific treatments to the exclusion of treatments focusing on broader, underlying transdiagnostic concerns like perfectionism. However, current agendas in the field of mental health recommend a shift towards more transdiagnostic understanding of psychopathology (Barlow & Carl, 2011; Cuthbert, 2015; Nolen-Hoeksema & Watkins, 2011). Moreover, traditional psychological treatments remain unaffordable and/or unavailable to many (Patel & Prince, 2010; Sherrill & Gonzales, 2017), pointing to a clear need for more accessible psychological interventions. Computerized and transdiagnostic interventions offer one solution to expand the accessibility and reach of treatments.

Rooted in well-supported theories of psychological change, such as those informing cognitive-behavioral therapies (e.g., Beck, 1976), cognitive bias modification (CBM) techniques are a family of computerized procedures that target and retrain particular cognitive processes thought to underlie psychopathology (Koster, Fox, & MacLeod, 2009) such as biased attention, interpretations, or memories (Hertel & Mathews, 2011). Perfectionism is thought to be largely perpetuated by maladaptive thinking patterns and cognitive biases (Shafran, Egan, & Wade, 2010) such as interpretations of events as involving failure, rigidly held high standards, tendency towards self-criticism, and dichotomous thinking (Egan et al., 2011; Shafran et al., 2002; Shafran et al., 2010). One type of CBM intervention, CBM interpretation retraining (CBM-I) targets cognitive biases related to how people process and interpret information, and thus may be particularly useful for modifying the cognitive biases perpetuating perfectionism. Indeed, previous research shows an association between perfectionism and biased interpretations and shows that the interpretations involved in perfectionism may be modifiable via CBM-I (Yiend, Savulich, Coughtrey, & Shafran, 2011). By interrupting maladaptive cognitive processes involved in perfectionism, and training new, more adaptive ways of thinking—for example, attending to successes as well as failures, and not responding to failures with self-criticism—CBM-I has the potential to improve problematic perfectionism.

CBM-I has shown promising results in previous research, including consistently changing interpretive biases in adults, and improving anxiety and negative mood states (see Jones & Sharpe, 2017 for a review of meta-analyses). Further, patients report finding CBM-I procedures acceptable and helpful (Beard, Weisberg, & Primack, 2012; Brosan, Hoppitt, Shelfer, Sillence, & MacKintosh, 2011). CBM-I may be especially effective at modifying perfectionism for several reasons. First, CBM-I has been shown to consistently modify targeted biases (Jones & Sharpe, 2017) and theoretical models of perfectionism provide conceptually clear and specific cognitive biases to target, such as interpreting events as involving failure or interpreting the self as a failure when performance is below self-imposed standards. Second, previous research shows that both CBM-I and cognitive-based interventions can be effective in improving not only interpretation biases, but also self-beliefs related to psychopathology (Shafran et al., 2002; Yiend, Parnes, Shepherd, Roche, & Cooper, 2014); maladaptive perfectionism—which is in part perpetuated by harsh self-criticism in the face of perceived failure—clearly fits this bill. Third, perfectionism is responsive to web-based cognitive behavioral interventions (Arpin-Cribbie et al., 2008; Rozental et al., 2017) and initial research on CBM-I for perfectionism found both perfectionistic interpretations and perfectionistic behaviors were responsive to modification in the short term (i.e., within a single study session; Yiend et al., 2011).

Despite promising initial evidence for the use of CBM-I to decrease perfectionism, important questions remain about whether CBM-I can lead to *lasting* change on perfectionism, and whether such change would lead to meaningful reductions in psychopathology. Based on cognitive theories of psychopathology, it would be reasonable to assume that changes in cognition would produce downstream improvements in related psychopathology, however, results in the broader CBM literature have been mixed. For example after reviewing meta-analyses on CBM,

Jones and Sharpe (2017) found that changes in cognitive biases were correlated with symptom improvement, but that the results of mediation models testing this mechanism of effect have been inconsistent. However, before establishing mediation, it is important that research first establishes the utility of CBM-I to improve perfectionistic thinking beyond a single-session study. Additionally, CBM procedures have shown failure to replicate (e.g., Everaert, Mogoase, David, & Koster, 2015) and publication and other reporting biases common in cognitive science (Ioannidis, Munafo, Fusar-Poli, Nosek, & David, 2014) could lead to initial over-estimations of the efficacy of CBM procedures. Thus although initial results regarding the use of CBM-I for perfectionism appear promising, further research is needed to replicate and expand on the existing findings.

In the present study, undergraduate participants were randomly assigned to complete two sessions (separated by 2–3 days) of either a newly developed perfectionism CBM-I intervention, or a control version of the task. Participants also completed various assessments of perfectionism at three time points: baseline (i.e., at Time 1 [T1], prior to completing the intervention or control task for the first time), at Time 2 (T2) after completing two sessions of the CBM-I intervention or control task, and at a Time 3 (T3) follow-up assessment 2–3 days later, as well as measures of anxiety and eating disorder symptomatology at T1 and T3. We hypothesized that relative to the control condition, and accounting for baseline levels of perfectionism, participants in the intervention condition would endorse perfectionistic interpretations at lower levels following the intervention. Additionally, we hypothesized that as a result of decreased perfectionistic thinking, participants in the intervention condition would demonstrate less perfectionism on an impossible task designed to elicit perfectionistic concerns and would show decreases in trait perfectionism at follow-up. We did not expect to observe changes in psychopathology as a function of the intervention, due to the use of a non-clinical sample and a low-dose intervention over a short time-frame.

1. Method

The aim of the present study was to examine the effect of two sessions of CBM-I on perfectionistic thinking within a short period of follow-up. The present study included additional assessments not relevant to these aims (e.g., psychopathology symptom measures, psychophysiology data). For additional information regarding the exclusion of the psychophysiological measures, please see footnote 2. The psychopathology symptom measures were included for exploratory purposes and are only briefly reported. All study procedures were approved by the University's Institutional Review Board.

1.1. Participants

Ninety-three undergraduates enrolled in a foundational Psychology course participated in the study for course credit. In an attempt to oversample for perfectionists, we sent email invitations describing the study to 50 potential participants with elevated perfectionism, defined as scoring > 1 SD above the mean on a screening survey (the Frost Multidimensional Perfectionism concern about mistakes and doubt, and personal standards subscales) available to the entire department participant pool at the beginning of the semester. Twelve participants joined the study as a result of this recruitment.

Of the 93 total participants who enrolled, 24 did not complete the full study (18 participants did not return for T2, and an additional six participants did not complete the T3 assessment) and were excluded from analyses, resulting in a final sample size of 69. The final sample included 10 of the 12 participants recruited by email invite. Independent samples *t*-tests confirmed that non-completers ($n = 24$) did not significantly differ from completers ($n = 69$) on any baseline study variables, all *p* values $> .05$. See Table 1 for participant demographics by study group.

Table 1
Demographic characteristics of sample.

	Retraining <i>n</i> = 33	Control <i>n</i> = 36
Gender	<i>n</i> (%)	<i>n</i> (%)
Female	17 (51.5)	20 (55.6)
Male	13 (39.4)	16 (44.4)
Prefer to self-describe	0 (0.0)	0 (0.0)
Missing	3 (9.1)	0 (0.0)
Race	<i>n</i> (%)	<i>n</i> (%)
American Indian/Alaska Native	0 (0.0)	0 (0.0)
Asian	3 (9.1)	5 (13.9)
Black/African American	1 (3.0)	1 (2.8)
Native Hawaiian/Pacific Islander	0 (0.0)	0 (0.0)
White	26 (78.8)	27 (75.0)
Bi- or Multi-racial	0 (0.0)	2 (5.6)
Prefer to self-describe	0 (0.0)	1 (2.8)
Missing	3 (9.1)	0 (0.0)
Ethnicity	<i>n</i> (%)	<i>n</i> (%)
Hispanic/Latino	1 (3.0)	2 (5.6)
Not Hispanic Latino	29 (87.9)	34 (94.4)
Missing	3 (9.1)	0 (0.0)
Age	<i>M</i> (<i>SD</i>)*	<i>M</i> (<i>SD</i>)
	19.1 years (1.0)	19.1 years (1.2)

Note: *age data missing from three participants in the retraining condition; descriptive statistics based on *n* = 30. Chi-square tests and an independent samples *t*-test indicated no significant group differences on demographic variables between study groups (all *p* values > .05).

General procedures. At T1 participants completed written informed consent, followed by a measure of perfectionism interpretations (Recognition Ratings test), two self-report perfectionism questionnaires, two measures of psychopathology (the Eating Disorder Examination Questionnaire and the State/Trait Anxiety Inventory) and a demographic questionnaire. Finally, participants were assigned to their study condition on an alternating basis (i.e., every other participant was assigned to the control condition) and completed either the first session of the perfectionism CBM-I intervention or the control condition task.

T2 occurred 2–3 days (*M* = 2.6, *SD* = 1.6) after T1 (with the exception of one participant who completed T2 15 days after T1). First, participants completed their assigned task (perfectionism CBM-I or control condition) for a second time. Participants then completed the measure of perfectionism interpretations (Recognition Ratings test) a second time. Lastly, participants completed an anagram task designed to elicit perfectionistic concerns.

T3 was scheduled to occur 2–3 days after T2 (*M* = 3.0, *SD* = 1.9) though 18.8% (*n* = 13) of the sample completed T3 outside the requested 2–3 day timeframe (ranged 0–13 days).¹ At T3 participants were emailed a link to complete the same two self-report perfectionism questionnaires and two psychopathology symptom measures administered at baseline. Participants were then given debriefing information.

CBM-I perfectionism task procedures. The perfectionism CBM-I intervention followed the established CBM-I paradigm developed by Mathews and Mackintosh (2000) and modified by Clerkin and Teachman (2011). The CBM-I perfectionism intervention was administered via computer. In the present study, participants read and imagined themselves in scenarios related to common triggers for

perfectionism. For example, participants read: “You enter a singing contest. You make it to the final round and then receive third place. You feel ...” The last word in each scenario was a word fragment that resolved the ambiguity of the scenario to be either consistent or inconsistent with a perfectionistic interpretation, depending on condition. Scenarios in the intervention condition were always resolved in a manner that was *inconsistent* with a perfectionistic interpretation (e.g., completing “p_oud” in this case). In the control condition, 50% of scenario resolutions were *consistent* with perfectionistic interpretations (e.g., completing “terrib_e” in this case) and 50% were *inconsistent* with perfectionistic interpretations. In order to increase participant engagement with the task, participants could not proceed to the next trial until they correctly completed the word fragment. Participants then completed a comprehension question to underscore their interpretation condition (e.g., “Does receiving 3rd place make you feel proud?”) and were likewise required to input the correct answer before proceeding (“yes” for the intervention condition, “no” for the control condition). The CBM-I task consisted of 60 scenarios related to perfectionism (developed specifically for the purposes of this study), as well as several irrelevant filler scenarios interspersed to make the purpose of the activity less transparent. Participants also completed unrelated practice scenarios at the outset.

CBM-I perfectionism task development. Previous research suggests a higher-order two-dimensional conceptualization of perfectionism, with one factor representing adaptive perfectionism (i.e., positive striving), and a second factor representing maladaptive perfectionism (i.e., critical self-evaluations and perceived failure to live up to high expectations; for a review see Lo & Abbott, 2013). Two authors (DRD and EMP) drafted 82 scenarios designed to target maladaptive dimensions of perfectionism, conceptualized based on the constructs and items of selected subscales from the Frost Multidimensional Perfectionism Scale (FMPS; Frost, Marten, Lahart, & Rosenblate, 1990) and the Hewitt and Flett Multidimensional Perfectionism Scale (HFMP; Hewitt & Flett, 1991). Specifically, we focused on those subscales shown to load onto the maladaptive factor of perfectionism: personal standards (FMPS)/self-oriented perfectionism (HFMP), socially prescribed perfectionism (HFMP), and concern over mistakes and doubts (FMPS). Four authors (ARS, DRD, EMC, and EMP) then reviewed the scenarios and provided feedback to improve their relevance to maladaptive perfectionism and/or their adherence to the CBM-I procedures. The authors who originally drafted the scenarios (DRD and EMP) are graduate students in a clinical psychology doctoral program, with substantial familiarity with the literature on perfectionism; ARS and EMC are both licensed clinical psychologists who have substantial experience with CBM intervention development and research (EMC) or clinical perfectionism (ARS). The scenarios were then piloted among a small (*N* ranged 8–10) sample of undergraduate research assistants who read psychoeducational information on the construct of maladaptive perfectionism, and then rated each scenario's perfectionistic and non-perfectionistic resolutions from –5 (*completely inconsistent with maladaptive perfectionism*) to +5 (*completely consistent with maladaptive perfectionism*). These ratings assessed face validity of the scenarios and were provided by a population similar to the study sample (undergraduate students interested in Psychology). In evaluating these ratings, we chose a final set of 60 scenarios whose non-perfectionistic resolutions were rated most negatively (e.g., *inconsistent with maladaptive perfectionism*) and whose perfectionistic resolutions were rated most positively (e.g., *consistent with maladaptive perfectionism*). Thirty scenarios were selected to be used for their non-perfectionistic resolution only (seen by all participants) and 30 scenarios were selected to be used for both their non-perfectionistic and perfectionistic resolutions (for the control condition, who received 50% perfectionistic resolutions). The 60 non-perfectionistic resolutions had a mean rating of –4.5 (*SD* = 0.22), and the 30 perfectionistic resolutions had a mean rating of 3.0 (*SD* = 0.38). To obtain a complete copy of the intervention for reference or for use in future research, please contact

¹ The reported results include these 13 participants, but analyses were also conducted with these participants excluded. The only change in results that crosses the significance threshold when excluding these 13 participants is a loss of significance in the *b* path and indirect effect for the mediation model. However, independent samples *t*-tests and a chi-square test did not find significant differences between these 13 participants and the remaining 56 on any variable used in the mediation model (all *p* values > .51). Given the similarity of findings with these participants included or excluded, we opted to include these participants to increase statistical power and ecological validity (insofar as the 2–3 day follow-up window was arbitrarily imposed by the study design).

the first author, DRD.

1.2. Measures

Trait Perfectionism. The *Hewitt and Flett Multidimensional Perfectionism Scale* (HFMP; Hewitt & Flett, 1991) is a 45-item scale that assesses three dimensions of perfectionism: self-oriented perfectionism (setting high standards for oneself and critically evaluating one's behavior), other-oriented perfectionism (setting high standards for others and critically evaluating other's behavior), and socially prescribed perfectionism (the belief that significant others hold you to high standards and evaluate you critically). Each subscale consists of 15 items, rated on a Likert scale from 1 to 7. Subscale scores were calculated by summing the relevant item scores, with higher scores indicating greater perfectionism. The self-oriented and socially prescribed perfectionism subscales were used as measures of maladaptive dimensions of trait perfectionism. Reliability in the current sample was good (self-oriented: $T1 \alpha = 0.90$, $T3 \alpha = 0.91$; socially prescribed: $T1 \alpha = 0.82$, $T3 \alpha = 0.86$).

The *Frost Multidimensional Perfectionism Scale* (Frost et al., 1990) is a 35-item self-report scale originally designed to assess perfectionism in six domains, but subsequently reduced (Stöber, 1998) to four subscales: concern over mistakes and doubt about actions (13 items), personal standards (7 items), parental expectations and criticism (9 items), and organization (6 items). Respondents indicate their agreement with each statement using a Likert scale from 1 to 5, with higher score indicating greater perfectionism. Subscale scores were calculated by averaging the relevant item scores. The personal standards subscale and concern over mistakes and doubt about actions subscale were used as measures of maladaptive dimensions of trait perfectionism. Reliability in the current sample was good (concern over mistakes and doubt about actions: $T1 \alpha = 0.91$, $T3 \alpha = 0.91$; personal standards $T1 \alpha = 0.82$, $T3 \alpha = 0.86$).

Psychopathology symptom measures. The *Eating Disorder Examination Questionnaire, 4th Version* (EDEQ-4; Fairburn & Beglin, 1994, 2008) is a 36-item self-report measure that assesses eating disorder thoughts and behaviors in the previous 28 days. It yields a total score and four subscale scores for restraint, eating concern, shape concern, and weight concern. Scores could range 0–6, with higher scores indicating more severe symptoms. Reliability for each subscale and the overall measure was good to excellent at both study measurement points (α ranged 0.83 to 0.97).

The *State Trait Anxiety Inventory* (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) is a two-part questionnaire that assesses state anxiety (20 items assessing how participants feel “right now”) and trait anxiety (20 items assessing how participants “generally feel”). Scores range from 20 to 80, with higher scores indicating greater anxiety. In the current sample, reliably for both subscales at both time points was excellent (α ranged 0.90 to 0.96).

Perfectionism interpretations. Based on work by Mathews and Mackintosh (2000), we developed a *Recognition Ratings* test for perfectionism. Recognition Ratings tests are commonly used to measure interpretation biases in CBM-I research. For the present study we utilized the standard Recognition Ratings test format and wrote 10 new perfectionism relevant scenarios. Unlike the CBM-I scenarios, these scenarios were presented with a title, and remained ambiguous throughout (i.e., invited both perfectionistic and non-perfectionistic interpretations). For example, one scenario read “THE SWIM MEET. You are swimming in a state championship meet. You give your very best effort during your race. As you raise your head above water to see how you did, you realize you've come in second place.” Participants were required to read each scenario and correctly fill in the missing letter of the final word and complete a comprehension question (e.g., “Did you try your best?”) to ensure that they were attending to the scenario's content.

Participants then completed a brief, 5-min filler task (a jigsaw puzzle) to ensure that their subsequent responses were based on their

impressions of the scenarios and not rote memorization. Next, participants completed the 10 item ratings measure. Each question showed the title of a scenario previously read (e.g., “THE SWIM MEET”) and asked participants to independently rate how similar each of the four different interpretation options were to that scenario. However, none of the four interpretation options were identical to the text read in the corresponding scenario, meaning that there was no “correct” or “incorrect” interpretation among the options. Participants were asked to respond based upon what they believed to be the meaning of the scenario they read. Participants rated each of the four statements separately, on a scale from 1 (*very different in meaning*) to 4 (*very similar in meaning*). The four statements consisted of (1) a perfectionistic interpretation (e.g., “As you raise your head above water to see how you did, you feel disappointed that you failed to get first place.”), (2) a non-perfectionistic interpretation (e.g., “As you raise your head above water to see how you did, you are happy with your accomplishment.”), (3) a positively valenced statement that was unrelated to perfectionism (positive foil; e.g., “As you raise your head above water to see how you did, you hear the audience cheering loudly.”), and (4) a negatively valenced statement that was unrelated to perfectionism (negative foil, e.g., “As you raise your head above water to see how you did, your goggles pinch uncomfortably at your face.”). Unlike the foil statements, the non-perfectionistic interpretations were designed to be relevant to perfectionism but in such a way that they were *inconsistent* with perfectionism (for example, interpretations that focused on self-acceptance or feeling good despite imperfect performance). In the current sample, reliability was good for the non-perfectionistic scenarios, ($T1 \alpha = 0.82$, $T2 \alpha = 0.85$), acceptable for the perfectionistic scenarios ($T1 \alpha = 0.69$, $T2 \alpha = 0.76$), and excellent for the foils (positive foil $T1 \alpha = 0.91$, $T2 \alpha = 0.89$; negative foil $T1 \alpha = 0.92$, $T2 \alpha = 0.91$).

Perfectionistic responses to behavioral task.² At T2, after completing the second CBM-I or control task session, participants completed an impossible anagram task designed to elicit perfectionistic concerns, based on similar procedures developed by Flett, Endler Tassone, and Hewitt (1994). In other words, this task was not designed to be a general stressor, but rather to capture in-vivo responses to a perfectionism-relevant task. This task was developed and used for this study because, unlike other perfectionism tasks (e.g., bead-sorting, copying), it required little physical movement and would introduce less noise to psychophysiological data concurrently collected (but ultimately not used, see footnote 2). To increase their investment in performing well, experimenters told each participant that the task was a brief measure of intelligence reflecting their verbal abilities. An anagram (a word with the letters jumbled) was displayed for 250 ms. Five possible solutions to the anagram task, labeled A through E were then displayed on the screen for 1 s. The answers then disappeared from the screen, and participants had 4 s to select the letter corresponding to their answer. After each item, participants indicated how confident they were in their response on a Likert scale from 1 to 5 (with higher scores indicating greater confidence) and answered a yes/no question about whether they wanted to re-do that item at the end (however, regardless of answers to this question participants were not given the opportunity to re-do items). The task consisted of three practice anagrams, followed by 40 test anagrams. A confidence score was calculated as the average response to each of the 40 confidence items, and a re-do score was calculated as the number of items participants endorsed wanting to re-do.

² During the second study visit heart rate, respiration and blood pressure were collected with the intention of comparing patterns of physiological responding consistent with either challenge or threat states between study groups during the anagram task. However, due to equipment and experimenter errors, substantial psychophysiological data were missing, and of the data that were collected, there were indicators that the data were not reliable and valid. Therefore, these analyses are not reported. Interested readers are invited to contact the first author for additional information.

2. Results

2.1. Data preparation, sample characteristics, and analytical plan

A series of chi-square and independent samples *t*-tests confirmed that random assignment to condition was successful as there were no group differences on demographic or T1 study variables between the intervention ($n = 33$) and control ($n = 36$) groups (all p values $> .05$). All variables were normally distributed (skewness and kurtosis scores $< |2|$), with the exception of the HFMPs other-oriented perfectionism subscale at T3 (kurtosis = 3.5); given only slight non-normality we kept this variable in its original form for ease of interpretation. Missing data on questionnaires ranged from 1.4% ($n = 1$) to 11.6% ($n = 8$). Results of Little's MCAR test suggested that the data were consistent with a pattern of missing completely at random, $\chi^2(319) = 82.7$, $p = .99$. Missingness was handled via the expectation maximization (EM) algorithm (maximum iterations = 25) in SPSS version 21 (IBM Corp., 2012). The EM algorithm is an iterative procedure that alternates between the expectation step (computing the 'conditional expectation of the complete data log-likelihood ... given the observed data and the current parameter estimates') and the maximization step (maximizing the expected log-likelihood obtained in the expectation step 'to obtain updated parameter estimates under the structural model'; Gold & Bentler, 2000, p. 333). In other words, the EM algorithm generates estimated values for missing data based on the existing data, in order to maintain the overall structure of the dataset. This results in a single, complete dataset, which was necessary in the present study given that planned analyses were not compatible with multiple imputation in SPSS. All reported analyses were conducted using the EM algorithm dataset (all $n = 69$). However, descriptive statistics (variable means and standard deviations) using original data with missingness are presented in Table 2 by study group.

Although participants did not need to meet a minimum level of perfectionism to participate (and indeed some participants scored near the floor of the perfectionism self-report questionnaires) on average our sample had elevated perfectionism. The Hewitt Lab (n.d.) has published normative data for the Hewitt and Flett Multidimensional Perfectionism Scale. Notably, the mean in the current study for self-oriented perfectionism at Time 1 ($M = 75.1$; $SD = 15.1$) was significantly higher than the means for the normative psychiatric patient sample ($N = 1112$; $M = 70.1$; $SD = 18.4$; $t_{(1173)} = -2.13$, $p = .03$) and the normative university student sample ($N = 1595$; $M = 65.9$; $SD = 14.9$; $t_{(1656)} = -4.80$, $p < .001$). The mean in the current study for socially-prescribed perfectionism at Time 1 ($M = 59.6$; $SD = 12.7$) was comparable to the mean for the normative psychiatric patient sample ($N = 1112$; $M = 58.0$; $SD = 15.8$ $t_{(1173)} = -0.79$, $p = .43$) and was higher than the mean of the normative university student sample ($N = 1595$; $M = 54.8$; $SD = 13.5$ $t_{(1656)} = -2.77$, $p < .01$). Thus, overall our sample had levels of maladaptive perfectionism comparable to or higher than psychiatric patients, and higher than university student norms.

To determine the effect of the perfectionism CBM-I on changes in interpretations, we conducted a series of four analyses of covariance (ANCOVAs) testing for differences between study groups on the T2 Recognition Ratings Test, controlling for baseline Recognition Ratings Test scores. We utilized a Bonferroni correction with this series of analyses, to account for the four separate analyses testing this hypothesis. Only alpha values less than 0.0125 will be considered significant in these analyses. Next, we tested for differences between the two study groups on self-report responses to the confidence and re-do items during the impossible anagram task, using independent samples *t*-tests. Third, a mediation model was used to test a key hypothesized mechanism of effect in interpretation training, specifically whether changes in interpretation mediate the relation between study condition

Table 2

Variable means and standard deviations across study groups and time points.

	Time 1		Time 2		Time 3	
	Re-Training [30 ≤ n ≤ 31]	Control [32 ≤ n ≤ 36]	Re-Training [30 ≤ n ≤ 31]	Control [31 ≤ n ≤ 36]	Re-Training [31 ≤ n ≤ 32]	Control [32 ≤ n ≤ 36]
Recognition Ratings	M (SD)	M (SD)	M (SD)	M (SD)		
perfectionistic interpretations	2.7 (0.5)	2.5 (0.4)	2.2 (0.5) ^a	2.5 (0.5) ^a		
non-perfectionistic interpretations	3.1 (0.4)	3.0 (0.5)	3.2 (0.6)	3.0 (0.5)		
positively valenced foils	1.9 (0.7)	1.7 (0.6)	1.8 (0.6)	1.6 (0.6)		
negatively valenced foils	1.8 (0.7)	1.7 (0.7)	1.6 (0.6)	1.5 (0.7)		
EDEQ	M (SD)	M (SD)			<i>M (SD)</i>	<i>M (SD)</i>
restraint	1.5 (1.5)	1.6 (1.5)			1.5 (1.4)	1.3 (1.3)
eating concerns	1.2 (1.3)	1.2 (1.2)			1.3 (1.3)	1.1 (1.1)
shape concerns	2.2 (1.9)	2.1 (1.7)			2.1 (2.0)	1.6 (1.4)
weight concerns	2.0 (1.9)	1.8 (1.6)			2.0 (1.8)	1.4 (1.4)
total score	1.7 (1.6)	1.7 (1.4)			1.7 (1.5)	1.3 (1.2)
STAI	<i>M (SD)</i>	<i>M (SD)</i>			<i>M (SD)</i>	<i>M (SD)</i>
state anxiety	36.2 (13.7)	36.3 (10.7)			39.3 (13.6)	40.7 (12.7)
trait anxiety	43.2 (11.8)	45.1 (8.2)			42.5 (12.6)	45.4 (7.3)
FMPS	M (SD)	M (SD)			<i>M (SD)</i>	<i>M (SD)</i>
concern over mistakes and doubt	2.9 (0.9)	3.1 (0.8)			2.8 (0.8)	2.8 (0.7)
personal standards	3.7 (0.7)	3.8 (0.7)			3.5 (0.8)	3.5 (0.7)
HFMPs	M (SD)	M (SD)			<i>M (SD)</i>	<i>M (SD)</i>
self-oriented	76.1 (12.9)	74.2 (17.1)			69.0 (15.3)	69.0 (15.7)
socially prescribed	59.5 (14.4)	59.7 (11.2)			59.1 (15.0)	59.6 (11.2)
Anagram Task			<i>M (SD)</i>	<i>M (SD)</i>		
confidence rating			2.7 (0.5)	2.6 (0.5)		
re-do score			8.3 (10.5) ^b	17.3 (14.5) ^b		

Notes: All analyses of group differences were conducted after missing data were handled via EM algorithm, resulting in intervention group $n = 33$ and control group $n = 36$.

^a Analysis of covariance (ANCOVA) test indicated significant group differences when controlling for T1 scores, $p < .01$.

^b Independent samples *t*-test indicated significant group differences, $p < .01$.

and other outcomes (in this case, responses to the anagram task). Lastly, a series of ANCOVAs was used to test the effect of condition on trait perfectionism and psychopathology while controlling for corresponding baseline scores.

2.2. Effects of perfectionism CBM-I on perfectionistic interpretations

To determine the effect of the perfectionism CBM-I on changes in interpretations, we conducted a series of four analyses of covariance (ANCOVAs) with one between-subjects factor (condition: intervention vs. control), and one covariate (baseline perfectionistic interpretations). As expected, there was a significant impact of condition on T2 perfectionistic interpretations, controlling for baseline perfectionistic interpretations, $F_{(1, 66)} = 18.49$, $p < .001$, $\eta_p^2 = .22$. In line with expectations, participants in the intervention condition showed lower endorsement of perfectionistic interpretations following the perfectionism CBM-I than those in the control condition. Contrary to expectations, there was not a significant impact of condition on T2 non-perfectionistic interpretations (i.e., the interpretations that were relevant to perfectionism by being *inconsistent* with maladaptive perfectionism), controlling for baseline non-perfectionistic interpretations, $F_{(1, 66)} = 1.25$, $p = .27$, $\eta_p^2 = .02$.

Pointing to the specificity of the perfectionism CBM-I, there was no significant impact of condition on T2 negative foil interpretations, controlling for baseline negative foil interpretations, $F_{(1, 66)} = 1.39$, $p = .24$, $\eta_p^2 = .02$. The effect of condition on T2 positive foil interpretations, controlling for baseline positive foil interpretations was also not significant when accounting for the Bonferroni correction we made ($F_{(1, 66)} = 5.28$, $p = .03$, $\eta_p^2 = .07$).

2.3. Effects of perfectionism CBM-I on perfectionistic responses to anagram task

We next conducted two independent samples *t*-tests to examine differences in self-report responses to the confidence and re-do items of the impossible anagram task. The control and intervention groups did not differ on ratings of their confidence in their responses, $t_{(67)} = -0.16$, $p = .87$. However, despite indicating comparable confidence in their responses, the intervention group endorsed wanting to re-do significantly fewer items (about half as many, see Table 2 for group means) than the control group, $t_{(64.8)} = 2.83$, $p = .006$ suggesting a greater acceptance of their performance and thus fewer perfectionistic performance concerns.

Testing Mechanism of Effect. Next, in a key test of the hypothesized mechanism of change for CBM-I interventions, we examined the indirect effect of condition on the responses to the anagram task *through* perfectionistic interpretations. Given that our results showed an effect of the perfectionism CBM-I on perfectionistic interpretations and responses to the re-do item on the anagram task, but *not* on non-perfectionistic interpretations or responses to the confidence item on the anagram task, we only examined the mechanism of change for the former variables. Specifically, using the PROCESS macro for SPSS (Hayes, 2013), we tested a mediation model (model 4 in PROCESS) with study condition entered as the independent variable, T2 perfectionistic interpretations as the mediator, and responses to the re-do items on the anagram task as the dependent variable. Baseline perfectionistic interpretations was entered as a covariate. Providing support for the proposed mechanism of change, all paths of the mediation model were statistically significant (all *p* values $< .05$; see Fig. 1), and the indirect effect of condition on responses to the anagram re-do items through T2 perfectionistic interpretations was also significant [95% CI: 0.38, 7.86]. In other words, being in the intervention condition was associated with lower endorsement of perfectionistic interpretations, which in turn was associated with decreased desire to re-do items on the anagram task.

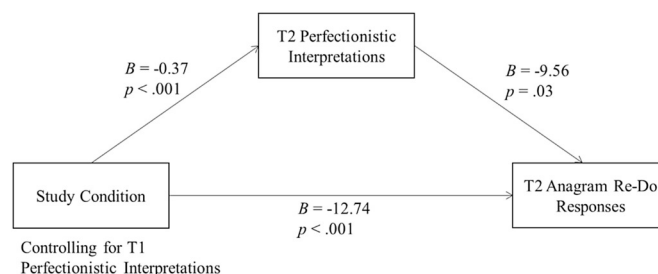


Fig. 1. Mechanism of effect mediation model.

2.4. Effects of perfectionism CBM-I on trait perfectionism

To examine the effect of condition on maladaptive dimensions of trait perfectionism, we next conducted a series of four ANCOVAs using the subscales of the HFMPs and FMPS that assess maladaptive dimensions of perfectionism (socially prescribed perfectionism, self-oriented perfectionism, concern over mistakes/doubt about actions, and personal standards). We anticipated that the intervention group, relative to the control group, would show lower levels of trait perfectionism on these subscales. Each ANCOVA had one between-subjects factor (condition: intervention vs. control) and one covariate (the corresponding baseline subscale score). Contrary to hypotheses, there were no significant effects of condition on trait perfectionism (all *p* values $> .09$).

2.5. Effects of perfectionism CBM-I on psychological symptoms

To examine the effect of condition on eating disorder and anxiety symptoms, we next conducted a series of seven ANCOVAs using the subscales of the EDEQ and STAI, as well as the total score of the EDEQ. We expected that given the use of a non-clinical sample, combined with the low-dose intervention administered over a short-time frame, we would not see an effect of the intervention on psychological symptoms. Each ANCOVA had one between-subjects factor (condition: intervention vs. control) and one covariate (the corresponding baseline subscale score). Consistent with hypotheses, there were no significant effects of condition on eating disorder or anxiety symptoms (all *p* values $> .12$).

3. Discussion

Perfectionism is a risk factor for multiple, distinct forms of psychopathology (Egan et al., 2011). Interventions to reduce perfectionism, especially interventions that modify perfectionistic interpretations and beliefs, have transdiagnostic utility and efficacy (Arpin-Cribbie et al., 2008; Riley et al., 2007; Rozenal et al., 2017; Steele & Wade, 2008; Yiend et al., 2011). The present study tested a CBM-I intervention for maladaptive perfectionism. Relative to the control group, participants who received the CBM-I perfectionism intervention made less perfectionistic interpretations, and demonstrated less perfectionistic responses to a task designed to elicit perfectionistic concerns (specifically, participants in the intervention condition endorsed wanting to re-do significantly fewer items than participants in the control condition, despite both groups endorsing similarly low levels of confidence regarding their performance). Moreover, the proposed mechanism of effect was supported: perfectionistic interpretations mediated the effect of condition on a behavioral indicator of perfectionism. Overall, CBM-I shows promise as an intervention for perfectionism.

The perfectionism CBM-I was a low-dose intervention (two sessions) delivered over a short period (2–3 days). The intervention achieved hypothesized effects on indicators of perfectionistic thinking (i.e. perfectionistic interpretations, perfectionistic concerns on an impossible anagram task). However, the perfectionism CBM-I was not associated with changes in trait perfectionism, eating disorder symptoms, or trait or state anxiety. Given the low-dose, time-limited intervention,

observing effects on perfectionistic interpretations and perfectionistic concerns, but not on trait measures of perfectionism or psychopathology is somewhat expected. It is possible that modifying perfectionistic traits and associated psychopathology follows a dose–response relationship, where sustained, trait-level change is observed only with higher doses administered over a longer period. Indeed, meta-analytic findings of CBM for depression and anxiety overall seem to suggest that participating in multiple sessions produces larger symptom reductions than participating in a single session; however results are somewhat mixed as one meta-analysis found that fewer sessions led to larger effects on symptom reduction (Hallion & Ruscio, 2011; Jones & Sharpe, 2017). Additional research is needed to determine optimal dose of the present intervention.

Current models of mental health treatment tend to center around treatment of specific diagnoses by a trained mental health provider. This model of treatment is costly in terms of both time and money, and most individuals who experience mental illness globally do not receive treatment (Andrade et al., 2014; Patel & Prince, 2010; Sherrill & Gonzales, 2017). These gaps in access have led to increased interest in treatment models that better reach underserved populations and overcome barriers to treatment, including technology-based interventions (Kazdin & Rabbitt, 2013). Furthermore, treatment protocols that address transdiagnostic risk factors such as perfectionism may be particularly well-suited to wide dissemination (McHugh, Murray, & Barlow, 2009). With additional research and development, CBM-I interventions for perfectionism have the potential to become an accessible treatment option, requiring little financial or time investment.

The findings of the current study should be interpreted in light of the limitations of the study design. First, our sample size was relatively small and utilized a convenience sample of racially and ethnically homogenous undergraduate students, necessitating a need for replication in larger, more diverse samples to confirm these findings and improve generalizability. Second, although our sample showed elevated perfectionism on average, participants did not have to demonstrate a minimum level of perfectionism to participate, and some participants endorsed very little perfectionism on the self-report questionnaires. In the future, this research should be conducted among targeted populations with elevated perfectionism. Third, in our mediation analysis both the mediator and DV were measured at T2, so the path between these variables tests a cross sectional rather than longitudinal association. Fourth, many of our study materials (i.e., our CBM intervention, Recognition Ratings Test, and anagram task) were self-developed, and additional examination of their psychometric properties would be beneficial. In particular, we conceptualized our anagram task as capturing maladaptive perfectionism because anecdotal feedback during piloting and from participants indicated that we were successful in creating an unpleasant and frustrating task, and therefore wanting to re-do items despite no discernible gain in doing so seemed to align with the constructs of maladaptive perfectionism (e.g., concern over mistakes, personal standards, self-oriented perfectionism). However, we cannot fully rule out that our impossible anagram task was actually measuring related concepts like positive striving or intolerance of uncertainty. Fifth and finally, we did not include a baseline measure of responses to the impossible anagram task, due to concern about participant fatigue during the already lengthy 1-h baseline visit as well as concerns about the task losing its salience to perfectionistic concerns upon repeated administrations in a short timeframe. Although a baseline measure is unnecessary to determine the differential effect of the re-training and control conditions on this task (given the use of an experimental design with random assignment), baseline data on this task may have provided for a more nuanced interpretation of these results.

In spite of the above limitations, this study has a number of significant strengths. The longitudinal design allowed for tests of the effects of perfectionism CBM-I after multiple sessions spanning several days, which replicates and builds upon previous evidence supporting

the effectiveness of CBM-I for reducing perfectionistic interpretations and behaviors in a single-session study design (Yiend et al., 2011). Additionally, we included a number of outcome measures, including perfectionistic interpretations, self-report trait perfectionism, and a task designed to assess real-time performance-related perfectionistic concerns.

Additional research will be needed to examine effects of CBM-I for perfectionism among diverse populations, and especially among clinical samples. Future research is also needed to test if higher doses of CBM-I for perfectionism can lead to reductions in relevant psychopathology through changes in perfectionistic thinking. Additionally, further development and testing of this intervention is required in accordance with recent improvements in CBM-I methodology to improve participant engagement and intervention effectiveness (for example including an imagery component and asking participants to complete prospective cognitions about what happens next in the scenario; Lee et al., 2015; Menne-Lothmann et al., 2014). Given that the present intervention is similar to an intervention previously developed by Yiend et al. (2011), future work to develop CBM-I for maladaptive perfectionism should also compare these two alternatives in an effort to integrate them into a single—and ideally more robust—intervention. Furthermore, the current perfectionism CBM-I program was administered in a lab; future developments of the intervention must test it in more accessible, user-friendly, and ecologically valid formats (e.g., programming the intervention as a game-type activity available via a website and/or smart phone application). Lastly, additional research is needed to determine the optimal format and target audience for perfectionism CBM-I (e.g., as a supplemental versus stand-alone treatment, as an intervention for individuals with elevated perfectionism versus a prophylactic for individuals with low perfectionism).

4. Conclusions

This study provides preliminary support for the effectiveness of a brief computerized CBM-I intervention modifying perfectionistic beliefs. We found that a CBM-I paradigm targeting maladaptive perfectionism, administered in two sessions across several days, was effective at reducing perfectionistic interpretations. Moreover, supporting a key hypothesized mechanism of effect in CBM-I, we found that reductions in perfectionistic interpretations following the intervention were in turn associated with decreased perfectionistic performance concerns. Further development and research of perfectionism CBM-I is needed, however, the results of the present study indicate that this future work is indeed warranted, as perfectionism CBM-I holds promise as an accessible and transdiagnostic intervention.

Disclosure statements

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