

Supplementary Materials

Elastic Net

In contrast to conventional ordinary least squares (OLS) linear regression, elastic net regularization (ENR) can incorporate a relatively large number of predictor variables and multicollinearity among them, both of which are features of the present study (Friedman et al., 2010; Zou & Hastie, 2005). ENR represents a hybrid of lasso and ridge regression, integrating the L1 and L2 penalizations. The L1 (lasso) penalization performs variable selection by shrinking coefficients to 0 for less contributive variables. This is an important feature of ENR given that we included a relatively large set of potentially relevant predictors of mindfulness app outcome, and alternative statistical approaches (e.g., conventional OLS regression) are ill-suited to the inclusion of numerous predictors, many of which may be highly correlated (e.g., multicollinearity inflates the variances of regression parameter estimates). The L2 (ridge) penalty addresses multicollinearity by constraining or “shrinking” parameter estimates. In summary, the combination of variable selection (from the L1 penalty) and constraining estimated coefficients (from the L2 penalty) may improve out-of-sample predictive performance (i.e., increases the generalizability of the model to new individuals) relative to linear regression (e.g., Zou and Hastie, 2005; Webb *et al.*, 2020). Given that the present study is focused on generating predictions of mindfulness app outcome for individual adolescents, the latter benefit of selecting an approach (ENR) with relatively robust out-of-sample predictive performance is a desirable feature. For comparison, in the revised submission, we re-ran our primary analyses reported in Table 2 (using 10-fold cross-validation) substituting linear regression for ENR. ENR yielded superior cross-validated performance relative to linear regression in predicting the cumulative (3-week intervention) effects of the mindfulness app on problem-focused (RMSE = 1.32 vs. 1.49;

R2 = .25 vs. .20) and emotion-focused (RMSE = 1.29 vs. 1.45; R2 = .17 vs. .14) rumination, and in predicting the immediate effect of mindfulness exercises on problem-focused (RMSE = 10.88 vs. 12.30; R2 = .14 vs. .13) and emotion-focused rumination (RMSE = 14.42 vs. 15.60; R2 = .22 vs. .20). Finally, another beneficial feature of ENR is that it is relatively less complex and more interpretable than other machine learning approaches, many of which have “black box” properties (e.g., non-linear associations and high-order interactions may underlie the predictive performance of decision-tree based algorithms).

Nested Cross-Validation

We tested a nested CV approach (i.e., incorporating both an outer and inner CV loop). Specifically, prior to implementing the repeated CV procedure described in the main text, we first split the data into 10 folds (10 training/test sets, representing the outer CV). For *each* of these training sets (10 in total), we implemented the above repeated 10-folds CV procedure (i.e., inner CV loop) and selected the optimal alpha and lambda parameters. We then predicted outcome for participants in the test set using these optimal parameters, and computed RMSE. Finally, we compared the average predictive performance (RMSE) of the latter nested CV approach with the non-nested CV approach, which yielded very similar results (median RMSE for predicting slope of change in problem-focused rumination: 1.2 (nested) vs. 1.3 (non-nested); for emotion-focused rumination = 1.3 (nested) vs. 1.3 (non-nested)..

Baseline Predictors of Mindfulness App Engagement

We tested the relation between baseline predictors and the extent to which adolescents engaged with the app-based mindfulness exercises. We computed two variables representing (1) total frequency and (2) total dose (in minutes) of mindfulness practice via the app. Specifically, we tested the association between each baseline predictor and (1) total number of mindfulness

exercises completed via the app and (2) total minutes of mindfulness practice (i.e., length of each meditation [1-, 5-, and 10-mins] X number of times practiced). Results revealed that total number of mindfulness exercises completed was significantly correlated with lower depression severity (CDI; $r = -.23, p = 0.038$), greater Acting with Awareness (FFMQ; $r = .25, p = 0.028$), having no prior experience with mindfulness ($t(78) = 2.21, p = .030$) and female gender ($t(78) = 2.30, p = .024$). Second, total number of minutes of mindfulness practice was significantly correlated with higher anxiety (MASQ; $r = .26, p = 0.020$) and female gender ($t(78) = 2.10, p = .039$).

CARE App

The CARE app was developed by LMH and the Child and Adolescent Research in Emotion (CARE) Lab. Research assistants conducted web searches to find freely available, short, guided mindfulness exercises. Potential exercises for inclusion were transcribed, and through consultation with LMH, we selected those that use practices common to Mindfulness Based Stress Reduction (MBSR)/Mindfulness Based Cognitive Therapy (MBCT) and seemed appropriate for adolescents. We conducted pilot testing with eight younger adolescents (Le et al., 2016) and 20 older adolescents (Hilt et al., 2018) to ensure that all of the exercises were generally helpful and easy to follow. Please see Hilt and Swords (2021) for additional information regarding the CARE app.

References:

- Hilt, L. M., & Swords, C. M. (in press). Acceptability and preliminary effects of a mindfulness mobile application for ruminative adolescents. *Behavior Therapy*. DOI: [10.1016/j.beth.2021.03.004](https://doi.org/10.1016/j.beth.2021.03.004)
- Le, T., Zhang, R., Kim, A., & Hilt, L.M. (2016, October). *Mindfulness mobile application for adolescents: A pilot study*. Poster session presented at the Association for Behavioral and Cognitive Therapies annual convention, New York, NY.
- Hilt, L.M., Tuschner, R.F., Liu, Q., Le, T., & Kim, A. (2018, April). *Acceptability of a mindfulness mobile application and effects on emotional regulation and depressive symptoms*. Paper presented at the Anxiety and Depression Association of American annual conference, Washington, DC.
- Webb, C. A., Swords, C. M., Lawrence, H., & Hilt, L. M. (2021). *Which adolescents are well-suited to app-based mindfulness training? A randomized clinical trial and data-driven approach for personalized recommendations*. PsyArXiv. <https://doi.org/10.31234/osf.io/7gbjd>