Motivational variables as moderating effects of a web-based mental health program for university students: Secondary analysis of a randomized controlled trial

Maria Hanano, Leslie Rith-Najarian, Elizabeth Gong-Guy, Denise Chavira

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Maria Hanano[1] MS, BA; Leslie Rith-Najarian[1, 2] PhD; Elizabeth Gong-Guy[1] PhD; Denise Chavira[1] PhD

[1]University of California, Los Angeles Los Angeles US
[2]Striveweekly Los Angeles US

Corresponding Author:
Maria Hanano MS, BA
University of California, Los Angeles
10911 Weyburn Ave, Suite 200
Los Angeles
US

Abstract

Background: Self-guided online interventions have the potential of addressing help-seeking barriers and symptoms common among university students, such as depression, anxiety. Unfortunately, self-guided interventions are also associated with less adherence, implicating motivation as a potential moderator for adherence and improvement for such interventions.

Objective: This secondary analysis of data from a randomized controlled trial (NCT No. 04361045) aimed to examine constructs of motivation as moderators of improvement for a self-guided 8-week online intervention in university students (n=1607).

Methods: Tested moderators included internal motivation, external motivation, and confidence in treatment derived from the Treatment Motivation Questionnaire. The primary outcome was improvement on depression and anxiety measured by the Depression Anxiety and Stress Scale-21.

Results: Piecewise linear mixed effects models showed that intrinsic motivation significantly moderated symptom change for the intervention group (t=-2.94, p=.003) at average and high (+1 SD) motivation levels (t=-2.28, p=.02, t=-4.05, p<.001 respectively).

Conclusions: The combination of an online intervention and high/moderate internal motivation resulted in greater improvement on the total DASS scale. These findings highlight the importance of conceptually differentiating motivation-related constructs when examining moderators of improvement. Clinical Trial: NCT No. 04361045

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Motivational variables as moderating effects of a web-based mental health program for university students: Secondary analysis of a randomized controlled trial

Background: Self-guided online interventions have the potential of addressing help-seeking barriers and symptoms common among university students, such as depression, anxiety. Unfortunately, self-guided interventions are also associated with less adherence, implicating motivation as a potential moderator for adherence and improvement for such interventions. Previous studies examining motivation as a moderator or predictor of improvement on online interventions have defined and measured motivation variably, producing conflicting results.

Objective: This secondary analysis of data from a randomized controlled trial (NCT No. 04361045) aimed to examine constructs of motivation as moderators of improvement for a self-guided 8-week online intervention in university students (n=1607).

Methods: Tested moderators included internal motivation, external motivation, and confidence in treatment derived from the Treatment Motivation Questionnaire. The primary outcome was improvement on depression and anxiety measured by the Depression Anxiety and Stress Scale-21.

Results: Piecewise linear mixed effects models showed that intrinsic motivation significantly moderated symptom change for the intervention group (t=-2.94, p=.003) at average and high (+1 SD) motivation levels (t=-2.28, p=.02, t=-4.05, p<.001 respectively). Significant results remained even after controlling for baseline severity. Results showed that confidence in treatment did not significantly moderate symptom change for the intervention group (t=1.44, p=.1). In this sample, only internal motivation was positively correlated with service initiation, intervention adherence, and intervention satisfaction.

Conclusions: The combination of an online intervention and high/moderate internal motivation resulted in greater improvement on the total DASS scale. These findings highlight the importance of conceptually differentiating motivation-related constructs when examining moderators of improvement. Results suggest that the combination of an online intervention and high/moderate internal motivation results in greater improvement. These findings highlight the importance of

conceptually differentiating motivation-related constructs when examining moderators of improvement. To better understand the moderating role of internal motivation, future research is encouraged to replicate these findings in diverse samples as well as to examine related constructs like baseline severity and adherence. Understanding these characteristics informs treatment strategies to maximize adherence and improvement when developing online-interventions, as well as allows services to be targeted to individuals likely to benefit from such interventions.

Trial Registration: The trial from which we used data for the presented secondary analyses was retroactively registered with ClinicalTrials.gov (NCT04361045).

Keywords: Web-based intervention; Internal Motivation; Depression; Anxiety; Self-determination

Introduction

Self-guided online mental health interventions have increased in popularity as an alternative service option for young people and many have proven effective in reducing an array of mental health problems [1]. Delivering such interventions to university students is particularly advantageous, as they address many barriers associated with traditional in-person campuses services – concerns about confidentiality, scheduling issues, preference for self-reliance, etc. [2,3] – and can be delivered on a large-scale prevention level. A particularly unique feature of online interventions is their ability to offer users increased autonomy to interact with the intervention according to their own preferences and needs, with less oversight [4]. However, the direct drawback of this is that self-guided online mental health programs have low adherence and completion rates [5-7]. According to Eysenbach's law of attrition [8], users of online interventions receive variable doses of the intervention due to less oversight and more autonomy. Consequently, any observed effects in symptom improvement favoring online interventions may be driven by those who actually remain engaged with the program. We are thus left with uncertainty: does the online intervention itself lead to improved symptoms, or are there characteristics of a subset of individuals that are driving effects? With online mental health interventions being substantially newer than in-person psychotherapies, there has increasingly been a call to identify intervention response moderators in order to better understand for whom these interventions work [9-11].

Given the self-guided nature of online interventions, motivation is likely an important moderator to consider. One of the prominent theories on motivation is self-determination theory (SDT), a theory concerned with human motivation, which assumes that individuals have an innate need to develop and grow psychologically [13,14]. As such, they theorize that an individual's drive to attain different types of goals is determined by three key needs that advance our growth: competence, autonomy, and relatedness. According to SDT[13,14], there is a spectrum of motivation ranging from external to intrinsic: *external* (i.e., drive to reduce negative consequences/punishments

or secure tangible rewards), *introjective* (i.e., to reduce internalized pressure, shame, guilt, etc.), *identifying* (i.e., drive towards goals and values that are identified as personally important), *integrated* (i.e., drive to act in congruence with values that are core to one's sense of self); and *intrinsic* (i.e., drive by interest, curiosity, satisfaction, and enjoyment). For the purposes of our paper, SDT provides a useful framework to conceptualize motivation, and we define *internal* motivation as all non-external types of motivation (i.e., introjective, identifying, integrated, and intrinsic).

SDT research has found that the various kinds of motivation differentially predict various health behaviors (i.e., physical exercise, dieting, etc.) [15], as well as greater treatment adherence and progress toward mental health interventions [14,16]. According to student feedback from an open trial of an online intervention, [12] motivational difficulty was one of the most common self-reported barriers to using the intervention. One study examining adults with alcohol use disorder enrolled in an alcohol treatment program found that those with more autonomous (i.e., identified or integrated motivation) reasons for engaging with the program had more regular attendance and involvement [17]. Another study that tested positive psychology self-help interventions found that university students with more intrinsic motivation experienced greater improvement post-intervention [18]. The authors concluded that in order for self-help interventions to be maximally effective, users need to (a) be receiving empirically supported intervention practices and (b) have their own motivation to use the intervention. Taken together, these SDT studies suggest that *internal* motivation is an important moderator of treatment engagement and response for *in-person* interventions.

Studies that have examined motivation as a moderator or predictor for *online* interventions have measured motivation differentially and produced conflicting results. For example, a study testing a web-based intervention for marijuana use in university students tested if effects were moderated by a readiness-to-change measure, which the authors selected to "assess level of motivation to change" [19]. The results of the study suggested moderation by the action subscale (i.e., taking actual steps to change) such that higher action scores predicted greater symptom

improvement, but no significant moderation by the problem recognition subscale [19]. A different

study of an online CBT intervention for adults operationalized "motivation" using a measure [20]

with four domains – readiness to change, distress from symptoms, social support, and doubt

concerning participation – and found that "high motivation" predicted less depression improvement

[21]. However, in a study of an online relaxation intervention for adults with mild to moderate

anxiety levels, there was no relationship between baseline "internal motivation" and post-

intervention reduction of stress symptoms [22]. In that same study, high baseline "external

motivation" (e.g., feeling pressured by others to get help) predicted worsened stress symptoms by

post-intervention [22]. In summary, previous online intervention research has employed variable

definitions and measures of motivation, which could be driving the divergent results.

The Current Research

Given the mixed findings of research examining motivation as a moderator of online mental

health intervention effects, there is a need for online intervention research that operationalizes the

construct of motivation using a more standardized definition. In contrast, SDT research has used a

standardized definition of motivation, and has more consistently found motivation to be a moderator

of intervention response and engagement, but only for in-person interventions. It has already been

recommended to consider SDT when developing and testing digital mental health apps, given that

intrinsic motivation is hypothesized to drive adherence behaviors [23].

In service of this aim, we selected the Treatment Motivation Questionnaire (TMQ) [17] to

operationalize our moderators. The TMQ was developed specifically to measure SDT's motivation

constructs in the context of treatment seeking [17]. The TMQ has an internal motivation scale, an

external scale, and a confidence in treatment scale. This third scale is included because the measure

developers argue that in order to be motivated to seek treatment, individuals must have some

confidence in the treatments' competence and ability to provide successful outcomes [17]. Indeed,

the construct of confidence in treatment was found to positively correlate to internal motivation,

involvement in treatment, less drop-out, number of activities completed, and was negatively correlated to external motivation [17]. Prior online intervention research has perhaps conflated these separate, yet related motivational constructs, namely: internal motivation for help-seeking, external motivation for help-seeking, and expectation of the intervention to be helpful. Using the three subscales of the TMQ as moderators would allow us to simultaneously test these constructs in one study. As far as we are aware, the TMQ and its three subscales have never been used within online mental health intervention studies.

To test motivation as a moderator of symptom improvement for online intervention users, we used data from a recently completed a randomized controlled trial (RCT) of a self-guided intervention, StriveWeekly [24]. StriveWeekly targets anxiety and depression in university students, given that these are the two most common mental health concerns for this population [25,26]. The main results of the RCT showed that the intervention effectively reduced symptoms of anxiety and depression [24]. We planned *a priori* to test three baseline variables as moderators: internal motivation for treatment, external motivation for treatment, and treatment expectations. The primary aim of the current study is to present these moderation analyses. Such analyses will allow us to determine if symptom improvement is driven by: the intervention, baseline motivation, or a combination of both. The secondary aim was to conduct exploratory analyses of how SDT motivation constructs relate to participant characteristics and intervention-related variables.

Methods

This study was approved by the appropriate Institutional Review Board.

Participants and Procedures

Participants were at least 18 years old and were undergraduate, graduate, and professional students at a large public university in southern California. Recruitment strategies included emails (via the registrar to all enrolled student and over departmental email lists), flyers around campus, social media, and announcements in psychology courses granting research study participation

credits. Participation was voluntary and those participating were given the choice of compensation, either entry into a $10-$100 gift card drawing or course credit. The only a priori exclusion criterion was concurrent enrollment in an online anxiety and depression treatment study on campus, resulting in nine participants being excluded. We also excluded participants with invalid data reporting (e.g., inconsistency in cross-validation item pairs; straight-lined responses), resulting in 18 students being excluded. During the course of the trial, 10 participants withdrew. The final sample included in data analyses was *n* = 1607.

During a 3-week period, recruitment materials directed participants to an enrollment website link. Informed consent was obtained online and then participants began the baseline survey. Within 72 hours thereafter participants were informed via email of their condition, assigned using an electronic random number generator. Participants in the intervention condition received a verification code to access the online platform. The 8-week intervention phase was followed by a post-intervention survey, which remained open for two weeks for participants in both conditions. Two weeks after completion of the post-intervention survey, students in the waitlist condition were granted access to the online platform. We also administered a 3-month follow-up survey to all participants who completed the post-intervention, though data from this last survey were included in our statistical models solely for missing data estimation.

For the duration of the study, participants in both conditions were allowed to access any other services on- or off-campus. We also delivered a safety follow-up and service referral protocol (enacted by five graduate student-level clinicians) to students endorsing suicidal ideation in any survey (per Patient Health Questionnaire-9's ninth item [27]). We did not exclude students receiving concurrent services or the additional support, rather we controlled for such differences in our statistical analyses.

Conditions

Intervention Group

Participants first set-up their account, which included selecting program brand pathway, setting reminder emails schedule preferences, and a goal-setting activity. During the eight-week intervention, students received an email every Monday which directed them to the section of the online platform with the current module's content. Each module presented a skill (e.g., mindfulness, physical exercise) and provided: psychoeducation; practice instructions; a list of practice activities; tips and suggestions; and a planning section for participants to tentatively commit to practice activities on a checklist and brainstorm ideas to overcome anticipated barriers to practice. Throughout the week participants could log any skills they practiced and rate their corresponding mood/stress levels. Participants could earn virtual medals for logging more activities, weekly prize raffle entry for submitting any end-of-the-week check-in, and grand prize entry for completing practice for all eight modules. There was also a "Campus" section on the platform which provided: relevant campus resources; a notification center with campus-specific updates; and an anonymous livestream of all campus users' activity. For additional details about the intervention content, please see Rith-Najarian and colleagues [24].

Waitlist Group

Participants in this group were not contacted during the eight-week intervention until we emailed them with the post-intervention survey link. Access to the online intervention was provided only if they completed the post- intervention survey.

Measures

Demographic Information

Per our consent form, student records were used to collect demographic information such as gender (male or female), student status (undergraduate, graduate, or professional), age, and ethnicity/ race (per the Common Data Set categories [28]).

Self-reported Service Use

Students were asked to indicate past and current use of health-related services and resources

on- or off-campus using a checklist of common resources/services (e.g., counseling center). These questions were included in the baseline and post-intervention surveys.

Primary Outcome

Our primary symptom outcome measure was the 21-item version of the Depression Anxiety and Stress Scale (DASS), which assesses self-reported symptoms related to depression, anxiety, and stress. The DASS has demonstrated high internal consistency (.83 - .90) and good construct validity in university student samples [29]. Internal consistency of the DASS using our sample at baseline was adequate to good (total score: α=.92; depression subscale: α=.89; anxiety subscale: α=.79). We had previously found [24] that the DASS-stress subscale did not have good internal factor structure and thus, we did not examine it on its own. DASS-21 total symptom scores were used.

Moderators

The Treatment Motivation Questionnaire [17] is a measure that assesses participants' reasons for initiating treatment and their expectations for completing the program. The TMQ has two motivation scales: (a) internal motivation (e.g., "I really want to make some changes in my life."), and (b) external motivation (e.g., "I came to treatment now because I was under pressure to come."). The TMQ also has a "confidence in treatment" scale (e.g., "I am confident this program will work for me.") and a "help seeking" subscale (e.g., "I accept the fact that I need some help and support from others to beat my problem"). The TMQ has predicted intervention completion in other research studies, for example in-person alcohol treatment [17] and online stress treatment [22]. For this study, questions were minimally adapted to apply to an online mental health promotion program instead of an in-person treatment (see Appendix for adapted measure). Questions from the help-seeking subscale were removed, as they relate directly to interactions with other treatment participants, which was not applicable to our study design. The TMQ was included in the baseline survey only. Internal consistency was adequate for the TMQ total (α=.80), TMQ internal motivation (α=.87), TMQ confidence in treatment (α=0.74), but not for TMQ external motivation (α=0.56).

Post-intervention Variables

To measure account set-up status and adherence, behavioral data from participants' accounts were collected from their online program account. Account set-up was defined in a binary way, with "yes" being coded if a participant completed the account set-up process and verified their email in order to received intervention email communications. Adherence was defined by number of weeks (0-8) for which the participant had logged skills practice at least once for the given module. We measured satisfaction by adapting the Client Satisfaction Questionnaire, [30] which has previously shown high internal consistency and concurrent validity in intervention research (see examples [31,32]). Internal consistency of the five-item satisfaction scale in our sample was excellent (α=.91). We assessed self-reported barriers encountered during intervention use using an original 10-item measure called the Digital Intervention Barriers Scale (DIBS; [33]). On the DIBS participants were asked how much they agree on a scale of 1-5 that they encountered a given barrier (e.g., "I had technical problems"). In our sample the DIBS showed good internal consistency (α=.77). Lastly, participants completed a checklist of self-identified motivators during the program (e.g., weekly prize drawings). See **Appendix** for these questionnaires.

Statistical software and analyses.

Preliminary Analyses and Covariate Selection

All preliminary analyses were run in SPSS version 25 [34]. Differences by condition or drop-out status were assessed through independent t-tests (for continuous variables, e.g., DASS scores) or Chi-squared analyses (for dichotomous variables, e.g., ethnicity). For t-tests, we reported the test statistic for which equal variance was assumed, unless Levene's test was significant. We previously identified [24] appropriate covariates for our linear mixed effects models as (a) gender and (b) baseline suicidal ideation based on between-group differences in baseline DASS scores.

Tests of Moderation

Piecewise linear mixed effects (LME) models were run in R [35] using the multilevel package

[36] and accounted for missing data with restricted maximum likelihood estimation, allowing all participants to be included in the analyses. Participant intercepts and time slopes were treated as random effects. Each of the three moderators (i.e., internal motivation, external motivation, and confidence in treatment) was tested in its own model. The main model included fixed effect terms for: group (with intervention condition as the reference group), time, group-by-time interaction, covariates, and covariate-by-time interactions in predicting DASS total scores. To this model we added the moderator by group-by-time interaction, and all lower order interactions. To transform the moderator into a categorical variable, scores that were one standard deviation below the mean or less were coded as "low", scores one standard deviation above the mean or more were coded as "high", and all scores in-between were coded as "average." In the presence of a significant moderator by group-by-time term, we calculated simple slopes using the reghelper package [37] and examined tests of time from baseline to post- intervention. If simple slope analyses were also significant, we ran additional LME models for that respective moderator as predicting DASS-depression and DASS-anxiety as separate outcomes.

Effect sizes

For ease of calculating and interpreting effect sizes for any significant moderator, models were run again treating the moderator as a categorical rather than continuous variable. Then, estimated marginal means were calculated with the emmeans package for R [38]. Within-group effect sizes were calculated using this formula:

$$d = \frac{M_1 - M_2}{\sqrt{\frac{(n_1 - 1)SD_1^2 + (n_2 - 1)SD_2^2}{n_1 + n_2 - 2}}}$$

Between-group effect sizes were calculated using Morris' (2008; [39]) recommended formula for reducing bias while maximizing precision in pretest-posttest-control group designs (i = intervention; w = waitlist).

$$d = C_P \left[\frac{\left(M_{i.post} - M_{i.pre} \right) - \left(M_{w.post} - M_{w.pre} \right)}{SD_{pre}} \right]$$

$$C_P = 1 - \frac{3}{4 \left(n_i + n_w - 2 \right) - 1}$$

$$SD_{pre} = \sqrt{\frac{\left(n_i - 1 \right) SD_{i.pre}{}^2 + \left(n_w - 1 \right) SD_{w.pre}{}^2}{n_i + n_w - 2}}$$

Ethical Considerations

The main trial from which the presented data was collected was approved by the University of California, Los Angeles' Institutional Review Board (IRB; #17-000761). The informed consent was conducted online and allows for secondary analysis to be conducted without an additional consent from participants. Students who endorsed suicidal ideation underwent safety follow-up conducted by trained graduate student clinicians as well as were connected with mental health services as needed. Data was collected and stored on an encrypted and secured campus platform and was limited to study staff listed on the IRB. When data was initially collected, it was associated with participants first names and emails. However, once datasets were created, the data was de-identified and participants were identified using participants IDs. Participant identifying information was then deleted from the secured campus platform and datasets were stored on password protected spreadsheets. Participants had the option of selecting one of two compensation choices for completing the baseline survey, either gift card drawings or research study course credits. Gift card drawings included one $100 and 10 $10 gift cards per survey. Participants were compensated using gift cards for completing posttest and follow-up surveys.

Results

Participant Sample

The sample consisted of 1607 ethnically and racially diverse participants, of which 74.2%

were female, 63.0% were undergraduate students, with a mean age of 22.8. See **Table 1** for demographic details of students by condition.

Preliminary Analyses

At baseline, there were no differences between conditions in: DASS total or subscale scores (p=.6-9); demographic variables (p=.3-6); baseline SI status (p=.3); resource use at baseline (p=.9); resource use by post-intervention (p=.9); or moderator variables (internal motivation, p=.6; external motivation, p=.4; confidence in treatment, p=.9). Correlations between DASS total and moderators at baseline are presented in **Table 2**.

Next, we assessed for differences by drop-out status. Comparing participants who completed the post-intervention survey versus those who had not, we found no differences in DASS scores (p=.2-5), moderator variables (p=.09-8), or the baseline SI covariate (p=.9). There was however a statistically significant difference in research drop-out by gender, $\chi^2 (1, 1607) = 15.14$, $p<.001$, with 35.5% of female students dropping out versus 46.3% of male students. There was also a difference in research drop-out by condition; 47.1% of students in the intervention group dropped out versus 38.5% in the waitlist group (38.5%) such that waitlist participants were disproportionately retained in the post-intervention survey, $\chi^2 (1, 1607) = 12.30$, $p<.001$. Examining each condition separately, there were no differences in baseline DASS scores between post-intervention completers versus drop-outs in the intervention group (p=.3-.7) or the waitlist group (p=.1-.5).

Finally, we checked for multicollinearity among variables by running separate linear regressions that included both covariates (baseline suicidal ideation and gender), condition, and each moderator as predictors of change in DASS scores. VIF scores for all regressions were between 1.00-1.06, suggesting an absence of multicollinearity per the common VIF<10 cut-off [40].

Table 1. *Demographic Composition and Baseline Characteristics by Condition in a randomized control trial of a randomized control trial of a self-guided web-based intervention for depression and anxiety for university students.*

	Intervention Group (*n* = 804)	Waitlist Group (*n* = 803)
Sex		
Male	203 (25.2%)	212 (26.4%)
Female	601 (74.8%)	591 (73.6%)
Ethnicity and Race		
Asian	196 (24.4%)	229 (28.5%)
Black non-Hispanic	12 (1.5%)	19 (2.4%)
Hispanic / Latinx	149 (18.5%)	161 (20%)
International	107 (13.3%)	96 (12%)
Native American	2 (0.2%)	1 (0.1%)
Pacific Islander	1 (0.1%)	1 (0.1%)
Two or More Races	41 (5.1%)	39 (4.9%)
Unknown	20 (2.5%)	22 (2.7%)
White Non-Hispanic	276 (34.3%)	235 (29.3%)
Type of Student		
Undergraduate	498 (61.9%)	515 (64.1%)
Graduate	306 (38.1%)	288 (35.9%)
	685 (85.2%)	682 (84.9%)
No Prior Mental Health Service Use		
DASS-21	*M* = 17.46 (*SD* = 10.74)	*M* = 17.31 (*SD* = 10.94)
Total	*M* = 5.45 (*SD* = 4.66)	*M* = 5.41 (*SD* = 4.53)
Depression	*M* = 4.72 (*SD* = 3.73)	*M* = 4.63 (*SD* = 3.88)
Anxiety		

Note : Table 1 was published previously in the main trial paper [24]

Table 2. *Baseline correlations of Treatment Motivation Questionnaire subscales and Total scores on the Depression Anxiety Stress Scale 21 in a randomized control trial of a self-guided web-based intervention for depression and anxiety for university students.*

Variables	1	2	3
1. DASS Total Baseline	-		
2. TMQ External total	.21**	-	
3. TMQ Internal total	.46**	.23**	-
4. TMQ Confidence total	-.20**	-.06*	-.02

Notes: N=1607, **p<.01; *p<.05

Primary Analyses

Testing Moderators of Intervention Outcome Effects

There was a significant group-by-group-by-time interaction when examining TMQ internal motivation as a moderator of change on total DASS scores (t=-2.94, p=.003). Simple slope tests of time were significant for the intervention group at average motivation levels (t=-3.41, $p<.001$) and at high (+1 SD) motivation levels (t=-5.39, $p<.001$), but not at low motivation levels for the

intervention group nor at any motivation levels for the waitlist group. The remaining two moderator models failed to produce significant three-way interactions: TMQ external motivation (t=0.66, p=.5), and TMQ confidence in treatment (t=1.44, p=.1). To control for the false discovery rate across the four models, we calculated the Benjamini-Hochberg critical value[41] as p<.0125 for the three-way interaction term with the smallest p-value, and the TMQ internal motivation model adequately met this criterion.

Given that intervention effects on total symptoms were moderated by internal motivation, we ran models predicting change in depression and anxiety symptoms separately. Predicting change in depression subscale scores, there was a significant group-by-time by motivation interaction (t=-2.67, p=.008), with simple slopes of time being significant only for the intervention group at average motivation levels (t=-2.28, p=.02) and at high (+1 SD) motivation levels (t=-4.05, p<.001). Predicting change in anxiety subscale scores, there was a significant group-by-time by motivation interaction (t=-2.69, p=.007), with simple slopes of time being significant only for the intervention group at average motivation levels (t=-3.66, p<.001) and at high (+1 SD) motivation levels (t=-5.33, p<.001). Treating internal motivation as a categorical variable (low, average, high), the three-way interaction terms remained significant, ps .005-02. **Figure 1** and **Table 3** present the within-group and between-group effect sizes for change in DASS scores by condition and internal motivation levels.

Post Hoc Probing of Baseline Symptom Severity as a Confounding Variable

Visual examination of estimated marginal means in **Table 3** suggested that internal motivation could be affected by baseline severity. Thus we ran a post hoc analysis to rule out this possibility.

First, we ran another set of LME models that treated baseline DASS scores as a predictor of post-intervention DASS scores, rather than using a repeated measure dependent variable of DASS scores. Thus, models did not include an effect of time, rather we examined the group by motivation

interaction. Of note, because baseline DASS scores were not included within the dependent variable, fewer missing cases could be imputed for post-intervention DASS scores and thus the sample size was smaller (*n*=992). Over and above the baseline symptom terms, the models produced significant group by motivation interaction terms in predicting post-intervention: total symptoms (*t*=- 3.32, *p*<.001), depression symptoms (*t*=2.50, *p*=.01) and anxiety symptoms (*t*=3.34, *p*<.001). Thus, regardless of baseline symptom severity, internal motivation still moderated intervention effects.

Second, we divided the internal motivation scale into two subscales: (a) *identifying* internal reasons for motivation (e.g., "I chose this program because I think it is an opportunity for change"; items 1, 5, 9, 11, 15, 17, 19), versus the remaining items about (b) *introjective* internal reasons for motivation (e.g., "I feel so guilty about my problems that I have to do something about it"). We conceptualized the introjective motivation items as more directly confounded with symptom severity, given that the negative affect aspects (e.g., guilt and worry) of the items overlap with diagnostic criteria for mood and anxiety disorders. We found that there was a significant group-by-time interaction for both the LME models testing: the *introjective* items as a moderator (*t*=-2.51, *p*=.01), as well as the i*dentifyin*g items (i.e., those hypothetically less confounded with symptom severity) as a moderator (*t*=-2.66, *p*=.008). Again, simple slopes of time for both LME models were significant only for the intervention condition at average and high motivation levels (*t*=-5.39 to -2.66; *p*=.008 to *p*<.001). Thus, intervention effects were still moderated by internal motivation as measured by items unrelated to symptom severity.

Table 3. *Effect Sizes and Estimated Marginal Means by Condition and Internal Motivation Level in a randomized control trial of a self-guided web-based intervention for university students*

Outcome	Motivation		Intervention *M (se)*			Waitlist *M (s*		
			Pre	Post	*d*		Pre	
	High	*N*=148	8.30 (0.31)	5.93 (0.42)	0.63	*N*=131	8.26 (0.33)	7

Depression	Average	*N*=524	5.24 (0.16)	4.54 (0.22)	0.19	*N*=526	5.12 (0.16)	5
	Low	*N*=128	3.42 (0.33)	3.36 (0.46)	0.02	*N*=143	3.57 (0.31)	3
Anxiety	High	*N*=148	6.96 (0.28)	4.81 (0.36)	0.64	*N*=131	6.98 (0.3)	6
	Average	*N*=524	4.46 (0.15)	3.69 (0.19)	0.23	*N*=526	4.51 (0.15)	4
	Low	*N*=128	3.50 (0.30)	3.40 (0.39)	0.03	*N*=143	2.87 (0.29)	2
Total	High	*N*=148	24.61 (0.75)	18.30 (1.03)	0.70	*N*=131	25.01 (0.80)	23
	Average	*N*=524	16.88 (0.40)	14.96 (0.54)	0.21	*N*=526	16.85 (0.40)	16
	Low	*N*=128	12.55 (0.80)	12.31 (1.11)	0.03	*N*=143	11.66 (0.76)	11

Figure 1. *Depression, Anxiety, and Stress Scale total scores within-group effect sizes with standard error bars by TMQ-internal in a randomized control trial of a self-guided web-based intervention for depression and anxiety for university students.*
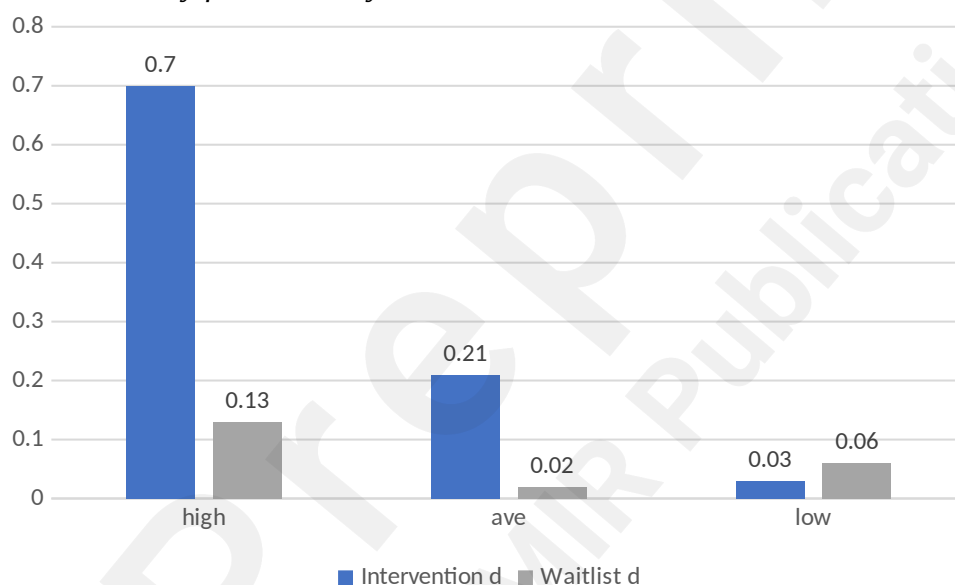
Notes: Effect sizes are based on marginal means. TMQ = treatment motivation questionnaire. High = +1 SD TMQ-internal scores, ave = mean TMQ-internal scores; Low = -1 SD TMQ-internal scores

Post Hoc Exploratory Analyses

Internal Motivation as a Predictor of Service Initiation

We assessed if internal motivation predicted students accessing the online intervention itself or other campus services. Using binary logistic regression predicting account set-up within the intervention condition (*n*=804), we found that students with higher motivation were more likely to complete setting up their account (Wald χ^2=10.46, *β*=0.02, *p*=.001). In contrast, the other three moderator variables did not predict account set-up in their own regression models (*p*=.2-7). Next, we

ran a binary logistic regression predicting other campus mental health service initiation (i.e., added use from baseline to post-intervention) in either condition (*n*=1607), by: internal motivation (high versus not-high), condition, and the internal motivation by condition interaction. We found that there was a significant interaction (Wald χ^2=5.66, *β*=-1.13, *p*=.02) such that for those in the waitlist group the odds of initiating services was 3.98 greater for those with high motivation, whereas for the intervention group the odds of Initiating services was 1.29 higher for those with high motivation. Again, binary regression models with the other three moderator variables produced no significant main effects or interactions in predicting campus service initiation (*p*=.09-8).

Correlates of Motivational Variables at Post-intervention

We assessed within the intervention condition (*n*=804) if internal motivation related to post-intervention variables (i.e., adherence, satisfaction, barriers) differently than did the other tested moderator variables. See **Table 4** for all correlations. Although the magnitude was small, internal motivation was significantly and positively correlated with intervention adherence and intervention satisfaction. External motivation was significantly and negatively correlated intervention adherence. Confidence in treatment had a significant positive correlation with treatment satisfaction and significant negative correlation with the DIBS self-reported barriers encountered.

Table 4. *Correlations between Motivation-constructs Moderators Variables with Adherence, Satisfaction, and Barriers Variables in a randomized control trial of a self-guided web-based intervention for depression and anxiety for university students.*

Variables	Adherence	Satisfaction	Barriers
TMQ Internal	.09*	.13**	.05
TMQ External	-.10**	-.03	.08
TMQ Confidence	.05	.32**	-.29**

Notes: **N=804,** **p*<.01; *p*<.05

Discussion

Summary of Findings

Considering the lack of consensus on the moderating effect of motivation for online mental health interventions, there is a need to examine motivation using standardized definitions that have

been validated in the literature. The primary aim of this study was to test SDT's three motivation constructs – internal motivation, external motivation, and confidence in treatment – as moderators of the effects of an online mental health intervention on anxiety, depression, and total symptom change. Our secondary aim was to explore how the three motivation constructs relate to participant characteristics and post-intervention variables such as adherence and campus service initiation. Such investigation could help us better understand the relative benefit of such self-guided interventions on university campuses, depending on which individual differences predict more improvement in internalizing symptoms.

Implications

In this study, we found that internal motivation moderated intervention effects, whereas external motivation and confidence in treatment did not have an impact on clinical outcomes. Students with high internal motivation experienced moderately sized effects in the intervention condition relative to the waitlist condition for depression (d=0.50), anxiety (d=0.49), and total symptoms (d=0.56). For students with average motivation, they also did significantly better in the intervention condition relative to waitlist, but effect sizes were minimal (ds from 0.15- 0.18). For students with low motivation in the intervention condition, there were no differences in symptom change between conditions. Results suggest that that moderate to high internal motivation combined with enrollment in a mental health intervention leads to more symptom change. Our results also indicate the inverse, that in the absence of an intervention (i.e., being assigned to a waitlist group) high internal motivation did not predict significantly more symptom change. Only for students in a self-guided, skills-based online intervention did internal motivation predict greater symptom improvement. A strength of our investigation is a set of *post hoc* analyses which were conducted to rule out the possibility that the moderating effect of internal motivation was due to overlap with baseline severity. Based on these findings, it would appear that regardless of severity of symptoms, high internal motivation coupled with an intervention can lead to symptom improvement. An

additional strength of the current study was that we tested a measure of motivation that is standardized and based on theory. Confidence in treatment was not significantly predictive of symptom improvement. Additionally, external motivation also did not significantly predict symptom improvement. It is important to note that the external motivation TMQ subscale did not show adequate internal consistency, and as such, we cannot confidently make conclusions about external motivations' role as a moderator of improvement. Results regarding external motivation should be interpreted with caution and must be replicated in other studies using a more reliable measure of external motivation. Ultimately, the current study provides support for internal motivation as a moderator of self-guided online intervention effects on anxiety, depression, and total symptom outcomes.

Exploratory analyses produced a number of significant results that contextualize and elaborate upon our primary findings. First, we found that internal motivation – but not the other two tested moderators – predicted more initiation of services. For students in the intervention condition, those with high internal motivation were more likely to set up their accounts as well as more likely to initiate other services on campuses by the time of post-intervention. For students in the waitlist group (i.e., without access to the online intervention), those with high internal motivation were even more likely to initiate other campuses services, which we might understand as other service initiation in lieu of access to the online program. This result further supports our assertion that internal motivation is not sufficient on its own: motivated individuals must have access to an evidence-based intervention in order to improve. Second, the three motivation-related constructs as measured at baseline differentially correlated with post-intervention variables: intervention adherence was correlated positively with internal motivation and negatively with external motivation; intervention satisfaction was correlated positively with internal motivation, and confidence in treatment; and self-report of more intervention barriers correlated negatively with confidence in treatment. These divergent correlational results hint at potential mechanisms through which internal motivation

eventually translates into great symptom reduction. These exploratory results should be replicated by future research that aims to specifically examine associations between internal motivation, service initiation, adherence, and treatment satisfaction.

Comparison with Prior Work and Future Directions

As reviewed in the introduction, prior studies examining the moderating role of motivation in online mental health interventions have produced conflicting results. Some studies found higher motivation predicted more symptom improvement, [19] others found higher motivation predicted less symptom improvement, [21,22] and others still found evidence of no significant moderation [19,22]. Across these studies, the various motivation measures included items reflective of internal and external motivation. While the external motivation subscale had low internal consistency, the measure and its' supporting theory still conceptually separated two conflated constructs of motivation. By discretely testing internal and external motivation in the current study, the emergence of only one moderator as significant – internal motivation – could help explain mixed findings from previous studies as being related to how "motivation" is defined. Another consideration is that our sample consisted of a student population only which may explain the discrepancy in our results compared to prior research. Future research is encouraged to examine motivation related constructs in larger and more diverse samples. If the findings of the current study are generalizable to other trials of self-guided online mental health interventions, then researchers should consider how users with internal motivation might be driving results. Although the intervention produced small effects overall – which is consistent with other self-guided digital interventions [42] – it produced moderate effects for self-motivated individuals. As such, moderator results suggest that overall effects are likely driven by the subset of individuals with high internal motivation. This interpretation is also supported by the finding that students in the waitlist condition with high internal motivation were likely to initiate other services, as well as the finding that high internal motivation was more likely among students who have previously or currently used resources. We recommend that researchers

conducting such online intervention trials measure baseline internal motivation and test it as a moderator of intervention response.

This study improves upon previous research by controlling for baseline symptom severity. First off, we would expect those individuals with higher baseline severity to naturally have lower scores at the next assessment period, due to the statistical phenomenon of regression toward the mean. Next, symptom severity has been found as a common moderator of effects in other online intervention research [43]. Moreover, symptom severity could be a confound or pre-requisite of motivation. In terms of the confound risk, there are example items on our selected internal motivation subscale that are conflated with symptom severity (e.g., "I feel so guilty about my problems …") [17]. We do not believe that there was a fully confounded relationship in the current study, as internal motivation predicted greater intervention response over and above baseline symptom severity and regardless of condition. However, while severity does not itself guarantee higher internal motivation for an intervention, it may be a pre-requisite in that having some level of symptoms is likely necessary for recognizing a need for change. Thus, it is important to control for baseline severity using measures that separate motivation-related constructs from severity, in order to understand their unique contributing roles in intervention response.

Overall, the benefits of intervention uptake and subsequent symptom improvement were primarily experienced by internally motivated individuals. On one hand, these findings suggest that campus services should strategically recruit and target those with internal motivation. On the other hand, a different challenge then remains: how do we help individuals with lower internal motivation at baseline? To develop strategies that enhance baseline internal motivation, future studies could explore predictors of internal motivation to participate in an online intervention. First, why are certain populations more likely to have higher internal motivation? Second, how might intervention design features facilitate higher internal motivation? In order to maximize improvement on online interventions, we must first understand and cultivate characteristics such as internal motivation in

order to support the success of individuals who might otherwise struggle to improve.

Finally, it would be interesting to investigate why higher internal motivation translates to larger intervention effects. For example, internal motivation could lead to higher adherence (e.g., more frequent interaction with the platform), which could in turn lead to better improvement. This hypothesis is feasible, given studies suggesting a dose-response relationship for online mental health interventions [44, 45]. Moreover, prior research has identified variables similar to internal motivation as significant predictors of adherence to online mental health interventions, including: intrinsic motivation [22]; internal locus of control [46]; expected behavioral ability to complete program [47,48]; and self-identification with "preparation" or "action" stages of change [49]. Our exploratory findings already provide preliminary support for the positive relationship between *internal* motivation and adherence, in contrast to *external* motivation which was correlated with lower adherence. Such findings suggest not only the importance of differentiating between various types of motivation, but also, that it would be worthwhile for future research to test adherence as a mediator between internal motivation and intervention effects.

Limitations

Despite the novelty of differentiating and examining motivation-related constructs as they relate to intervention response, the current study has some limitations worthy of consideration. In line with the "law of attrition" and a fundamental challenge of online intervention trials, [8] a significant limitation in the study is the low post-intervention completion rate (i.e., 39% attrition). As such, results may be pertinent to the subsample of post-treatment survey completers, limiting the generalizability of our results to the overall sample. Another limitation in our study was that external motivation was not reliably measured using the TMQ subscale. As such, the null moderation results of external motivation in the current study cannot be confidently interpreted. Future research is encouraged to explore other more reliable measures of external motivation, and to examine its relationship with improvement on self-guided online interventions. Next, the use of a waitlist

condition may have caused some issues. Those assigned to the waitlist condition were notified that they would not be able to access the intervention until the following academic term, which could have been experienced as insensitive or frustrating. If this negative experience worsened their symptom severity, or facilitated the increased accessing of other campus services, then it could have contributed to the relative success of the intervention group. An alternative to this waitlist condition would be an active control group such that participants can interact with some kind of parallel platform or materials. A final limitation is generalizability of our results. The study recruited university students, a population that may have higher internal motivation to engage with new learning of any kind; as such, results may not translatable to non-student populations. Future research should aim to replicate these findings in larger and more diverse populations. Additionally, our online intervention was aimed at preventing symptoms of depression and anxiety; thus results may differ in the context of treatment-level interventions or interventions targeting symptoms that have less overlap with motivational constructs.

Conclusion

Self-guided online programs are often beset with low intervention completion and adherence, whether it be no longer accessing the online program midway through delivery or only spending a few minutes passively viewing the intervention content without practicing the learned material [10, 50]. Given that the demand of self-motivation has been identified as a main barrier to the online intervention tested in this study [12], examining various forms of motivation as potential moderators of intervention effects was warranted. Our findings indicate that a combination of (a) high or moderate internal motivation and (b) access to a self-guided intervention lead to symptom improvement. Considering the implication of internal motivation on intervention outcomes, it is important to understand the characteristics of participants that may best benefit from these interventions, and perhaps even create trainings or pre-intervention courses to cultivate such characteristics. Additional variables related to motivation such as baseline severity, adherence and

motivation-related constructs that reflect individual differences must be explored in order to better understand the moderating role of motivation on an online intervention. In conclusion, understanding characteristics that moderate improvement will assist campus services in targeting individuals that can benefit from online interventions and can inform treatment strategies that maximize intervention effects.

Data Availability
The dataset used to conduct these secondary analyses is available at https://osf.io/7vfsz

Conflicts of Interest
Leslie Rith-Najarian has financial interest in the success of StriveWeekly.com. Dr. Rith-Najarian is the CEO of Strive Weekly Inc, a company that offers Striveweekly.com commercially. Dr. Rith-Najarian also owns the copyright for Striveweekly.com registered with the United States Copyright Office. The authors have no other conflicts of interest to disclose.

Abbreviations
CBT: Cognitive Behavioral Therapy
DASS-21: Depression, Anxiety, and Stress Scale
LME: Linear-Mixed Effects
RCT: Randomized controlled trial
SDT: Self-determination Theory
TMQ: Treatment motivation questionnaire

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Supplementary Files

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CONSORT (or other) checklists

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