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MAJOR ARTICLE

Comparison of two approaches to prevention of mental health problems in college students: Enhancing coping and executive function skills

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ABSTRACT

Objective: College students face a significant number of stressors, increasing risk for internalizing and externalizing psychopathology. The current study examines two promising avenues of intervention aimed to reduce stress and prevent psychopathology in this population: a coping skills group and a cognitive training program. **Participants:** 62 undergraduate students from two universities were recruited from 2013 to 2015. **Methods:** Students were randomized to a 6-week coping skills group or cognitive training program and completed measures of stress, coping, executive function, and symptoms of anxiety, depression and Attention-Deficit Hyperactivity Disorder (ADHD) at pre- and post-intervention. **Results:** Participants in both conditions reported significant decreases in social stress, executive function difficulties, and anxiety symptoms post-intervention. Students in the cognitive program improved significantly more on measures of behavior regulation and ADHD symptoms compared to the coping group at post-intervention. **Conclusions:** Brief stress management interventions targeting coping and executive function may benefit college students at risk for psychopathology.

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College life presents students with a number of new challenges, including increased academic demands, diminished contact with family members, interpersonal stress, and for many students, financial stress.¹ Stress is one of the most potent risk factors for mental health problems across the life span.^{2,3} Studies have found evidence for main effects of stress on the development of depression as well as interactions between stress and genetic vulnerabilities as sources of risk for both depression and anxiety.^{4,5} However, research has also shown that depression and anxiety can arise in the absence of stress.⁶ Further, symptoms of depression and anxiety can lead to higher levels of stress.⁷ Recent large-scale surveys indicate that 80% of college students frequently or sometimes experience “daily stress”⁸ and that a quarter of students report that stress has hurt their academic performance, including lower grades or dropped courses.⁹ Furthermore, college students experience high rates of stress-related mental health problems, including depression and anxiety,⁴ and mental health problems are a leading cause of withdrawal from college.⁵

Research on interventions to reduce or prevent stress-associated risk for psychopathology in college students is wide ranging. This includes both narrowly focused interventions designed to teach single specific skills such as mindfulness, cognitive reappraisal, and problem-solving^{6,7} and broadly focused interventions to build multiple skills.^{8,9} Across modalities, interventions in college students have shown promise in reducing symptoms of anxiety, depression, and general distress.^{10,11} Despite this evidence and availability of on-campus counseling, many students do not obtain needed services to prevent or treat mental health problems.¹² Therefore, interventions to reduce stress and risk for mental health problems are a high priority.

Two promising avenues for preventive interventions in college students include the development of skills to cope with and regulate emotions in response to stress and the enhancement of executive function skills that are necessary for managing stress and regulating emotions. Coping is defined as conscious purposeful efforts to regulate emotion, cognition, behavior, physiology, and the environment in response to stress.¹³ Drawing on the

work of Weisz et al.¹⁴, a control-based model of coping and emotion regulation organizes responses into three distinct categories: primary control coping (ie, changing the stressor or acting directly upon one's emotions), secondary control coping (ie, adapting to the stressor), and disengagement coping (ie, avoiding the stressor). The ability to move flexibly between coping responses depending on the situation may be most adaptive for coping with a broad range of stressors.¹⁵ Primary and secondary control coping are associated with decreased risk, and disengagement coping is associated with greater risk for symptoms of anxiety and depression in college students^{16,17} and other at-risk populations.¹⁸ Randomized controlled trials have shown that interventions can enhance skills to cope with stress and regulate emotions and that changes in these skills mediate intervention effects on depression and anxiety.^{19,20}

Executive function skills are defined as “a set of general-purpose control mechanisms, often linked to the prefrontal cortex of the brain, that regulate the dynamics of human cognition and action.”²¹ (p.8) Executive function skills include working memory/updating, attentional control/inhibition, and shifting/cognitive flexibility, and are linked to mental health, success in school, and cognitive, social, and psychological development.²² For example, depressed adults demonstrate impairment across areas of executive functioning and poor executive functioning is associated with sub-threshold levels of depressive symptoms.²³ Executive function deficits predict increases in depressive symptoms and are associated with greater symptoms of anxiety.²⁴ Further, these deficits are linked to symptoms of Attention-Deficit Hyperactivity Disorder (ADHD) and anxiety in college students.²⁵

A promising but still controversial approach to preventing mental health problems is through computerized cognitive training programs designed to improve executive function skills, with most programs targeting working memory. These programs have shown evidence of near-transfer effects on executive function skills including working memory and attentional control^{26,27} and have demonstrated some evidence of transfer effects to ADHD^{28,29} and depressive symptoms,³⁰ including in college student samples. In a recent meta-analysis, Melby-Lurvag and Hulme³¹ concluded that working memory training produces short-term and specific training effects that may not generalize across other domains. However, more research is needed to explore the potential of these programs to impact other skills that require executive functions, including primary and secondary control coping.

There are clear links between coping and executive function skills, such that executive function skills provide

a foundation for the ability to cope effectively with stress.¹⁶ For example, impairment in working memory is associated with difficulties in the use of cognitive reappraisal to cope with stress.³² In addition, laboratory studies of emotion regulation in adults demonstrate associations among the use of reappraisal and activation in prefrontal regions associated with executive function skills.^{33,34} This suggests that interventions to teach coping skills may also improve executive function skills and cognitive training interventions could contribute to improvements in coping skills.

The current study examined the feasibility and acceptability of two interventions for preventing mental health problems in college students, one designed to enhance coping skills and the second, an on-line cognitive training program. First, we examined rates of compliance and levels of satisfaction with the interventions. Second, we hypothesized that both intervention groups would demonstrate significant decreases in stress following the 6-week programs. Third, we hypothesized that both programs would lead to significant increases in primary and secondary control coping, decreases in disengagement coping, and improvements in executive function skills from pre- to post-intervention. Lastly, we hypothesized that both groups would report significantly fewer symptoms of anxiety, depression, and ADHD following intervention.

Method

Participants

Participants included 62 full-time students enrolled in two universities in the Southeast and mid-Atlantic regions. Age of students ranged from 18 to 22 years ($M = 19.67$, $SD = 1.02$; 81.8% female). Participants were 72.7% Euro-American, 9.1% African-American, 12.1% Asian, 4.5% mixed, and 1.5% other; 90.9% were non-Hispanic. Students completed measures prior to randomization and immediately post-intervention (6-weeks post-baseline assessment). Due to constraints of university semester schedules, long-term follow up data were not obtained for the majority of the sample and therefore are not included in the current study.

Measures

Stress

Participants completed the Perceived Stress Scale (PSS),³⁵ a 10-item measure of perceived stress in the prior month. Example items such as, “how often have you been upset because of something that happened unexpectedly” and “how often have you found that you

could not cope with all the things you had to do” were endorsed on a five-point scale from “never” to “very often.” Participants also completed the Responses to Stress Questionnaire – Social Stress Version (RSQ-SSV).^{16,36} The RSQ-SSV includes 14 items that assess how often students have experienced social stress in the past 6 months. Items such as “Having trouble making new friends/meeting people,” and “Being teased/hassled by other people,” were endorsed on a 4-point scale ranging from “not at all” to “very often.” For both stress measures, total scores represent the sum of responses. Internal consistency for the PSS was $\alpha = .86$ and for the RSQ social stress items was $\alpha = .75$.

Coping

The RSQ-SSV includes 57 items that reflect five factors of controlled and automatic responses to stress: three coping factors (primary control engagement coping, secondary control engagement coping, disengagement coping), and two involuntary stress response factors (involuntary engagement/stress reactivity and involuntary disengagement).³⁷ The current study examined the three coping factors. The RSQ has been used to assess coping in response to social stressors with college students in the United States and abroad.^{16,37} To control for response bias and individual differences in base rates of item endorsement, proportion scores were calculated for the three coping factors.³⁸ Internal consistencies for the current sample were $\alpha = .80$ for primary control coping, $\alpha = .84$ for secondary control coping, and $\alpha = .67$ for disengagement coping.

Executive function

Students completed the Behavior Rating Inventory of Executive Function-Adult version (BRIEF-A),³⁹ a self-report measure of executive function skills (e.g., inhibition, working memory, emotional control, planning/organization). The nine subscales on the BRIEF form two broad index scores, the Behavioral Regulation Index (BRI) and Metacognition Index (MI) as well as a total score, the Global Executive Composite Index (GEC), with higher scores indicating more difficulties with executive functioning. The BRIEF has adequate internal consistency, test-retest reliability, and convergent validity with other measures of executive function.⁴⁰

Students also completed two tests from the Delis-Kaplan Executive Function Scales (D-KEFS)⁴¹: the D-KEFS Color-Word Interference test, a measure of shifting and inhibition; and the D-KEFS Tower Test, a measure of cognitive flexibility and planning. Age-based scaled scores were calculated, with higher scores indicating better executive functioning. The D-KEFS has acceptable test-retest reliabilities in adults, and low-to-

moderate correlations with other direct measures of verbal ability and cognitive flexibility⁴¹ and self-reported executive functioning.⁴²

Mental health symptoms

The Patient Health Questionnaire (PHQ)⁴³ is a self-report measure of mental health disorders. The current analyses examined two of the six PHQ modules: depression (9 items) and generalized anxiety disorder (7 items). Responses on each module are summed to yield a severity rating, with established cutoffs indicating mild, moderate, moderately severe, and severe symptom levels. The PHQ, particularly the depression module, has been utilized in college samples to document rates of mental health disorders⁴⁴ and identify those in need of mental health treatment.⁴⁵ The reliability and validity of the PHQ have been demonstrated in a variety of large samples.⁴³ Internal consistencies for the current sample were $\alpha = .69$ for depression symptoms and $\alpha = .69$ for anxiety symptoms.

ADHD symptoms were assessed using the Adult ADHD Self-Report Scale (ASRS).⁴⁶ The 6-item measure assesses the frequency of these symptoms in the past 6 months. Items such as “When you have a task that requires a lot of thought, how often do you avoid or delay getting started?” are endorsed on a 5-point scale from “never” to “very often.” The ASRS has good reliability and validity,⁴⁷ including as a screener for ADHD in college samples.⁴⁸ Internal consistency for this scale was $\alpha = .80$ in the current sample.

Procedure

Students were recruited from two university campuses in the Southeastern and Mid-Atlantic regions of the United States. Students were recruited through a number of methods, including (a) email to student list serves, (b) student wellness and activity fairs, (c) introductory psychology courses, (d) partnership with university counseling centers, and (e) fliers posted in campus areas (ie, dining halls, student dorms, and class buildings). The study was reviewed and approved by institutional review boards at both sites, and informed consent was obtained from participants. Because this study was focused on the prevention of mental health problems, students were ineligible if they: (a) indicated they had a diagnosis of Bipolar Disorder, Schizophrenia, or Autism Spectrum Disorder and/or (b) endorsed clinically significant levels of symptoms of anxiety, depression, or eating disorders on the PHQ.

Two hundred twenty interested participants were screened via phone to determine initial eligibility criteria. Eight students were excluded based on the phone screen;

77 additional students declined to participate in the study further; and the remaining 135 students completed on-line questionnaires assessing their stress levels, coping, and mental health symptoms. Based on the on-line questionnaires, 118 were eligible to participate in an in-person assessment of executive function skills and 105 completed that assessment. Of these eligible participants, 33 were assigned to the coping skills group and attended at least three sessions, and 33 were assigned to cognitive training and completed at least three sessions (interventions described below); these form the sample for the current study. Six students who were eligible for the study dropped out before beginning the intervention or before completing at least three sessions. Initial assignment to intervention condition was block randomized in groups of eight students; ie, every block of eight students were randomized to the same condition (coping skills group vs. cognitive training program). However, because this was a pilot study, participants who were assigned to the coping skills condition during randomization but were unavailable during the group meeting time were re-assigned to the cognitive training condition. The final sample for analyses in the current study included 30 students in the coping skills group and 32 students in the cognitive training group (total $N = 62$).

An additional 17 students were assigned to a combined condition involving both interventions simultaneously, and 16 students were assigned to a written-information control condition. However, because these conditions were much smaller than the two primary intervention conditions, and recruitment into these conditions did not always occur during the same semesters as recruitment into the two primary conditions, those participants are not included in the present study analyses.

Coping skills group

The coping skills group intervention is a manualized program consisting of six weekly sessions. Groups comprised 6–8 students and were led by 1–2 group leaders, including doctoral students in clinical psychology and licensed clinicians from the participating university's counseling centers. The primary goal of the coping skills intervention was to educate students about stress and health and facilitate the development of adaptive coping skills to manage stress (Table 1 for specific session content). Based on previous research on interventions to teach coping skills,^{19,49} the program taught four skills to manage both controllable and uncontrollable stress, including two primary control coping skills (problem solving, expressive writing) and two secondary control coping skills (mindful acceptance, cognitive reappraisal). The skills were taught through didactic instruction,

modeling, role-playing, and homework assignments. Intervention fidelity was maintained through use of a detailed written manual, weekly supervision at each site and weekly cross-site project management calls.

Cognitive training program

The cognitive training intervention utilized an adaptive on-line cognitive training program, Lumosity.⁵⁰ The researchers selected games that fit into one of three executive function categories: working memory, attention control/inhibition, or shifting/cognitive flexibility. Each session trained students using three games tapping each of these three areas of executive function for a total of nine games per session. Students in the intervention were instructed to complete one 15- to 20-minute session per day, 5 days per week for 6 weeks (30 sessions total). Examples of games include “Memory Match,” which aimed to train working memory by requiring participants to remember which squares on a grid had been highlighted; and “Ebb and Flow,” which trained attention control/inhibition and shifting by requiring participants to use the arrows on the keyboard to indicate the direction in which leaves were either moving or pointing (up, down, left, right). Doctoral students in clinical psychology served as cognitive training “coaches.” Cognitive training coaches tracked participant's progress through the program each week, and called participant's weekly to review their progress and problem solve any difficulties completing the program.

Results

Feasibility and acceptability of the intervention

Compliance with both intervention conditions was high: students assigned to the coping skills program attended an average of 5.75 of 6 sessions (96%) and completed or attempted an average of 4.1 of 5 (82%) weekly homework assignments; 12 students who missed a session received one individual make-up session, which is included in this attendance average. Students assigned to the cognitive training program completed an average of 26.7 of 30 (89%) assigned sessions. Qualitative ratings collected following the intervention indicated that students found the coping skills and cognitive training useful. For example, when participants in the coping skills group were asked what they liked most about the group, 72% mentioned the format and 60% listed one or more specific skills. When asked what was most helpful about the program, 35% mentioned mindfulness, 20% problem-solving, 20% expressive writing, and 15% cognitive restructuring. Fifty-five percent said the homework load was “reasonable.” When those assigned to the cognitive

Table 1. Description of the coping skills and cognitive training intervention conditions.

Coping skills group intervention		
	Session topic	Homework
Session 1	Stress and Emotions: Introduction to the group, psycho-education about stress and emotions, effects of stress on mental and physical health, identifying stressors, and distinguishing between controllable and uncontrollable sources of stress.	-Rate My Day to track daily emotions and stressors -Stress Bubble Sheet to practice identifying stressors and the thoughts, feelings, behaviors, and physiological responses to stress
Session 2	Expressive Writing: review emotions in response to stress, introduction to expressive writing to regulate negative emotions, practice expressive writing in session.	-Rate My Day -Expressive writing practice three times for 15 minutes each time
Session 3	Problem-Solving: introduction to problem-solving for controllable stressful situations, apply problem-solving to controllable social, academic, and family-related stressors.	-Expressive writing practice -STEPS for Problem-Solving worksheet
Session 4	Mindful Acceptance: Introduction to acceptance and mindfulness, practice mindful acceptance for uncontrollable stressors.	-STEPS for Problem-Solving worksheet -Mindfulness practice every day for 10 minutes
Session 5	Cognitive Reappraisal: Introduction to cognitive reappraisal/positive but realistic thinking, practice cognitive reappraisal for uncontrollable stressors.	-Mindfulness practice -Tracking My Thoughts worksheet to practice identifying negative thoughts and generating alternative thoughts
Session 6	Integration: Review and integration of skills for controllable and uncontrollable stress, discussion of how to apply skills to future stressors.	N/A
Cognitive training intervention		
Executive function targeted	Games assigned	
Working memory	Pinball Recall, Memory Matrix, Memory Match Overload, Memory Lane, Rhyme Workout, Monster Garden	
Attention/inhibition	Lost in Migration, Lost In Migration (version 2), Playing Koi, Color Match, Color Match (version 2), Robot Factory	
Cognitive flexibility/shifting	Train of Thought, Brain Shift Overdrive, Disconnection, Ebb and Flow, By the Rules, Route to Sprout	

Note. Students in the cognitive training program played 9 games per session (approximately 15–20 minutes per session), 5 days per week; each session included 3 games targeting working memory, 3 games targeting attention/inhibition, and 3 games targeting cognitive flexibility/shifting.

training program were asked what they liked the best, 45% mentioned the variety of games, 29% said they enjoyed playing in the games general, and 23% mentioned a specific game. Overall, 86% of participants said they would recommend the intervention to a friend.

Correlations among stress, coping, executive functioning, and symptoms

Table 2 shows correlations among key study variables. As expected, the two measures of stress were significantly positively correlated, the three symptoms measures were significantly correlated, and the three coping scales were significantly correlated. The BRIEF index scores were significantly and positively correlated with one another, whereas among the D-KEFS scores, only the two scores derived from the Color-Word test were correlated. In addition, the BRIEF was not correlated with the D-KEFS, with the exception that D-KEFS Color-Word Condition 4 scores were positively correlated with BRIEF MI scores.

Looking across constructs, both social and perceived stress were significantly correlated with coping,

symptoms of depression and anxiety, and most of the BRIEF scales, but not the D-KEFS scales. Coping was correlated with symptoms of depression and anxiety; however, only primary control coping was significantly correlated with ADHD symptoms. Primary and secondary control coping were generally correlated with the BRIEF scales, but were not correlated with the D-KEFS scales. Lastly, the D-KEFS scales were not correlated with any symptom measure, whereas the BRIEF scales were significantly correlated with all symptom measures.

Pre-post changes in stress, coping, executive functioning, and symptoms

A series of repeated measures analyses of covariance (ANCOVA) were conducted in which pre- and post-intervention scores for stress, coping, executive functioning, and mental health symptoms served as within-subject factors; and intervention group (coping skills group versus cognitive training) served as the between-subject factor; and site and gender served as covariates (seven dependent variables showed differences on site or gender in separate analyses). As hypothesized, significant main effects of time were observed for social

Table 2. Correlations among stress, coping, executive function, and symptoms at initial assessment.

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Perceived stress	—												
2. Social stress	.40***	—											
3. Primary control coping	-.45***	-.50***	—										
4. Secondary control coping	-.57***	-.65***	.46***	—									
5. Disengagement coping	.43***	.49***	-.65***	-.48***	—								
6. D-KEFS Color-Word 3	-.20	.05	.05	.15	.00	—							
7. D-KEFS Color-Word 4	.02	.08	-.03	.05	.05	.46***	—						
8. D-KEFS Tower Test	.12	.19	-.09	-.13	.08	-.04	.22	—					
9. BRIEF BRI	.45***	.31*	-.36**	-.38**	.05	-.16	.01	.07	—				
10. BRIEF MI	.36**	.14	-.17	-.23	.07	-.21	-.26*	.06	.65***	—			
11. BRIEF GEC	.41***	.23	-.28*	-.32**	.06	-.21	-.16	.07	.87***	.94***	—		
12. Depression Symptoms	.62***	.39***	-.40***	-.40***	.36**	-.08	.04	.06	.31**	.37**	.38***	—	
13. Anxiety Symptoms	.54***	.32**	-.39***	-.45***	.22	-.05	-.04	-.02	.38**	.43***	.44***	.76***	—
14. ADHD Symptoms	.13	.12	-.40***	-.16	.14	-.21	-.15	.05	.49***	.61***	.62***	.28*	.36**

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

D-KEFS = Delis-Kaplan Executive Function System; BRIEF = Behavior Rating Inventory of Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite; PHQ = Patient Health Questionnaire. We applied the False Discovery Rate (FDR)^{52,53} correction for bivariate correlation analyses. Prior to the FDR correction, 45 correlations are significant at the $p < .05$ level (correlations $r = .26$ or higher are significant). With the FDR correction, 42 correlations remained significant at the $p < .05$ level (correlations $r = .31$ or higher are significant). Findings in the table are presented without the FDR correction. Using the more conservative Bonferroni correction approach, 39 correlations remained significant at the $p < .05$ level (correlations $r = .36$ or higher are significant).

stress, all executive functioning scores including the D-KEFS and BRIEF, and symptoms of anxiety (Table 3). In all cases, the pattern of scores indicated that the sample reported less stress, improved executive functioning, and less anxiety from pre- to post-intervention. Contrary to hypotheses, significant main effects of time were not observed for coping or symptoms of depression or ADHD. Further, significant main effects of group were not observed for any variable. However, significant group x time interactions were evident for BRIEF BRI scores and ADHD symptoms. Planned comparison t -tests indicated that only participants assigned to the cognitive training program reported significant improvements on the BRIEF BRI and ADHD symptoms. Effect sizes for within-group changes were generally in the medium range for the cognitive training condition ($d_{\text{BRIEF-BRI}} = -.67$, $d_{\text{ADHD}} = -.31$) compared to small effect sizes for the coping skills group ($d_{\text{BRIEF-BRI}} = -.17$, $d_{\text{ADHD}} = -.08$).

Comment

Preliminary analyses of the feasibility and acceptability of two interventions revealed participants assigned to both conditions found them to be useful, completed the majority of intervention sessions, and most would recommend the program to a friend. Further, the study demonstrated associations between measures of coping and executive function, coping and symptoms of psychopathology, and executive function and symptoms of psychopathology. These findings are consistent with those of prior research, demonstrating links between stress, coping, executive function, and mental health.^{16,23}

As hypothesized, students in both conditions demonstrated significant decreases in social stress from pre- to post-intervention, suggesting that both intervention modalities may be beneficial in reducing stress in college students. Further, consistent with hypotheses, students in the two intervention conditions improved in their executive function skills from pre- to post-intervention on both performance-based and self-report measures of executive function. However, students in the cognitive training intervention demonstrated significantly *greater* reductions in problems with behavior regulation as compared to students in the coping skills intervention. The findings support the hypothesis that students in the cognitive training intervention would show improvements in executive function skills and are consistent with prior studies of cognitive training that show near-transfer effects on executive function tasks.³¹ These findings support prior research demonstrating links between coping and executive function,^{16,32} and suggest that interventions targeting coping skills may have a dual effect on executive function skills.

Contrary to hypotheses, participants in the coping skills and cognitive training groups did not report significant changes in coping from pre- to post-intervention. Given that the coping group program was very brief, requiring that students learn a new skill each session, additional sessions may have been necessary to produce improvements in coping. Notably, in a depression prevention program targeting secondary control coping skills in at-risk children and adolescents from which this program was designed, improvements in coping did not appear until 4 months after the acute phase of the intervention had been completed.¹⁹ Therefore, it is plausible that

Table 3. Repeated measures analysis of covariance comparing changes in stress, coping, executive functioning, and symptoms for coping and lumosity groups, controlling for association of gender and site.

Variable	Coping Group (N = 30)		Lumosity (N = 32)		F _{time} (p)	F _{group} (p)	F _{group x time} (p)
	Pre Mean (SD)	Post Mean (SD)	Pre Mean (SD)	Post Mean(SD)			
Perceived stress	18.10(7.06)	16.34 (6.06)	17.78 (4.33)	16.28 (5.23)	3.42(.07)	.28(.60)	.02(.88)
Social stress	8.14(5.36)	5.21(3.76)	8.52 (5.66)	5.55 (4.82)	21.74 (<.001)	.59(.45)	.00(.98)
Primary coping	0.25 (0.09)	0.25 (0.08)	0.24 (0.09)	0.24 (0.08)	.02(.89)	.02(.90)	.04(.84)
Secondary coping	0.28 (0.12)	0.30 (0.11)	0.28 (0.09)	0.32 (0.16)	2.36(.13)	.02(.89)	.26(.61)
Disengagement coping	0.13 (0.06)	0.13 (0.06)	0.13 (0.05)	0.13 (0.05)	.40(.53)	.00(.98)	.06(.80)
D-KEFS C-W3	11.78 (2.17)	12.59 (1.90)	11.84 (1.85)	13.19 (2.06)	35.45 (<.001)	1.44 (.23)	2.15(.15)
D-KEFS C-W4	11.72 (1.95)	13.00 (1.67)	12.09 (1.61)	13.00 (1.83)	55.72 (<.001)	2.53(.12)	1.64(.21)
D-KEFS tower	10.88 (2.64)	11.34 (2.46)	10.59 (2.82)	11.84 (2.32)	4.28 (.04)	.63(.43)	.89(.35)
BRIEF BRI	49.48 (9.34)	48.00 (9.05)	53.19 (6.75)	47.94 (8.90)	17.10 (<.001)	1.38(.25)	5.35 (.02)
BRIEF MI	52.71 (10.38)	51.16 (10.77)	53.22 (7.18)	49.69 (8.12)	11.84 (.001)	.23(.63)	1.80(.18)
BRIEF GEC	51.32 (10.44)	49.58 (10.46)	53.44 (6.39)	48.78 (8.19)	16.54 (<.001)	.76(.39)	3.43(.07)
PHQ depression	5.00 (3.42)	4.83 (3.79)	5.09 (2.91)	4.44 (3.40)	.92(.34)	.41(.53)	.31(.58)
PHQ anxiety	5.21 (3.22)	4.55 (3.04)	5.13 (2.60)	4.13 (3.13)	5.03 (.03)	.00(.96)	.22(.64)
ADHD	8.97 (5.27)	9.41 (5.75)	9.14 (4.67)	7.66 (5.03)	1.22(.28)	.23(.64)	4.24 (.04)

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

D-KEFS = Delis-Kaplan Executive Function System; C-W = Color-Word Interference Test; BRIEF = Behavior Rating Inventory of Executive Function; BRI = Behavior Regulation Index; MI = Metacognition Index; GEC = Global Executive Composite; PHQ = Patient Health Questionnaire.

We also analyzed results using the FDR approach as an alternative to control for Type I error.^{52,53} This method resulted in the following: prior to applying the FDR, the ANCOVAs produced eight significant main effects for *time* at the $p < .05$ level. With the FDR correction, six main effects for *time* remain significant (time effects for the D-KEFS Tower Test and PHQ GAD are no longer significant). Further, prior to the FDR correction, ANCOVAs produced two significant *group x time* interactions at the $p < .05$ level favoring the cognitive training condition. However, when the FDR correction is applied, these interactions are no longer significant. Findings in the table are presented without the FDR correction (but those findings significant with the FDR correction are noted in bold). In addition, using the more conservative Bonferroni correction approach, ANCOVAs produced similar results, in that six main effects for time remained significant, but no group \times time interactions were significant.

over longer term follow-up and more opportunity to practice these skills, students would begin to show improvement in both primary and secondary coping. In addition, the cognitive training program was brief, and long-term follow-up is needed to examine whether cognitive training program may improve coping skills over time.

Lastly, neither intervention condition produced significant decreases in symptoms of depression, but students in both programs reported significant decreases in anxiety from pre- to post-intervention. This may be in part due to low levels of anxiety and depression in the study sample, as those students who scored in the moderately severe to severe range on either symptoms were excluded from the study. Notably, in a study examining a preventive intervention for children of depressed parents, results showed that significant reduction in anxiety during the intervention phase preceded and predicted later changes in depressive symptoms.⁵¹ Finally, students in the cognitive training program showed significantly greater improvement in ADHD symptoms compared to students in the coping skills group. Research has demonstrated links between deficits in executive function and symptoms of ADHD, and preliminary evidence suggests that cognitive training programs can improve ADHD symptoms.^{25,28} Future research examining executive function as a potential mediator of changes in ADHD symptoms in cognitive training interventions will be important to clarify these relationships.

Limitations

First, the sample is predominantly female, and therefore findings may not generalize to a more heterogeneous sample of college students. Second, because the current study lacked a control group condition of adequate sample size, we cannot examine whether similar improvements in stress, anxiety, and executive functioning would have occurred in the absence of treatment. Further, long-term follow-up is needed in order to determine whether program effects may emerge later for the coping skills intervention, and whether effects of cognitive training were maintained over time.

Conclusions

Despite these limitations, the current study is the first comparison of the efficacy of two distinct interventions for college students, both of which can be feasibly implemented on college campuses. In addition, the study provides an opportunity to improve understanding of the associations among stress, coping, executive function, and symptoms of anxiety, depression, and ADHD in a sample of young adults. Findings support both avenues of intervention as viable opportunities to decrease stress and anxiety, and improve executive functioning, in college students.

Future research examining the effects of both coping skills and cognitive training interventions in high-risk samples, such as students reporting high levels of stress

or symptoms of psychopathology or youth exposed to chronic stress, will be important to better understand these interventions. Further, it will be important to examine the effectiveness of these approaches as compared to individual counseling offered at traditional college counseling centers to better understand the most efficient and effective ways to provide mental health services to college students. In addition, because emotions and symptoms of depression can arise independent of exposure to stress, research examining how individuals regulate emotions in the absence of stress and how interventions may improve coping or cognitive function in the absence of an identifiable sources of stress is needed. Lastly, future research should examine potential moderators of intervention effects in order to better tailor interventions to students who may benefit most.

Conflict of interest disclosure

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements, of the United States and received approval from the Institutional Review Board of Vanderbilt University and Loyola University Maryland.

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