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Anxious, but not depressive, symptoms are associated with poorer prospective memory performance in healthy college students: Preliminary evidence using the tripartite model of anxiety and depression

Marissa Ann Bowman[a], Tony J. Cunningham[b,c], Holly F. Levin-Aspenson[c], Andrea E. O'Rear[c], Joseph R. Pauszek[c], Stephanie Ellickson-Larew[c,d], Brandy S. Martinez[c] and Jessica D. Payne[c]

[a]Department of Psychology, University of Pittsburgh, Pittsburgh, PA, USA; [b]Division of Sleep Medicine, Harvard Medical School, Cambridge, MA, USA; [c]Department of Psychology, University of Notre Dame, Notre Dame, IN, USA; [d]Massachusetts Veterans Epidemiology Research and Information Center, Veterans Affairs Boston Healthcare System, Boston, MA, USA

ABSTRACT

Prospective memory (PM) – or memory for tasks to be completed in the future – is essential for daily functioning. Although depression and anxiety have been shown to impair PM performance, few studies have explored the relative contributions of different symptom domains. Here, we examined the relation between anxiety, depression, negative mood, and PM performance using the tripartite model. The tripartite model attributes the substantial overlap between anxiety and depression to general distress/negative affect. Twenty-seven non-diagnosed undergraduate participants first completed self-report measures of depression (Beck Depression Inventory-II), anxiety (Beck Anxiety Inventory [BAI], State Trait Anxiety Inventory [STAI]), and affect (Positive and Negative Affect Schedule). They were then given an event-based PM instruction to be completed during three ongoing cognitive tasks. Depressive symptoms and positive affect were unrelated to PM performance. Higher anxiety symptoms (BAI, $r = -0.62$; STAI, $r = -0.41$) and negative affect ($r = -0.45$) were associated with poorer PM performance, with anxiety doubling the variance explained over-and-above negative affect ($\Delta R^2 = 0.20$). These preliminary results suggest that anxiety symptoms may be uniquely related to impairments in PM function, and highlight the need for future studies to consider the individual contributions of symptoms to understand changes in cognition and behavior.

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Prospective memory; anxiety; depression; tripartite model

Introduction

The ability to remember to do something at the appropriate time in the future, or prospective memory (PM), is critical for daily living (McDaniel & Einstein, 2007). Difficulty in PM can have consequences for employment (e.g., missing a deadline) and health (e.g., failing to take medication). Individuals with anxiety and depression often experience these problems of daily living, with meta-analytic evidence demonstrating increased odds of absenteeism (Bhui, Dinos, Stansfeld, & White, 2012), and medication non-adherence (DiMatteo, Lepper, & Croghan, 2000). A small, but converging, literature has shown that individuals with anxiety and depression have impairments in PM, which may be one possible pathway for these results. Developing a better understanding of the relationship between anxiety, depression, and PM is thus important for improving both cognitive and functional outcomes.

Anxiety and depression have been individually linked to poorer PM performance in laboratory studies. For the reader's convenience, we have summarized all extant studies examining the association between depression, anxiety, and/or mood and PM performance in Table 1. These laboratory studies instruct participants to respond differently at a certain occasion (event-based task) or at a predetermined time point (time-based task). Prospective memory tasks may also vary as a function of the focality of a cue – focal task cues are processed during the ongoing task (e.g., the ongoing task is to count the number of vowels in each word, and the focal task is to respond differently when three letter "E's" appear), whereas non-focal task cues are not (e.g., in the same ongoing task, the non-focal task is to respond differently when the word is a verb; Altgassen, Kliegel, & Martin, 2009). One study showed that high state anxiety (how anxious a person feels now), but not trait anxiety (how anxious a person *generally* feels), was associated with poorer performance on a focal PM task (Harris & Cumming, 2003). In another study, both state and trait anxiety were negatively associated with subjective reports of PM ability (e.g., "Do you forget appointments if you are not prompted by someone else or by a reminder such

CONTACT Jessica D. Payne Jessica.Payne.70@nd.edu University of Notre Dame, Haggar Hall, Room 122-B, Notre Dame, IN 46556, USA
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Table 1. Prospective memory studies with measures of depression, anxiety, and/or mood.

Study	Clinical symptom(s)	Measure of symptom	Ongoing task	Prospective memory task	Results (separated by task type)
Altgassen, Kliegel, & Martin, 2009	Depression; adults with or without diagnosed depression	Diagnosis of major depressive disorder from Structured Clinical Interview (SCID)	Count the number of vowels in word-pairs to determine which word has more vowels	*Event-based, focal task*: Indicate when one of the words has three e's *Event-based, non-focal task*: Indicate when one of the words is a verb	*Focal task*: no significant difference between depressed and non-depressed *Non-focal task*: Depressed individuals performed worse than non-depressed
Altgassen et al., 2011	Depression; adults with or without diagnosed depression	Diagnosis of major depressive disorder from SCID; Beck Depression Inventory (BDI)	Determine which of two words belonged to a category (semantic categorization task)	*Event-based, focal task*: Indicate if one of the words was on a cued list presented at beginning of study	*Event-based task*: Depressed individuals performed worse than non-depressed, but only for positively-valenced stimuli; depressed individuals needed more repetitions of the cued word list at encoding
Arnold et al., 2015	Depression, anxiety; non-clinical undergraduates	BDI-II, Hospital Anxiety and Depression Scale (HADS), State Trait Anxiety Inventory (STAI)	Identify whether a colored word matches the color of previously presented rectangles	*Event-based, non-focal task*: Indicate if one of the colored words was on a cued list presented at the beginning of the study	*Prospective component*: Individuals with high state anxiety performed worse than those with low state anxiety; no significant difference for depressed compared to non-depressed *Retrospective component*: no significant difference for anxiety and depression
Cuttler & Graf, 2008	Depression, anxiety, checking compulsions; non-clinical undergraduates	BDI, STAI	Determine if a letter string is a word or non-word (lexical decision-making task)	*Event-based, non-focal task*: Ask the experimenter for the return of a personal belonging at the end of the task *Subjective report of PM*: Self-ratings on a questionnaire of PM ability	*Activity-based task*: No significant association with depression, state, trait anxiety *Subjective report of PM*: Depression, state, and trait anxiety were individually associated (not included in one model).
Harris & Cumming, 2003	Anxiety; non-clinical undergraduates	STAI	As words are read aloud, generate a word that pairs thematically with each word (word-pair associates)	*Event-based, focal task*: Indicate if the word was presented on a cued list presented at beginning of study by writing the word instead of a paired word	*Prospective component*: Individuals with high state anxiety performed worse than those with low state anxiety; no significant association with trait anxiety *Retrospective component*: No significant association for state or trait anxiety
Harris & Menzies, 1999	Depression, anxiety, stress; non-clinical undergraduates	Depression, Anxiety and Stress Scales (DASS)	Generate word-pair associates	*Event-based, focal task*: Indicate by writing a symbol if word is a piece of clothing or a part of the human body	Anxiety was a significant predictor of performance, after adjustment for depression and stress
Kliegel et al., 2005	Induced negative or neutral mood; non-clinical undergraduates	Six-minute long video clips	Indicate if animal word was the same as that presented two stimuli previously (n-back)	*Time-based*: Press a target key every one minute	*First half of the task*: Individuals in a negative mood performed worse than those in a positive mood *Second half of task*: No significant difference as a function of mood
Kliegel & Jäger, 2006	Depression, anxiety; non-clinical undergraduates and healthy community-dwelling volunteers	HADS	Indicate if a picture matches the one shown two stimuli previously (n-back)	*Event-based, focal task*: Indicate if the picture is an animal *Time-based task*: Press a target key every two minutes	*Event-based task*: No significant difference as a function of depression or anxiety *Time-based task*: Higher depressive symptoms performed worse, adjusted for anxiety Anxiety was not significantly associated
Li et al. (2013)	Depression; undergraduates with high or low depressive symptoms per BDI-II	BDI-II, DASS	Memory for Intentions Screening Test (MIST)	*Event-based, focal tasks*: four tasks, half with a 2-min delay interval and the other half with a 15-min delay *Time-based tasks*: four tasks, half with a 2-min delay interval and the other half with a 15-min delay	*Event-based tasks*: no significant difference as a function of depressive symptoms *Time-based tasks*: individuals with high depressive symptoms performed worse *Delays*: High depressive symptoms associated with worse performance on 15-min delay, but not 2-min delay
Livner et al., 2008	Depression; subsample of population-based study of older adults	Comprehensive Psychopathological Rating Scale	Memorize a series of orally presented words	*Event-based, non-focal task*: Remind the experimenter to make a phone call at the end of the study	*Event-based task*: Depressive symptoms impaired the retrospective component of the task, but not the prospective component
Rude et al., 1999	Depression; adults with or without diagnosed depression	SCID, BDI	General knowledge test	*Time-based task*: press a target key every five minutes to check the time	*Time-based task*: Depressed individuals performed worse than non-depressed
Schnitzspahn et al., 2014	Induced negative, neutral or positive mood; healthy community-dwelling adults aged 18–84	Six-minute long video clips	Indicate if animal word was the same as that presented two stimuli previously (n-back)	*Time-based task*: Press a target key every one minute	*Time-based task*: Individuals with induction of negative and positive mood performed worse than neutral mood in young adults (18–25) No significant difference for mood in older adults (59–84 years old)

as a calendar or a diary?", Cuttler & Graf, 2008). Depressive symptoms have also been related to impairments in PM performance, on time-based tasks (Kliegel & Jäger, 2006; Li, Weinborn, Loft, & Maybery, 2013; Rude, Hertel, Jarrold, Covich, & Hedlund, 1999), non-focal tasks (Altgassen et al., 2009), and focal tasks when stimuli were positively valenced (Altgassen, Henry, Bürgler, & Kliegel, 2011). A limitation of all of these studies, however, is a failure to consider the other symptom domain. Yet this is critical, as depression and anxiety are highly co-morbid (Hirschfield, 2001), but are dissociable.

To our knowledge, only three studies have included both anxiety and depression symptoms in one regression model with the outcome of PM performance. In evaluating performance on time-based tasks, higher depressive symptoms, adjusted for trait anxiety symptoms, were associated with worse performance (Kliegel & Jäger, 2006). For focal PM task performance, one study reported that trait anxiety, but not stress and depression in the same regression model, was associated with worse performance on a task that involved writing down paired associates to words read aloud (ongoing task) and responding differently to words that belonged to the category of clothes or body parts (Harris & Menzies, 1999). In contrast, another study of a focal PM performance reported that neither depressive nor trait anxiety symptoms were associated with performance on a task that required a different response from the ongoing n-back task when an animal picture appeared (Kliegel & Jäger, 2006). In a study of non-focal PM performance, high state anxiety was associated with poorer performance on a non-focal task that asked participants to identify whether a colored word matched the color of previously presented rectangles and respond differently if one of the words matched a list of cued words (Arnold, Bayen, & Böhm, 2015).

In general, the results of the few existing studies including both depression and anxiety symptoms in regression models suggest that anxiety affects the ability to store or correctly recall the PM instruction during an ongoing task, while depression affects the ability to disengage from the ongoing task to perform the PM task. Anxiety, but not depression, was associated with focal (Harris & Menzies, 1999) and non-focal (Arnold et al., 2015) event-based PM performance. Moreover, depression, but not anxiety, was associated with impaired time-based PM performance (Kliegel & Jäger, 2006). All three of these studies assessed nonclinical undergraduate participants, although Kliegel and Jäger (2006) also included healthy community-dwelling participants. Thus, these studies suggest that anxiety affects the ability to store and recall information, while depression affects the ability to disengage from the ongoing task. These studies have taken important first steps to disambiguate the overlap between depressive and anxious symptoms in PM performance, which is critical given evidence that depression and anxiety are highly comorbid (Hirschfield, 2001). Limiting these studies, however, is a lack of consideration of affective state.

In clinical psychology research, Clark and Watson (1991) have attributed the strong correlation between anxiety and depression to general distress (i.e., negative affect). In their model, anxiety is characterized by high levels of physiological hyperarousal and high levels of negative affect, whereas depression is characterized by low levels of positive affect and high levels of negative affect (Watson et al., 1995). This theory gained further credence after an exploratory factor analysis (Watson et al., 1995) and a subsequent confirmatory factor analysis (Joiner, 1996) demonstrated psychometric support for the tripartite model in nonclinical college samples. These findings suggest that the inclusion of an affective state measure is informative when attempting to tease apart the theoretical distinction between depression and anxiety, even within otherwise healthy, nonclinical college cohorts.

Previous clinical PM studies of anxiety and depression have not accounted for negative affect in their models. Yet, assessing affect is important for PM studies. An individual's emotional state can determine the amount of attentional resources that can be devoted to a task at any given time (Ellis & Ashbrook, 1988). In support of this, experiments involving negative mood induction have been shown to impair performance on both a PM task (e.g., a time-based PM task, Schnitzspahn et al., 2014) and an ongoing task (e.g., an n-back working memory task; Kliegel et al., 2005) compared to individuals induced into a positive or neutral mood. Therefore, it is plausible that naturally occurring affective states may also impact PM performance. Moreover, including a measure of negative affect in PM studies of anxiety and depression may be helping in parsing apart the highly overlapping constructs anxiety and depression.

In the present study, we examined the contributions of anxious and depressive symptoms on PM performance using a focal, event-based task. Additionally, we assessed how these symptoms affect PM beyond what they share in terms of general distress/negative affect using one cohesive model – the tripartite model (Clark & Watson, 1991). It is important to examine measures of affect and psychopathology together if we are to disentangle their unique and shared effects. This approach also allows for comparisons of the relative contributions of different areas of affect and psychopathology to prospective memory

performance, as well as the incremental predictive power of specific phenomena (e.g., anxiety) over and above more general domains (e.g., negative affect). We reasoned that utilizing this model in a pilot study of clinical influences on prospective memory performance might help us to begin to clarify whether general distress or unique components of depression or anxiety drive poor PM performance and provide a more nuanced understanding of the possible associations between clinical symptoms and diminished performance on future-oriented tasks.

Based on the research outlined above, we hypothesized that this study would provide preliminary evidence that higher levels of (1) anxiety and (2) negative affect would negatively correlate with PM performance. In line with previous research suggesting that depression impairs time-based PM performance and not focal, event-based PM performance, we did not expect (3) depression to be associated with PM impairment here. Importantly, to further probe hypotheses 1–3, we used the tripartite model to provide preliminary evidence for a framework distinguishing between the relative contributions of anxiety, depression, and negative affect. Given its novelty in PM tasks specifically and memory research more generally, we used the tripartite model in an exploratory manner to evaluate whether symptoms unique to anxiety or depression were associated with PM performance. If the tripartite model aligns with previous findings in the literature concerning anxiety, depression, and PM performance, it would suggest that the symptoms unique to anxiety, but not depression, would be associated with PM performance.

Method

Participants

Twenty-seven University of Notre Dame undergraduate students (19 female; ranging from 18 to 30 years of age; mean age of 19.9) participated as part of a larger ongoing study assessing sleep and memory. Participants were compensated with cash payment or class credit. The University of Notre Dame Institutional Review Board (IRB) approved all testing procedures, and written consent was obtained before the experiment. All participants were instructed to refrain from using tobacco, caffeine, alcohol, and recreational drugs for 24 hours prior to participation in the study. They were all fluent English speakers and had normal or corrected-to-normal vision. Participants who reported substance abuse, a previously diagnosed major mental illness, prior sleep disorders, or the use of medications affecting the central nervous system were excluded from the study. Given that participants with psychological diagnoses were ineligible to participate in the larger ongoing study, our results here examined clinical symptoms in an otherwise healthy population.

Procedure

Participants were randomly assigned to either a morning (n = 15) or evening (n = 12) condition to control for time of day effects on performance. The morning group arrived at the laboratory at 9:00 AM, while the evening group arrived at the laboratory at 9:00 PM. Although performance differences as a function of time of day have never been observed in our laboratory, we nevertheless include these conditions because successful memory retrieval has been shown to change as a function of time of day in some studies (e.g., Folkard & Monk, 1980). All other tasks and instructions were identical between conditions. Participants filled out a series of self-report questionnaires and engaged in three cognitive tasks (living/nonliving decision, lexical decision, and semantic categorization; Scullin & McDaniel, 2010) on a desktop computer with a 17-inch monitor running E-Prime software (Schneider, Eschman, & Zuccolotto, 2002). The three ongoing tasks occurred in the same order for all participants. The PM instruction was an event-based focal task.

In the living/nonliving decision task, participants were presented with an object word and were asked to determine whether the object was living (e.g., “cat”) or non-living (e.g., “couch”), as quickly and accurately as possible. In the lexical decision task, participants were asked to determine whether a string of letters formed a word or a non-word. In the semantic categorization task, participants were presented with an item (e.g., “pizza”) and were asked to determine if it matched the category presented next to it (e.g., “food”). There were 164 trials of each task. After completion of all three of these tasks, participants were given the PM instruction. Specifically, participants were instructed to press the “Q“ key on the keyboard whenever the words “table” or ”horse” appeared in any of the three tasks in the next session (Scullin & McDaniel, 2010). After receiving these instructions, all participants completed a 20-minute distractor task involving a second set of self-report and demographic questionnaires.

Participants then engaged in a second round of all three ongoing cognitive tasks, which included a test of PM for the critical words. Each of the three tasks showed the words “table” and “horse” only once. Therefore, participants were given opportunities to remember the PM task instructions and press the “Q” key on the keyboard following the presentation of these

words a maximum of six times. Once again, there were 164 trials of each ongoing task during the second session. PM performance was measured for each participant as the proportion of successful attempts recalling and completing the instruction to press the letter "Q" in response to the words "horse" or "table" over the total number of times these words were presented during the tasks.

Measures

The Beck Depression Inventory (BDI-II; Beck, Steer, & Brown, 1996) is a 21-item self-report measure of depression in adolescents and adults. Respondents rate their experience of each symptom (e.g., "I don't have enough energy to do anything") over the past two weeks using a four-point intensity scale (from 0–3, with unique descriptors for each question). Scores below 13 are interpreted as indicating minimal depression, 14–19 as indicating mild depression, 20–28 as indicating moderate clinical depression, and above 29 as indicating severe clinical depression (Beck et al., 1996).

The Beck Anxiety Inventory (BAI; Beck, Epstein, Brown, & Steer, 1988) is a 21-item self-report measure of anxiety that focuses on somatic content to minimize the overlap with depression. Respondents rate their experience of each symptom (e.g., "fear of the worst happening") over the past week using a four-point intensity scale (0 = "it did not bother me at all," 3 = "I almost could not stand it"). Scores between 8 and 15 are interpreted as indicating mild anxiety, 16–25 as indicating moderate anxiety, and 25 and above as indicating severe anxiety. The BAI was included in the study as a measure of trait anxiety, or how anxious respondents tend to feel in general, given evidence for high test–retest reliability across time (Beck et al., 1988; but see Brown et al., 1997, for evidence that BAI scores can change with intervention).

The State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) assesses how anxious respondents tend to feel in general (i.e., trait anxiety) and how anxious they are feeling currently (i.e., state anxiety). This study used only the state anxiety subscale, as that was the only subscale administered. This subscale consists of 20 items (e.g., "I feel over-excited and rattled"). Respondents rate their current experience of each symptom using a four-point intensity scale (1 = "not at all," 4 = "very much so"), and higher scores reported on the STAI indicate greater state anxiety.

The Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988) is a 20-item self-report affect measure comprising two scales: Positive Affect (PA) and Negative Affect (NA). The NA scale contains 10 negative affect terms (e.g., "upset"), while the PA scale contains 10 positive affect terms (e.g., "enthusiastic"). This study used present-moment time instructions for the PANAS, such that respondents rated the extent to which they were experiencing each affect term "right now" using a five-point scale (1 = "very slightly or not at all," 5 = "extremely"). The PA and NA scales both show strong internal consistency under present-moment time instructions and have been shown to be independent of each other (Watson et al., 1988).

Statistical analysis

We first examined whether memory performance differed between morning versus evening conditions using a one-way analysis of variance (ANOVA), and if memory performance differed as a function of the ongoing task in paired sample t-tests. Second, we examined the bivariate correlations among the self-report measures of affect, anxiety, and depression to determine whether these correlations were consistent with prior research and theory. In subsequent correlations, we evaluated the association between these clinical constructs and PM performance. Finally, to test the tripartite model, we conducted hierarchical linear regression analyses to examine whether BDI-II, BAI, or STAI scores were associated with differences in PM performance over and above PANAS negative affect. In these models, we first included PANAS negative affect as an independent variable, and in a second step, we included the BAI, the STAI, or the BDI-II. These hierarchical regression models allow us to evaluate the unique role of anxiety or depression on prospective memory performance, after partialling out the variance explained by negative affect. We did not include positive affect in our models, as positive affect is not theorized to explain the overlap between anxious and depressive symptoms (Clark & Watson, 1991). In sensitivity analyses, we examined whether these associations differed as a function of the ongoing task.

Results

There were no differences in memory performance between the morning and evening conditions, $F(1, 25) = 0.69$, $p > .40$. Moreover, there were no differences in any of the self-report measures between the morning and evening conditions (all ps $> .20$). Thus, we collapsed across participants for all subsequent analyses. In paired sample t-tests, there was no significant difference in PM performance across all ongoing tasks (all ps $> .4$). Sample characteristics are presented in Table 2.

Table 2. Sample characteristics.

	Measure	Minimum	Maximum	Mean	St. Deviation
PM performance	Task	0	6	3.9	2.0
Living-nonliving	Task	0	2	1.2	0.8
Lexical decision	Task	0	2	1.2	0.8
Semantic	Task	0	2	1.3	0.8
Anxiety	BAI	0	27	8.9	6.9
Anxiety	STAI	24	62	37.7	7.9
Depression	BDI-II	0	23	4.4	4.9
Positive affect	PANAS	10	40	22	7.8
Negative affect	PANAS	10	26	12.7	3.8

PM: prospective memory; BAI: Beck Anxiety Inventory; STAI: State-Trait Anxiety Inventory; BDI-II: Beck Depression Inventory-II; PSQI: PANAS: Positive and Negative Affect Schedule.

The basic elements of the tripartite model were replicated in this dataset, such that BAI anxiety correlated positively with negative affect (r = 0.63, p < .001) and was independent of positive affect (r = 0.02, p = .90), whereas BDI-II depression correlated positively with negative affect (r = 0.57, p = .002) and negatively with positive affect (r = −0.42, p = .03). The STAI's state anxiety pattern of correlations with the PANAS was more similar to depression (i.e., negatively correlated with positive affect, positively correlated with negative affect) than to anxiety assessed by the BAI, which is consistent with criticisms that the STAI measures depression more so than it measures anxiety (Creamer, Foran, & Bell, 1995). Associations among self-report measures are reported in Table 3.

Trait and state anxiety were associated with worse overall PM performance as measured both by the BAI (r = −0.62, p< .001) and the STAI (p = .03), respectively. Negative affect was also associated with poorer PM performance (r = −0.45, p = .02). However, depression scores (r = −0.27, p = .20) and positive affect scores (r = −0.21, p = .30) were not associated with PM performance (Table 3).

In sensitivity analyses, we examined whether the PM performance from any specific task (i.e., living/non-living task, lexical decision-making task, and semantic categorization task; two opportunities in each task) was driving this relation. We found that anxiety assessed by BAI was associated with PM performance within all three tasks individually (all ps < 0.001). Anxiety assessed by the STAI was significantly associated with PM performance within the lexical decision-making task only (r = −0.45, p = .02). Negative affect from the PANAS was significantly associated with PM performance on the lexical decision-making task (r = −0.41, p = .04) and the semantic categorization task (r = −0.48, p = .01), but not the living/nonliving task. Depression scores and positive affect scores were not significantly associated with PM performance on any of the three tasks individually.

We next ran a series of hierarchical linear regression analyses to clarify the relative contributions of BAI (trait) and STAI (state) anxiety, BDI-II depression, and PANAS negative affect to overall PM performance. In the first step, PANAS negative affect was included. In the second step, BAI, STAI, or BDI-II was included (Table 4). Only BAI anxiety was associated with PM performance over-and-above PANAS negative affect (β= −0.56, p = .01, R^2 = 0.40). Moreover, adding BAI scores to the model nearly doubled the amount of variance explained and diminished the contribution of negative affect (Figure 1). In a model adjusting for both BDI-II depression scores and PANAS negative affect, BAI scores were significantly associated with PM performance (β = −0.57, p = .01), suggesting that the trait component of elevated anxiety is the strongest correlate of diminished PM.

In sensitivity analyses, this same pattern of results occurred when each of the three ongoing tasks (living/non-living task, lexical decision-making task, and semantic categorization task) was considered individually. Specifically, after adjusting for PANAS negative affect, BAI was a significant or trending correlate of PM performance during two of the ongoing tasks –

Table 3. Bivariate associations among anxiety, depression, and mood measures.

	PM Score	BAI	STAI	BDI-II	PANAS PA
BAI	**−0.62**				
STAI	**−0.41**	**0.65**			
BDI-II	−0.27	**0.43**	**0.62**		
PANAS PA	−0.21	0.02	**−0.55**	**−0.42**	
PANAS NA	**−0.45**	**0.63**	**0.63**	**0.57**	−0.12

Correlation coefficients that are significant at p< 0.05 are indicated in bold. Performance indicates performance on the PM task.
PM Score: PM Score; BAI: Beck Anxiety Inventory; STAI: State-Trait Anxiety Inventory; BDI-II: Beck Depression Inventory-II; PANAS PA: Positive and Negative Affect Schedule, Positive Affect; PANAS NA: Positive and Negative Affect Schedule, Negative Affect.

Table 4. Incremental predictive power of BAI, BDI-II, and STAI over PANAS NA.

	β	R^2
Step 1: PANAS NA	−0.45*	0.20
Step 2: PANAS NA	−0.09	
BAI	−0.56*	0.40$^+$
Step 1: PANAS NA	−0.45*	0.20
Step 2: PANAS NA	−0.32	
STAI	−0.21	0.23
Step 1: PANAS NA	−0.45*	0.20
Step 2: PANAS NA	−0.44	
BDI-II	−0.02	0.20

p < .05 = *; significant R^2 change at p < .05 = $^+$.
BAI: Beck Anxiety Inventory; STAI: State-Trait Anxiety Inventory; BDI-II: Beck Depression Inventory-II; PANAS NA: Positive and Negative Affect Schedule, Negative Affect.

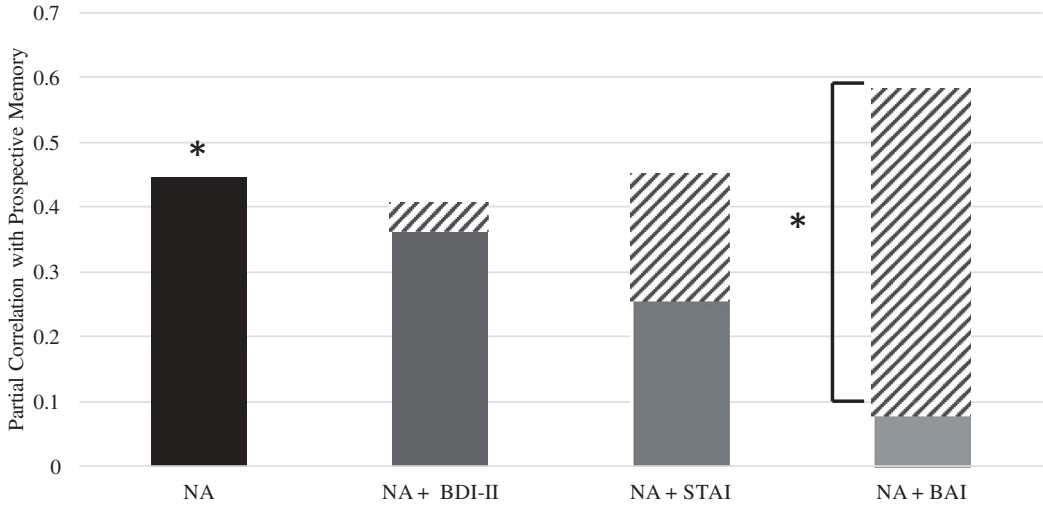

Figure 1. Contributions of anxiety and depression to negative affect.

The variance in PM performance explained by negative affect (NA), as well as the contribution of BAI, STAI, and BDI-II above and beyond NA.*Notes* .* significant at $p < .05$NA: Positive Affect and Negative Affect Schedule, Negative Affect; BDI-II:Beck Depression Inventory-II; STAI: State-Trait Anxiety Inventory; BAI: BeckAnxiety Inventory.

semantic categorization ($\beta = -0.48$, $p = .03$), and living/non-living ($\beta = -0.48$, $p = .06$). Although the direction of results was the same for lexical decision-making ($\beta = -0.34$, $p = .16$) it was not significant, which may be due to low power. BDI-II and STAI were not significant or trending correlates of PM performance during any of the three ongoing tasks after adjustment for PANAS negative affect (ps > 0.3).

Discussion

The current study examined the relationship between PM and anxiety, depression, and negative affect in a sample of non-diagnosed college students. Using the tripartite model as a framework to begin to disambiguate the relative contributions of various symptoms, we found preliminary evidence that, above and beyond negative affect, anxious symptoms assessed by the BAI are associated with poor PM performance. Because STAI was not a significant correlate of PM performance, the results of this study may suggest that trait, but not state, anxiety is the more important component for successful execution of future tasks than the more affective components assessed by the STAI. Additionally, it may be that the BAI assesses the physiological arousal associated with anxiety, whereas the STAI assesses the more affective components of anxiety.

Anxiety, depression, and negative affect

Our analyses replicated the basic structure of the tripartite model in the present sample, as theorized by Clark and Watson (1991). That is, BAI anxiety was positively related to PANAS negative affect and linearly independent of PANAS positive affect, whereas BDI-II depression was positively related to PANAS negative affect and negatively related to PANAS positive affect. Furthermore, PANAS positive and negative affect scales were linearly independent of each other.

Our hierarchical regression analyses indicated that trait anxiety as measured by the BAI was associated with PM impairment over-and-above the contribution of PANAS negative affect; furthermore, including BAI scores in the model nearly doubled the amount of variance explained. The contribution of negative affect to diminished PM appears to be driven almost entirely by anxiety, as the effect dropped to null when anxiety scores from the BAI were included in the model. In contrast, neither the STAI nor the BDI-II provided incremental prediction over-and-above the contribution of PANAS negative affect. This test using the framework of the tripartite model suggests that the symptoms unique to anxiety are associated with impaired PM performance.

Our findings suggest that anxiety and negative affect are related to impairments in PM performance on a focal, event-based task, while depressive symptoms had no effect. This may be because depressive symptoms have been related to PM when the instruction is an event-based *non-focal* task (Altgassen et al., 2009; Livner, Berger, Karlsson, & Bäckman, 2008) or a time-based PM task (Kliegel & Jäger, 2006), whereas our instruction was an event-based *focal* task (depression was non-significant in two other studies with focal, event-based tasks; Altgassen et al., 2009; Li et al., 2013). Consistent with our

results, another study that included anxiety and stress in the model also found that depression was not a significant correlate (Harris & Menzies, 1999). Therefore, the form of prospective memory tested may be important (i.e., ones that require substantial disengagement from the ongoing task), or previous studies that have found an association between depression and PM in focal, event-based tasks may have done so only because of its strong correlation with anxiety. As such, we would expect that an individual experiencing both anxiety and depression might have worse PM than someone experiencing only depression. Using the tripartite model as a framework, our findings suggest that the effect of negative affect on PM is driven by the unique components of anxiety, such that previously obtained significant findings for related domains (depression, general negative affect) may actually be an indirect function of those domains' correlations with anxiety or having an impact on other forms of PM. Due to power limitations, these results should be viewed as preliminary, yet our findings highlight this is an interesting area for future work on psychopathology and PM function.

Measurement considerations and limitations

The prospective memory tasks were selected to replicate a previous study examining the role of sleep and prospective memory (Scullin & McDaniel, 2010). This task was event-based and focal to the ongoing task. However, depression has been shown in previous studies to particularly impact performance on time-based PM tasks (Kliegel & Jäger, 2006; Li et al., 2013; Rude et al., 1999), and non-focal tasks (Altgassen et al., 2009). Therefore, our task selection may be one reason that we do not report an effect of depression. While the study did not dissociate prospective from retrospective components of the task (e.g., Arnold et al., 2015), it should be noted that the retrospective demands of the task were minimal in the sense that participants only remembered two high-frequency nouns. In sensitivity analyses, we reported that there were significant associations between clinical measures and PM performance on some, but not all, ongoing tasks. This was unexpected, as all PM cues were focal to the ongoing tasks. Future work might also evaluate differences across PM tasks of the same type (focal versus non-focal) to determine if this is a unique feature of the current study.

In the current study, participants had the opportunity to execute the PM task a total of six times. Only 18% of our sample correctly executed all six of the tasks. Although Graf and Uttl (2001) questioned whether a binary outcome (success or failure) has the variability necessary to accurately reflect real-world PM performance, Kelemen, Weinberg, Alford, Mulvey, and Kaeochinda (2006) reported that studies with high variability in performance had better alternate form reliability than those experiments where the majority of participants executed all of the PM tasks. Based on this evidence, our task may have been sufficiently challenging to be a reliable measure of individuals' capacity for PM. However, we only tested participants in one session, and so do not have the ability to directly measure reliability.

Our results for two measures of anxiety were inconsistent. Although the BAI and STAI both purport to measure anxiety, our key findings were obtained only for BAI scores. This difference in results may be because the BAI measures trait anxiety and physiological arousal, whereas the STAI measured state anxiety and affective components of anxiety. This discrepancy could also indicate construct validity issues with the STAI. We found that patterns of STAI relations with PANAS scales resembled those that would be expected for a depression scale (positive relations with negative affect and negative relations with positive affect), rather than those that would be expected for an anxiety scale (positive relations with negative affect and no relation to positive affect). These findings are consistent with criticisms (e.g., Bieling, Antony, & Swinson, 1998) that the STAI includes substantial depression content (e.g., "I am regretful"), which necessarily compromises its ability to measure anxiety with fidelity. Anxiety measures with more optimal construct validity (e.g., the BAI) than the STAI may be better recommended for future studies investigating associations between anxiety and cognitive performance.

The current study tested the tripartite model to examine the association of emotional states and PM. Future work might evaluate the role of emotion on the process model of PM, which posits that there are four stages to successful PM performance: an individual must form an intention to do something (intention formation), retain the intention during other ongoing activities (intention retention), initiate the intention at the appropriate time (intention initiation), and execute the action as planned (Kliegel, Martin, McDaniel, & Einstein, 2002). Based on the literature reviewed in Table 1, we think it is plausible that anxiety may interfere with intention retention (e.g., Kliegel, Altgassen, Hering, & Rose, 2011; Kliegel et al., 2002), that depression may interfere with the intention initiation component (Kliegel & Jäger, 2006; Li et al., 2013; Rude et al., 1999), and that affect may be related to intention execution (Kliegel et al., 2005; Schnitzspahn et al., 2014). This integration of the tripartite model with the process model of PM is speculative based on

current literature. The current study is a preliminary step to merge the cognitive concept of prospective memory with the clinical framework of the tripartite model. A larger-scale study designed to test how the process model of PM and the tripartite model might be the next step in bringing these two fields together.

Our study has three critical limitations that must be noted. First, the small sample size limited our power when including more than one independent variable in our regression models, so these results should be considered preliminary and interpreted with caution at this stage. Second, the sample used here was non-clinical group of college-aged students. Although the decision to use such a sample was consistent with our initial goal, clinical symptoms reported were only in the mild to moderate range. This was particularly true for depression symptoms, in which the average BDI-II was 4.4 (4.9) with a range of 0–23. This reduced range could have had an effect on our correlation analysis and may have contributed to the findings that depression did not have an effect on this task. As such, it will be necessary to replicate the findings reported here with larger samples, both in non-diagnosed and clinical populations to fully determine their scope and validity. Finally, our study is correlational in nature, and thus cannot be used to understand directionality of associations.

In spite of these limitations, our study is novel in that it is the first to examine PM performance with the framework of the tripartite model, and while preliminary, it is hypothesis-generating for future studies of its kind. Additionally, it is important to note that the findings reported here fall directly in line with previous research in a non-clinical sample suggesting that anxiety symptoms impair PM performance in focal, event-based tasks while depression symptoms do not (Harris & Menzies, 1999). As such, our findings provide additional evidence of possible differential associations between clinical symptoms and PM performance, and suggest that accounting for negative affect may be important for disentangling these symptoms.

Conclusion

To our knowledge, this study is the first to compare the relative contributions of self-reported anxiety, depression, and negative affect to PM performance. Using the framework of the tripartite model, our findings provide preliminary evidence that the unique components of anxiety (i.e., somatic tension and arousal) and, at least indirectly, overall negative affect, have a meaningful impact on future-oriented cognitive functioning. Methodologically, results from this study highlight the value of incorporating clinical psychology frameworks with cognitive psychology tasks. By including perspectives from psychometrics and clinical science, we were able to examine clinical variables with greater theoretical precision and thereby consider more generalizable applications for cognitive research. More widespread use of this approach in research might improve our understanding of psychological phenomena and the potential applications of our findings.

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Data availability statement

These data are not from a publicly available dataset. For access to script, output, and data, please contact the corresponding author.

Disclosure statement

No potential conflict of interest was reported by the authors.

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