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Anxiety, Worry, and Difficulty Concentrating: A Longitudinal Examination of Concurrent and Prospective Symptom Relationships

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Difficulty concentrating is an understudied cognitive phenomenon, despite its status as a diagnostic criterion for generalized anxiety disorder and contributor to clinically significant distress and impairment. Worry may constitute a cognitive mechanism by which anxiety leads to difficulty concentrating. The present study examined concurrent and prospective associations between self-reported anxiety, worry, and subjective difficulty concentrating across three timepoints (T1 April/May, T2 July/August, T3 October/November 2020) in 198 adults (*M* age = 37.94, *SD* = 13.42; 81% women, 2% gender minority) drawn from a larger study of trajectories of psychopathology during the COVID-19 pandemic. In multilevel models, anxiety was associated with worry both between ($\beta = 0.65$, *SE* = 0.13) and within participants ($\beta = 0.12$, *SE* = 0.11). Difficulty concentrating was also associated with worry between ($\beta = 0.38$, *SE* = 0.03) and within participants

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($\beta = 0.09$, $SE = 0.02$). In a structural equation model, worry partially mediated the longitudinal association between anxiety and difficulty concentrating, though this effect was nonsignificant after controlling for difficulty concentrating at T2 and worry, depression, sleep disturbance, and difficulty concentrating at T1. The unadjusted mediation and these other findings are in line with theoretical accounts of worry as a cognitive mechanism linking anxiety to subjective attentional problems.

Keywords: anxiety; worry; attention; cognitive control; longitudinal studies

THE SUBJECTIVE experience of difficulty concentrating is a transdiagnostic symptom of anxiety and related forms of internalizing psychopathology, including generalized anxiety disorder (GAD), major depressive disorder, and posttraumatic stress disorder (PTSD; American Psychiatric Association [APA], 2013; Eysenck et al., 2007; Günak et al., 2023; Hsu et al., 2019; Snyder, 2013). However, the mechanisms that account for the relationship between anxiety and subjective difficulty concentrating remain largely unknown. One plausible mechanism is worry, which has been linked with difficulty concentrating in both GAD-diagnosed and nonclinical samples (Armstrong et al., 2011; Hallion et al., 2018; Mitchell et al., 2012). Theoretical frameworks such as processing efficiency theory (Eysenck & Calvo, 1992) suggest that worry may lead to subjective difficulty concentrating through reduced working memory capacity. Identifying the cognitive mechanisms of difficulty concentrating can therefore help to inform theoretical debates about the cognitive impairments that drive the onset and maintenance of clinically significant anxious psychopathology.

Although theoretical models have proposed mechanistic explanations for anxiety-related attentional impairments (e.g., Eysenck et al., 2007; Hirsch & Mathews, 2012), these accounts are primarily concerned with "objective" attentional control (i.e., attention as indexed by cognitive task performance) rather than subjective experience. Task-indexed attentional impairments are not reliably associated with subjective difficulty concentrating in nonclinical samples spanning the trait anxiety spectrum (Quigley et al., 2017; Reinholdt-Dunne et al., 2013; Todd et al., 2022; Tortella-Feliu et al., 2014). Similarly, individuals diagnosed with GAD show intact or even enhanced performance relative to nonclinical controls on standard neuropsychological batteries (Leonard & Abramovitch, 2019) and laboratory measures of cognitive control (Hallion et al., 2019; Price & Mohlman, 2007). Therefore, objective attentional impairment does not appear sufficient to explain the association between trait anxiety and subjective difficulty concentrating.

Examining prospective associations between anxiety, worry, and subjective difficulty concentrating over time may illuminate habitual worry as an alternative mechanism explaining the high level of subjective difficulty concentrating associated with anxiety. Anxious affect prospectively predicts increased momentary worry within-person (Naragon-Gainey, 2019), consistent with theoretical conceptualizations of worry as a strategy for avoiding sudden increases in negative emotionality by sustaining a chronic level of distress (Newman & Llera, 2011). Cognitive models contend that state worry may concurrently interfere with attentional functioning through the consumption of working memory capacity (Eysenck & Calvo, 1992) or the depletion of attentional control (Hirsch & Mathews, 2012). Consistent with a model in which worry consumes attentional capacity, worry inductions reduce performance on tests of randomness and interval generation that place high demand on working memory, and this effect is greater in high trait worriers (Hayes et al., 2008; Leigh & Hirsch, 2011). Over more extended time periods such as weeks or months, entrenched patterns of worried thinking may reinforce biased attentional allocation towards negative or threat-related stimuli, which may interfere with attentional functioning by inhibiting task-relevant information (Hirsch & Mathews, 2012; for a discussion of anxiety-related attentional bias to threat, see Beckwé et al., 2014; Goodwin et al., 2017; Verkuil et al., 2009). We selected a time frame of 3 months between assessments for the present study to allow sufficient time for these longer-term, prospective associations to unfold.

In contrast to the extensive literature on task-indexed attentional functioning, the subjective experience of difficulty concentrating is understudied, particularly in relation to worry and in naturalistic settings over extended periods of time. More severe worry has been linked to greater reported difficulty concentrating among adults with GAD (Hallion et al., 2018) and in nonclinical samples (O'Carroll & Fisher, 2013; Williams et al., 2017; but not Sample 2, cf. Williams et al., 2017). However, these studies relied on cross-sectional measures of worry and difficulty concentrating, implicitly conceptualizing these constructs as static traits. Naturalistic longitudinal data, by contrast, can capture the continuous

waxing and waning of anxiety symptoms in response to stressors that occur outside of controlled lab environments and over time periods of weeks and months.

The COVID-19 pandemic, which was in its early phase during data collection in the present study, may be a particularly conducive context for studying anxiety and associated difficulty concentrating. Worry about pandemic-related health risks was common, particularly early in the pandemic (Taylor et al., 2020). However, subjective difficulty concentrating was still cross-sectionally associated with other GAD symptoms (e.g., worry; restlessness; irritability) in a nonclinical sample even after controlling for COVID-related worries and stress symptoms (Bardeen et al., 2022), suggesting that relationships between difficulty concentrating, worry, and anxiety likely extend beyond pandemic-specific concerns and contexts.

The present study used data from the COVID-19 Mental Health Workgroup, a longitudinal multisite study of the mental health impacts of the COVID-19 pandemic (see parent project on Open Science Framework: https://osf.io/ghp2x/). We hypothesized that anxiety would be associated with worry severity and that worry severity would be associated with difficulty concentrating both within and between participants, and that worry severity would fully mediate the relationship between anxiety and difficulty concentrating over time. To disentangle the impact of pandemic-related worry on difficulty concentrating from trait-level worry, the present study included a content-agnostic measure of worry severity as a primary construct of interest, and a content-specific measure of COVID worry as a covariate in sensitivity analyses. We further probed the robustness of these hypothesized associations by adjusting models for depression symptom severity, which is highly comorbid with anxiety (ter Meulen et al., 2021) and shares difficulty concentrating as a symptom (Hsu et al., 2019); sleep disturbance, which has been linked with difficulty concentrating (Cox et al., 2018); and worries about the COVID-19 pandemic specifically, which may be associated with difficulty concentrating independently of trait worry (Brown et al., 2023).

Method

DESIGN

Participants were 198 adults (*M* age = 37.94, *SD* = 13.42; 81% women, 2% gender minority; 86% White, 19% Asian, 6% Black or African-American, 2% American Indian or Alaska Native, 3% other race; see Table S1 in Supplemental Materials for complete demographic and clinical characteristics) drawn from a larger study, the COVID-19 Mental Health Workgroup Study (Breaux et al., 2024). Adults who had previously participated in eligible prepandemic research studies were recontacted at several points during the early-to-mid COVID-19 pandemic and invited to participate in a study about mental health during the COVID-19 pandemic (for additional detail on study recruitment see preregistration at https://osf.io/zhdgw). All study procedures were approved by the University of Pittsburgh Institutional Review Board. All participants from the larger study who had sufficient data to contribute to at least one analysis described in the current paper were retained. As prepandemic data availability was inconsistent for our constructs of interest, the present study used data from the first three pandemic timepoints only: April and May 2020 (T1), July and August 2020 (T2), October and November 2020 (T3). All symptom measures used in the present study were administered at each wave and included instructions to rate experiences of the construct being assessed for the *past week*.

PRIMARY MEASURES

Depression, Anxiety, and Stress Scales–21 Item Version (DASS-21)

Anxiety symptoms were measured using the Stress and Anxiety subscales of the DASS-21, a widely used measure of anxiety and depression symptoms in the past week with strong convergent and discriminant validity and reliability in both nonclinical and clinical samples, and adequate-to-good internal consistency within each subscale (Antony et al., 1998; Henry & Crawford, 2005). Items were rated on a 4-point Likert scale, from 0 (*Did not apply to me at all–Never*) to 3 (*Applied to me very much, or most of the time–Almost always*) with past-week instructions. Item ratings on each 7-item subscale were summed to create total scores, which were doubled to produce scores comparable with clinical cutoffs for the 42-item version of the DASS. Because the Anxiety and Stress subscales tend to be highly correlated, especially in individuals with anxiety disorders (Antony et al., 1998; Ng et al., 2007), these subscales were averaged to create a single composite anxiety score. Cronbach's alpha for the DASS-21 Anxiety and Stress Scales (combined) in the present sample was 0.90 at T1, 0.89 at T2, and 0.92 at T3.

Attentional Control Scale (ACS)

Difficulty concentrating was measured using the Attentional Control Scale, a widely used 20-item self-report measure with robust psychometric

properties (Derryberry & Reed, 2002; Judah et al., 2014). Items were rated on a 4-point Likert scale from 1 (*Almost never*) to 4 (*Always*) with past-week instructions. Item ratings were summed to produce a single cumulative score for each participant, with lower scores indicating more severe difficulty concentrating. Cronbach's alpha for the ACS total score in the present sample was 0.88 at T1, 0.87 at T2, and 0.89 at T3.

Penn State Worry Questionnaire–Past Week (PSWQ-PW)

The PSWQ-PW is a 15-item self-report measure of excessiveness and uncontrollability of worry in the past week (Stöber & Bittencourt, 1998). Items were rated on a 7-point Likert scale from 0 (*Never*) to 6 (*Almost always*), with total scores ranging from 0 to 90. The PSWQ-PW has demonstrated high internal consistency and sensitivity to changes in worry severity from week to week in a sample exceeding clinical cutoffs for pathological worry (Stöber & Bittencourt, 1998). Cronbach's alpha in the present sample was 0.96 at all three timepoints.

COVARIATES FOR SENSITIVITY ANALYSES

DASS-21 Depression subscale

Depression symptom severity was measured using the Depression Subscale of the DASS-21 (described above). Total scores range from 0–42, with higher scores indicating more severe depressive symptoms. Cronbach's alpha in the present sample for the DASS-21 Depression subscale was 0.91 at T1, 0.90 at T2, and 0.91 at T3.

Patient-Reported Outcomes Measurement Information System (PROMIS)™ Sleep Disturbance Short Form

Sleep disturbance was measured at each timepoint using the PROMIS™ Sleep Disturbance Short Form (Yu et al., 2012), an 8-item self-report measure assessing perceived problems with sleep latency, quality, and restorativeness in the past week. This measure has demonstrated good validity and reliability in samples spanning a wide range of sleep-related symptom severity (Yu et al., 2012). Items were rated on a 5-point Likert scale from 1 (*Not at all*) to 5 (*Very much*) and total scores range from 8–40, with higher scores indicating more severe sleep disturbance. Cronbach's alpha in the present sample was 0.92 at T1, 0.91 at T2, and 0.93 at T3.

COVID Worries Domain of the Coronavirus Health Impact Survey (CRISIS)

COVID worry was measured at each timepoint using the CRISIS COVID Worries domain subscale (Nikolaidis et al., 2021) with past-week instructions. The CRISIS is a comprehensive self-report measure assessing the emotional and behavioral impacts of the COVID-19 pandemic, as well as preexisting risk and protective factors. The 7-item COVID Worries Subscale of the CRISIS has demonstrated excellent internal consistency and good validity and reliability (Nikolaidis et al., 2021). Items were rated on a 5-point Likert scale from 0 (*Not at all*) to 4 (*Extremely*) and total scores range from 0–28, with higher scores indicating more severe COVID-related worries. Cronbach's alpha in the present sample for the COVID Worries Subscale was 0.86 at T1, 0.89 at T2, and 0.87 at T3.

DATA ANALYSIS

Primary Analyses

All analyses were conducted in R (R Core Team, 2022). Our first two hypotheses (anxiety predicting worry severity; and worry severity predicting difficulty concentrating; both within- and between-person) were tested with multilevel models based on maximum likelihood estimation using the *lme4* package (Bates et al., 2015), with assessment occasions (Level 1) nested within participants (Level 2). For the main predictor in each model (anxiety or worry severity, respectively), we computed the participant-mean score over all three timepoints (Level 2) and individual deviations from participant-mean scores at each timepoint (Level 1). All multilevel models included a fixed effect of timepoint and a random effect of participant. The dependent variable was either worry severity or difficulty concentrating, respectively.

The hypothesis that worry severity would fully mediate the relationship between anxiety and difficulty concentrating was tested using *lavaan* (Rosseel, 2012). The present sample size ($N = 198$) was considered sufficiently powered for structural equation modeling, given that a recommended $N{:}q$ ratio (of N observations to q parameters) for structural equation modeling is 20:1 (Jackson, 2003), and our most complex model had nine parameters. The recommended sample size for this model would be $N = 180$ and our sample size was $N = 175$ (due to missing data). Effect size was evaluated as the ratio of the indirect effect to the total effect as recommended by Wen and Fan (2015). To probe the specificity of the results, we also tested a competing model in which anxiety at T2 was entered as a mediator of the association between T1 worry severity and T3 difficulty concentrating (results in Supplemental Materials).

Sensitivity Analyses

In light of the high comorbidity between depression and anxiety (ter Meulen et al., 2021), we reran the model testing the association between anxiety and worry severity with depression severity added as a covariate. We also reran the model testing the association between worry and difficulty concentrating with depression severity, sleep disturbance, and COVID worry as covariates, since depression and sleep disturbance have both been linked with more severe difficulty concentrating (Cox et al., 2018; Hsu et al., 2019), and worries specific to the COVID-19 pandemic may have explained additional variance in difficulty concentrating beyond that explained by general past-week worry severity (Taylor et al., 2020).

For the mediation model, we first added each outcome as a predictor at the previous timepoint; e.g., T2 difficulty concentrating predicting T3 difficulty concentrating. Second, we added T1 worry severity, difficulty concentrating, depression symptom severity, and sleep disturbance as predictors of T3 difficulty concentrating.

Overlapping Items

Theoretical considerations identified items from three measures as having potential construct overlap: "I was worried about situations in which I might panic and make a fool of myself" (DASS-21 item 9); "I find it easy to dismiss worrisome thoughts" (PSWQ-PW item 8); and "I worried about not being able to fall asleep" (PROMIS™ Sleep Disturbance Short Form item 7). In a sensitivity analysis with these three items removed, we found that sleep disturbance was no longer significantly associated with difficulty concentrating in the multilevel model testing the association between worry and difficulty concentrating (all other predictors were unchanged). Therefore, we report the results of the main analyses below with potentially overlapping items removed (see Supplemental Materials for results with all items included).

Results

PRELIMINARY ANALYSES

Descriptive statistics (Table 1), repeated-measures correlations (Table S2 in Supplemental Materials), and zero-order correlations at each timepoint (Tables S3, S4, S5 in Supplemental Materials) were computed for all analytic variables.

Evaluation of Missingness and Multicollinearity

No outliers (≥2.5 *SD* above or below the sample mean) were observed on any analytic variables. Multilevel modeling is generally robust to data missing at random (Quené & van den Bergh, 2004). Of 594 observations from 198 participants across three timepoints, 50 observations (8.42%) were missing data on at least one primary analytic variable (anxiety, worry, or difficulty concentrating). See Supplemental Materials for analysis of missingness in the original dataset ($N = 1{,}203$) which includes participants not included in the present analyses due to missing data. Individuals missing data on at least one primary analytic variable were significantly more likely to identify as gay or bisexual than individuals with no missing data (see Supplemental Materials), but this was considered ignorable missingness as sexual orientation has no bearing on the major theories of interest in the present study. Complete case analysis was used for mediation path models. Variance inflation factors for reported models ranged from 1 to 4.14 and did not exceed recommended thresholds of 5 or 10 indicating severe multicollinearity (James et al., 2017).

PRIMARY ANALYSES

Association Between Anxiety and Worry

To test the first hypothesis, that anxiety would be significantly associated with worry within- and between-person, we constructed a multilevel model with timepoint, participant mean anxiety, and person-mean centered anxiety as fixed effects, participant as a random intercept, and worry as the dependent variable (Table 2). Anxiety was associated with worry both between ($b = 1.85$, $SE = 0.13$, $\beta = 0.64$, $p < .001$) and within ($b = 0.86$, $SE = 0.11$, $\beta = 0.12$, $p < .001$) participants. This means that both an individual's average level of anxiety (between-person) and deviations from their average level of anxiety at a given timepoint (within-person) were associated with their reported worry at the same given timepoint. Timepoint was positively associated with T2 worry ($b = 1.69$, $SE = 0.72$, $\beta = 0.09$, $p = .019$), suggesting that worry was significantly higher at T2 compared to T2. When this model was rerun controlling for depression severity (Table 4), anxiety remained significantly associated with worry both between ($b = 1.66$, $SE = 0.15$, $\beta = 0.58$, $p < .001$) and within ($b = 0.73$, $SE = 0.12$, $\beta = 0.10$, $p < .001$) participants. Depression symptom severity was also significantly associated with worry ($b = 0.19$, $SE = 0.07$, $\beta = 0.10$, $p = .006$).

Association Between Worry and Difficulty Concentrating

To test the second hypothesis, that worry would be significantly associated with difficulty concentrat-

Table 1
Means and Standard Deviations for Study Variables by Timepoint

	Time 1	*Time 2*	*Time 3*
DASS-21$_{Anx}$	12.25 (7.64)	12.76 (7.51)	11.33 (7.71)
PSWQ-PW	48.19 (20.43)	51.33 (19.50)	48.35 (21.38)
ACS	49.20 (9.30)	49.45 (8.78)	48.54 (9.49)
DASS-21$_{Dep}$	13.49 (10.06)	13.48 (9.41)	12.82 (10.06)
PROMIS™ Sleep-SF	21.04 (3.73)	21.11 (3.99)	20.91 (3.71)
CRISIS Worries	11.06 (6.04)	11.31 (6.34)	10.72 (6.04)

Note. DASS-21$_{Anx}$ = Depression Anxiety Stress Scales 21 Anxiety composite; PSWQ-PW = Penn State Worry Questionnaire–Past Week; ACS = Attentional Control Scale; DASS-21$_{Dep}$ = Depression Anxiety Stress Scales 21 Depression subscale; PROMIS™ Sleep-SF, Patient-Reported Outcomes Measurement Information System (PROMIS)™ Sleep Disturbance-Short Form; CRISIS Worries = Coronavirus Health Impact Survey COVID Worries Domain. Time 1, April/May 2020; Time 2, July/August, 2020; Time 3, October/November 2020. Note that means and standard deviations are presented with all items included so that original scale scoring is interpretable. DASS-21 scores have been doubled to produce scores comparable with clinical cutoffs for the 42-item version of the DASS.

Table 2
Within- and Between-Person Differences in Anxiety Predicting Past-Week Worry ($N = 198$)

	b	*β*	*SE*	*t*	χ^2 (1)	*p*
Model 1						
Fixed effects						
Intercept	24.44	0.08	1.90	12.84		<.001
Time 2	1.86	0.10	0.77	2.40		.017
Time 3	1.42	0.07	0.78	1.81		.071
Participant mean DASS-21$_{Anx}$	1.85	0.64	0.13	13.92		<.001
Random effects (*variance, SD*)						
Participant (intercept)	139.02	0.37	11.79			
Residual	58.97	0.15	7.68			
Model 2					57.98	<.001
Fixed effects						
Intercept	24.48	0.09	1.90	12.90		<.001
Time 2	1.69	0.09	0.72	2.35		.019
Time 3	1.40	0.07	0.73	1.92		.055
Participant mean DASS-21$_{Anx}$	1.85	0.64	0.13	13.92		<.001
Participant-centered DASS-21$_{Anx}$	0.86	0.12	0.11	7.88		<.001
Random effects (*variance, SD*)						
Participant (intercept)	142.13	0.37	11.92			
Residual	50.81	0.13	7.13			

Note. DASS-21$_{Anx}$ = Depression Anxiety Stress Scales 21 Anxiety composite; PSWQ-PW = Penn State Worry Questionnaire.

ing at the within- and between-person levels, we constructed a multilevel model with timepoint, participant mean worry, and person-mean centered worry as fixed effects, participant as a random intercept, and difficulty concentrating as the dependent variable (Table 3). Difficulty concentrating was associated with worry both between ($b = 0.20$, $SE = 0.03$, $\beta = 0.38$, $p < .001$) and within ($b = 0.13$, $SE = 0.02$, $\beta = 0.09$, $p < .001$) participants. This means that both an individual's average level of worry (between-person) and deviations from their average level of worry at a given timepoint (within-person) were associated with difficulty concentrating at the same given timepoint. Difficulty concentrating did not significantly vary between timepoints. When this model was rerun controlling for depression severity, sleep disturbance, and COVID-related worries (Table 4), worry remained significantly associated with difficulty concentrating both between ($b = 0.15$, $SE = 0.03$, $\beta = 0.29$, $p < .001$) and within ($b = 0.11$, $SE = 0.02$, $\beta = 0.07$, $p < .001$) participants. Depression symptom severity ($b = 0.10$, $SE = 0.03$, $\beta = 0.11$, $p = .003$) was also significantly associated with difficulty concentrating, but sleep disturbance ($b = 0.13$, $SE = 0.08$, $\beta = 0.04$, $p = .115$) and COVID-related worries ($b = 0.08$, $SE = 0.05$, $\beta = 0.05$, $p = .118$) were not.

Mediation Analysis

To test the third hypothesis, that worry would fully mediate the relationship between anxiety and difficulty concentrating, we conducted a mediation analysis using structural equation modeling.

Table 3
Within- and Between-Person Differences in Past-Week Worry Predicting Difficulty Concentrating ($N = 187$)

	b	β	*SE*	*t*	χ^2 (1)	*p*
Model 1						
Fixed effects						
Intercept	39.79	0.03	1.62	24.56		<.001
Time 2	−0.01	−0.00	0.36	−0.01		.989
Time 3	0.75	0.08	0.36	2.08		.039
Participant mean PSWQ-PW	0.20	0.38	0.03	6.31		<.001
Random effects (*variance, SD*)						
Participant (intercept)	53.54	0.62	7.32			
Residual	11.72	0.14	3.42			
Model 2					29.08	<.001
Fixed effects						
Intercept	39.98	0.05	1.62	24.72		<.001
Time 2	−0.30	−0.03	0.35	−0.86		.393
Time 3	0.50	0.05	0.35	1.41		.158
Participant mean PSWQ-PW	0.20	0.38	0.03	6.31		<.001
Participant-centered PSWQ-PW	0.13	0.09	0.02	5.48		<.001
Random effects (*variance, SD*)						
Participant	53.68	0.62	7.33			
Residual	10.86	0.13	3.30			

Note. PSWQ-PW = Penn State Worry Questionnaire–Past Week; ACS = Attentional Control Scale.

Table 4
Sensitivity Analyses With Depression Severity, Sleep Disturbance, and COVID-Related Worries as Covariates

	b	β	*SE*	*t*	*p*
Model predicting PSWQ-PW ($N = 198$)					
Fixed effects					
Intercept	24.09	0.08	1.89	12.74	<.001
Time 2	1.60	0.08	0.72	2.24	.026
Time 3	1.37	0.07	0.72	1.90	.059
Participant mean DASS-21$_{Anx}$	1.66	0.58	0.15	11.25	<.001
Participant-centered DASS-21$_{Anx}$	0.73	0.10	0.12	6.19	<.001
DASS-21$_{Dep}$	0.19	0.10	0.07	2.77	.006
Random effects (*variance, SD*)					
Participant (intercept)	140.44	0.37	11.85		
Residual	50.24	0.13	7.09		
Model predicting ACS ($N = 187$)					
Fixed effects					
Intercept	37.42	0.05	2.14	17.50	<.001
Time 2	−0.32	−0.03	0.35	−0.94	.350
Time 3	0.47	0.05	0.35	1.32	.188
Participant mean PSWQ-PW	0.15	0.29	0.03	4.69	<.001
Participant-centered PSWQ-PW	0.11	0.07	0.02	4.38	<.001
DASS-21$_{Dep}$	0.10	0.11	0.03	3.02	.003
PROMIS™ Sleep-SF	0.13	0.04	0.08	1.58	.115
CRISIS Worries	0.08	0.05	0.05	1.57	.118
Random effects (*variance, SD*)					
Participant	52.00	0.60	7.21		
Residual	10.53	0.12	3.25		

Note. DASS-21$_{Anx}$ = Depression Anxiety Stress Scales 21 Anxiety composite; PSWQ-PW = Penn State Worry Questionnaire–Past Week; ACS = Attentional Control Scale; DASS-21$_{Dep}$ = Depression Anxiety Stress Scales 21 Depression subscale; PROMIS™ Sleep-SF = Patient-Reported Measurement Outcomes Information System (PROMIS)™ Sleep Disturbance – Short Form; CRISIS Worries = Coronavirus Health Impact Survey COVID Worries Domain.

All parameters were estimated simultaneously, standardized estimates were computed using all path information, and standard errors were computed through 5,000 bootstrapped samples. The initial path model regressed T3 difficulty concentrating on T2 worry and T1 anxiety, and T2 worry

on T1 anxiety. All paths were significant (total effect of T1 anxiety on T3 difficulty concentrating: $b = 0.51$, $SE = 0.08$, $\beta = 0.41$, CI = [0.36—0.66]; indirect effect of T1 anxiety on T3 difficulty concentrating through T2 worry: $b = 0.18$, $SE = 0.07$, $\beta = 0.15$, CI = [0.06—0.32]; direct effect of T1 anxiety on T3 difficulty concentrating: $b = 0.32$, $SE = 0.09$, $\beta = 0.26$, CI = [0.15—0.51]). See Figure 1 for other path coefficients. Effect size was evaluated as the ratio of the indirect effect to the total effect ($b = 0.36$, $SE = 0.13$, $\beta = 0.36$, CI = [0.11—0.65]). This suggests that 36% of the total effect of anxiety on difficulty concentrating was statistically attributable to worry in the specified model, consistent with partial mediation. Our hypothesis of full mediation was therefore not supported.

Post-hoc linear regression tests of the pairwise relationships between anxiety, worry, and difficulty concentrating from one timepoint to the next, controlling for each outcome at the previous timepoint, were conducted (see Table S6 in Supplemental Materials).

SENSITIVITY ANALYSES

The path model testing worry as a mediator of the association between anxiety and difficulty concentrating was rerun adding covariates in two steps. After regressing each outcome on itself at the previous timepoint, the main paths of interest were no longer significant (total effect of T1 anxiety on T3 difficulty concentrating: $b = 0.05$, $SE = 0.05$, $\beta = 0.04$, CI = [−0.05—0.16]; indirect effect of T1 anxiety on T3 difficulty concentrating through T2 worry: $b = 0.01$, $SE = 0.01$, $\beta = 0.004$, CI = [−0.008—0.03]; direct effect of T1 anxiety on T3 difficulty concentrating: $b = 0.05$, $SE = 0.06$, $\beta = 0.04$, CI = [−0.06—0.16]). See Figure 2 for other path coefficients. Effect size was evaluated as the ratio of the indirect effect to the total effect ($b = 0.10$, $SE = 20.59$, $\beta = 0.10$, CI = [−0.19—22.81]), suggesting that 10% of the total effect of T1 anxiety on T3 difficulty concentrating is statistically attributable to T2 worry in the specified model.

In the second step, we added paths for worry, difficulty concentrating, depression symptom severity, and sleep disturbance at T1 and retained paths from the above model regressing each outcome on itself at the previous timepoint. With the addition of worry, difficulty concentrating, depression symptom severity, and sleep disturbance at T1 as exogenous predictors, the main paths of interest were no longer significant (total effect of T1 anxiety on T3 difficulty concentrating: $b = 0.07$, $SE = 0.07$, $\beta = 0.05$, CI = [−0.07—0.21]; indirect effect of T1 anxiety on T3 difficulty concentrating through T2 worry: $b = 0.01$, $SE = 0.01$, $\beta = 0.01$, CI = [−0.003—0.05]; direct effect of T1 anxiety on T3 difficulty concentrating: $b = 0.05$, $SE = 0.07$, $\beta = 0.04$, CI = [−0.09—0.19]). See Figure 3 for other path coefficients. Effect size was evaluated as the ratio of the indirect effect to the total effect ($b = 0.21$, $SE = 255.72$, $\beta = 0.21$, CI = [−0.08—36.90]), suggesting that 21% of the total effect of anxiety on difficulty concentrating is statistically attributable to worry in the specified model.

Discussion

The present study tested whether the well-established relationship between anxiety and subjective difficulty concentrating may be attributable to worry. Consistent with hypotheses, at both the within- and between-person levels, more severe anxiety incrementally predicted more severe worry, and more severe worry incrementally predicted more severe difficulty concentrating. These associations were robust when controlling for depression symptom severity, sleep disturbance, and COVID-related worries. In pairwise comparisons, anxiety also prospectively predicted increases in worry, which held when controlling for worry severity at the previous timepoint. However, worry did not prospectively predict increases in difficulty concentrating after controlling for difficulty concentrating at the previous timepoint. Rather than the hypothesized full mediation, worry partially mediated the association between anxiety and difficulty concentrating. In the simple mediation model, worry was a significant predictor of difficulty concentrating. However, the indirect effect of anxiety on difficulty concentrating through worry was nonsignificant when controlling for outcomes at previous timepoints and other possible sources of variance.

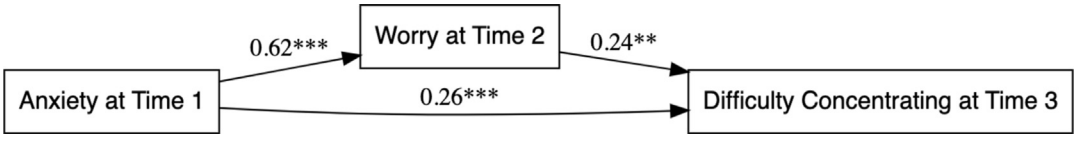

FIGURE 1 **Mediation models.** Structural equation model with worry as a mediator of the association between anxiety and difficulty concentrating, without covariates ($N = 184$). Coefficients are standardized betas.

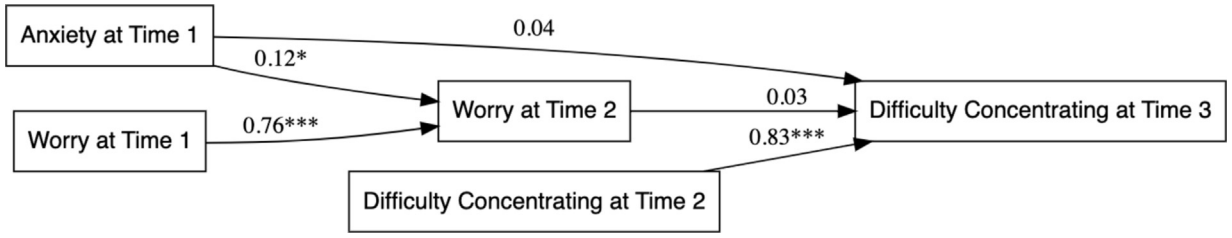

FIGURE 2 **Mediation model with covariates.** Structural equation model with worry as a mediator of the association between anxiety and difficulty concentrating, regressing each outcome on itself at the previous timepoint (N = 180). Coefficients are standardized betas. All paths are estimated simultaneously so path coefficients represent the effect of each predictor on the linked outcome controlling for all other predictors linked to that outcome.

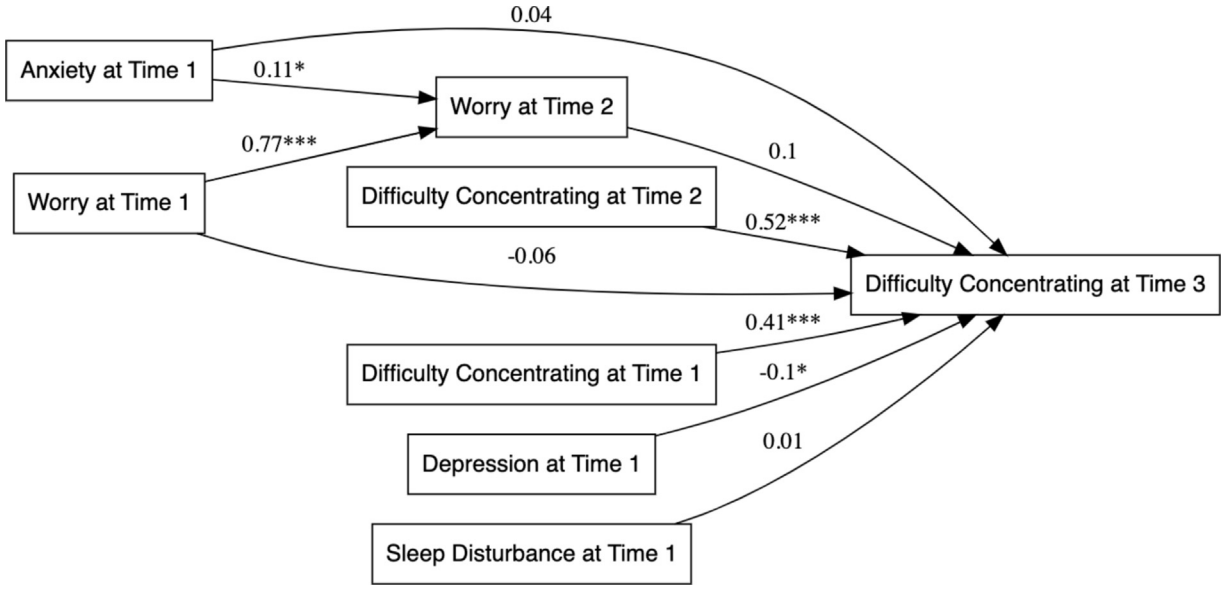

FIGURE 3 **Mediation model with full covariates.** Structural equation model with worry as a mediator of the association between anxiety and difficulty concentrating, regressing each outcome on itself at the previous timepoint, and including depression, sleep disturbance, and difficulty concentrating at T1 as additional exogenous predictors of difficulty concentrating at T3 (N = 175). Coefficients are standardized betas. All paths are estimated simultaneously so path coefficients represent the effect of each predictor on the linked outcome controlling for all other predictors linked to that outcome.

We found clear support for a within-person relationship between worry and anxiety: when participants experienced higher anxiety relative to their own average, they also experienced higher worry, and this association remained significant when controlling for depressive symptoms and individual differences in anxiety. This pattern of results is consistent with prior longitudinal research documenting a robust relationship between anxiety and worry (Calmes & Roberts, 2007; Hong, 2007), and suggests that worry severity tracks with fluctuations in anxiety symptom severity over time, consistent with theoretical perspectives of psychopathology as a dynamic system of within-person processes (Mestdagh & Dejonckheere, 2021). Although assessed over a longer timescale, the present findings align with prior experience sampling research showing that within-person increases in worry predict subsequent increases in negative emotion, and that this association is more pronounced in individuals with GAD (Pawluk et al., 2021).

Consistent with theoretical conceptualizations of worry as an emotion regulation strategy, higher T1 anxiety predicted more severe T2 worry, even when controlling for T1 worry. Contemporary theoretical accounts of worry suggest that individuals may be motivated to engage in worry to avoid increases in negative emotionality. Although the original articulation of avoidance theory (Borkovec et al., 2004) described worry as a means to avoid the aversive somatic experience of anxiety, more recent evidence suggests that worry sustains negative emotionality to facilitate avoidance

of negative emotional contrasts (e.g., abrupt increases in distress). In this conceptualization, known as the contrast avoidance model, worry is sustained because chronic distress is preferable to sudden disappointment (Newman & Llera, 2011). That higher anxiety at the initial assessment predicted more severe worry at the following assessment, even controlling for worry at the initial assessment, is consistent with the idea that individuals experiencing higher anxiety may worry more as an emotion regulation strategy.

Higher-than-average worry was also significantly associated with more severe difficulty concentrating within-person, and this association remained significant when controlling for depression severity and sleep disturbance, consistent with theoretical conceptualizations of worry as a source of attentional interference (Eysenck & Calvo, 1992). Specifically, when individuals were experiencing elevated worry relative to their personal average, they also reported experiencing more severe difficulty concentrating. Although strong inferences cannot be drawn, this correlational finding is broadly consistent with a causal mechanistic framework in which worry interferes with attentional functioning through the consumption of cognitive resources (e.g., Eysenck & Calvo, 1992; Hirsch & Mathews, 2012). However, mean levels of difficulty concentrating did not significantly vary by timepoint, consistent with prior work showing that self-reported attentional control has time-invariant as well as time-varying components (Olatunji et al., 2021).

In contrast to mechanistic models of anxiety and attention (e.g., Eysenck et al., 2007; Hirsch & Mathews, 2012), which propose that impairments in attentional control both maintain pathological worry and interfere with attentional functioning, the present study found that within-person increases in worry temporally precede associated increases in difficulty concentrating. Although preliminary, these findings are broadly consistent with a model in which elevated worry over time might contribute to impairments in subjective attentional functioning. (Note, however, that the reverse direction was not tested; i.e., difficulty concentrating predicting worry.) For example, higher worry may increase attentional bias to threat (Goodwin et al., 2017), which may lead to preferential attending to negative information over task-relevant information, resulting in increased difficulty concentrating on the task at hand (Basanovic et al., 2021). The impact of worry on subjective attentional functioning should be further investigated, to clarify the mechanisms by which worry may impair subjective attentional performance.

Contrary to hypotheses, worries about the COVID-19 pandemic were not associated with difficulty concentrating after controlling for general worry severity. This pattern suggests that the broader pathological features of worry (e.g., excessiveness, uncontrollability), rather than pandemic-related worry specifically, were more closely related to attentional disturbance. It is particularly surprising that COVID-related worries were not uniquely associated with difficulty concentrating in light of the uncertainty, threat, and negatively valenced information that characterized the pandemic context. These environmental features play a significant role in prominent theoretical accounts of anxiety-related psychopathology (Borkovec et al., 2004; Hirsch & Mathews, 2012; Norr et al., 2013). COVID-related stress includes multiple pandemic-related worry topics (Taylor et al., 2020), and high levels of COVID-related stress have been linked to more severe GAD symptoms for nonclinical participants reporting worse difficulty concentrating (Bardeen et al., 2022). In contrast, our findings appear to be consistent with a broader theoretical model in which worry, particularly the pathological (perseverative and difficult-to-control) components of worry, directly interferes with attentional functioning by consuming cognitive capacity, resulting in a subjective experience of difficulty concentrating.

The finding that worry partially mediated the effect of anxiety on difficulty concentrating aligns with theoretical models implicating worry as a possible mechanism underlying the association between anxiety and attentional dysfunction (Eysenck & Calvo, 1992; Hirsch & Mathews, 2012). However, this effect did not survive the addition of covariates, and a similar pattern of results emerged for a competing model with anxiety as a mediator of the association between worry and difficulty concentrating. These results suggest that anxiety and worry may have a shared impact on difficulty concentrating, consistent with prior cross-sectional (Hallion et al., 2018) and prospective longitudinal (Olatunji et al., 2021; Zainal & Newman, 2021) work linking worry and GAD to subjective or task-indexed attentional impairments. Additionally, T1 depression was independently associated with T3 difficulty concentrating, controlling for all other predictors. Depressive symptoms are theorized to have a reciprocal self-maintaining relationship with impaired attentional disengagement from negative information (Koster et al., 2011), which may explain the robust

associations in the present study between depression severity and difficulty concentrating.

The present study should be interpreted in light of several strengths and limitations. This study stands among the few that have characterized the relationship between worry and subjective difficulty concentrating in a nonclinical sample varying in anxiety severity (O'Carroll & Fisher, 2013; Williams et al., 2017). Strengths include the use of a naturalistic longitudinal dataset collected during a globally salient naturalistic stressor and the use of multilevel modeling to test symptom relationships at the between- and within-person levels. In terms of limitations, the reliance of the larger study on a convenience sample of adults recruited from prior research studies could have missed insights into the mental health of understudied and vulnerable populations during the COVID-19 pandemic. Although the examination of prospective associations between worry and subjective difficulty concentrating is a strength, the present study's use of descriptive self-report data with several months between assessment waves could have missed symptom dynamics that unfold on more granular timescales, such as worry interfering directly with concentration (Leigh & Hirsch, 2011), attention to task-relevant versus task-irrelevant attention (McVay & Kane, 2013), or anxiety impacting cognitive performance efficiency rather than effectiveness (Eysenck et al., 2007). Using only self-report data also carries the risk of shared method variance, potentially inflating the strength of observed associations.

The present findings provide preliminary support for the role of worry in anxiety-related subjective attentional symptoms, and suggest that worry-focused interventions (e.g., cognitive-behavioral or mindfulness-based interventions; Querstret & Cropley, 2013) may be useful for clients with elevated anxiety who present with concentration difficulties. However, future research is needed to clarify the directionality, causality, and mechanisms of these associations and strengthen recommendations for practitioners. A recent neurocognitive update to processing efficiency theory proposed a bidirectional relationship between worry and impaired attentional control (Eysenck et al., 2023), suggesting that future research may benefit from statistical approaches that can assess directional relations over time, such as cross-lagged panel models (Baribeau et al., 2022). More intensive sampling designs (e.g., ecological momentary assessment, experience sampling methods) with briefer assessments may be able to capture fluctuations in attentional capacity and anxiety symptoms on shorter timescales (Hoffart et al., 2023; Naragon-Gainey, 2019; but see Mestdagh & Dejonckheere, 2021, for a review of psychometric considerations in ambulatory assessment). Taken together, the present findings support a model of subjective difficulty concentrating in anxiety as a multidetermined phenomenon, and suggest that the potential role of perseverative cognition such as worry warrants continued investigation.

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