

The Recursive Cycle of Perceived Mindset and Psychological Distress in College

Kathryn M. Kroeper¹, Laura K. Hildebrand², Tao Jiang³,
Ariana Hernandez-Colmenares², Katrina Brown¹, Abigail Wilk¹,
Steven J. Spencer², Andrew F. Heckler², & Kentaro Fujita²

Accepted Manuscript

Social Psychological and Personality Science.

© 2024, Social and Personality Psychology Consortium. This paper is not the copy of record and may not exactly replicate the final, authoritative version of the article. The final article is available via its DOI: <https://doi.org/10.1177/19485506241247384>

¹ Sacred Heart University

² The Ohio State University

³ Northwestern University

Author Note

The corresponding author is Kathryn M. Kroeper, Department of Psychology, Sacred Heart University, <https://orcid.org/0000-0003-2701-5053>; Email: kroeperk@sacredheart.edu.

Word Count: 5,068 (excluding references, tables, table notes, figures, and figure captions)

Author Biographies

Kathryn M. Kroeper is an Assistant Professor at Sacred Heart University.

Laura K. Hildebrand is a postdoctoral fellow at The Ohio State University.

Tao Jiang is a postdoctoral fellow at Northwestern University.

Ariana Hernandez-Colmenares is a graduate student at The Ohio State University.

Katrina Brown is an undergraduate student at Sacred Heart University.

Abigail Wilk is an undergraduate student at Sacred Heart University.

Steven J. Spencer is a Professor of Psychology at The Ohio State University.

Andrew F. Heckler is a Professor of Physics at The Ohio State University.

Kentaro Fujita is a Professor of Psychology at The Ohio State University.

Author Contributions

Kathryn M. Kroeper: conceptualization, methodology, software, formal analysis, writing (original draft), writing (review and editing), visualization; **Laura K. Hildebrand:** data curation, validation, writing (review and editing); **Tao Jiang:** methodology, formal analysis, validation, writing (review and editing); **Ariana Hernandez-Colmenares:** data curation, writing (review and editing); **Katrina Brown:** literature review, writing (review and editing); **Abigail Wilk:** literature review, writing (review and editing); **Steven J. Spencer:** writing (review and editing), supervision; **Andrew F. Heckler:** conceptualization, methodology, investigation, project administration, writing (review and editing), supervision; **Kentaro Fujita:** conceptualization, writing (review and editing), supervision.

Acknowledgements

We would like to express gratitude to Tina Nguyen and Sri Suresh for their assistance with data curation, cleaning, project administration, and preliminary analyses.

Abstract

College students are experiencing a significant mental health crisis, with rising rates of psychological distress. To help understand this trend, the present study examines recursive relationships in the classroom between perceived mindset beliefs—i.e., whether students perceive *others* in their classroom to view intelligence as malleable or fixed—and psychological distress. Across three time points, 288 undergraduates taking a physics course completed measures of perceived classroom mindset and psychological distress. Random intercept cross-lagged panel analyses, which controlled for demographic factors and students' own mindset beliefs, revealed that perceiving the classroom culture as more fixed-minded early in the semester was associated with increased psychological distress later. Likewise, increased psychological distress early in the semester was associated with perceiving the classroom culture to be more fixed-minded later. These findings suggest that perceived mindset and distress are mutually reinforcing, highlighting the importance of addressing both in interventions aimed at alleviating student distress.

Abstract Word Count: 149

Keywords: mindset cultures, growth-mindset, fixed-mindset, psychological distress, recursive processes

The Recursive Cycle of Perceived Mindset and Psychological Distress in College

*“This class has **destroyed me** [...] Like **I walk in [the classroom] and feel more discouraged and dumber every day** [...] I don’t understand the point of writing a test, where the assumption is that, like the highest grade is going to be a 60%. Like what does that do other than discourage students and make them feel dumb?”*

- Alice, a college physics student (Le, 2022)

Today’s college students are grappling with a mental health crisis, as evidenced by the growing prevalence of depression, anxiety, and other forms of psychological distress over the past 15 years (Duffy et al., 2019). This has led to a surge in treatment-seeking behavior on campuses (Lipson et al., 2019) and the need for educational institutions to focus on alleviating student distress. In this work, we explore how perceptions that one’s classmates, teaching assistants, and instructors believe intelligence to be fixed versus malleable (i.e., perceived classroom mindset beliefs) represents both an antecedent and consequence of psychological distress among college students. Notably, this work uniquely explores the temporal dynamics of this relationship, demonstrating for the first time that perceived classroom-level fixed mindset beliefs and psychological distress may mutually reinforce each other in the classroom.

Student-Level Mindset Beliefs and Psychological Distress

College students’ beliefs about the fixed (vs. malleable) nature of their own traits, such as their intelligence, may worsen mental health issues, especially when students encounter adversity (Yeager & Dweck, 2023). Two recent meta-analyses have shown that endorsing *fixed* mindset beliefs, or believing that human traits are mostly stable and unchangeable, is linked to increased psychological distress (e.g., anxiety, depression, and stress), whereas embracing *growth* mindset beliefs, or believing that human traits can be developed through hard work, persistence, and seeking help from others, is linked to psychological well-being (Burnette et al., 2020; Schleider

et al., 2015).¹ When students hold fixed mindset beliefs, experiencing setbacks, such as earning a poor test grade or receiving critical feedback from an instructor, can be paralyzing. For these students, failure in the classroom is often attributed to a lack of inherent ability, leading to a sense of hopelessness and perceived inability to overcome their academic challenges (Seo et al., 2022). This in turn fuels psychological distress (Liu et al., 2015). In contrast, students with a growth mindset are less bothered by setbacks because, instead of seeing setbacks as evidence of a permanent inadequacy, they view them as chances to enhance their skills (Yeager & Dweck, 2023).

Classroom-Level Mindset Beliefs and Psychological Distress

The relationship between mindset and psychological distress in the classroom is not simply a matter of *individual* beliefs. The mindset *culture* in a classroom can affect student distress too. Mindset cultures are reflected in a classroom's collective norms, values, policies, and practices (Murphy & Dweck, 2010; Murphy & Reeves, 2019), and they are created and sustained by various actors in the classroom environment, such as instructors, teaching assistants, and even peers (Muenks et al., 2021; Muenks & Yan, 2023; Yeager et al., 2019, 2022). In a fixed-mindset classroom culture the emphasis is on celebrating talent and brilliance, and distinguishing between students who supposedly possess these qualities from those who do not, leading to limited constructive feedback from instructors or peers because it is presumed that certain students lack the potential to improve (Kroeper, Fried, et al., 2022; Kroeper, Muenks, et al., 2022; Rissanen et al., 2018; Sun, 2019). In a growth mindset classroom culture, however, it is emphasized that traits are malleable, and students will improve as long as they put in effort, experiment with new strategies, and seek help when struggling. In such a culture, persistence and

¹ Fixed and growth mindsets are also often referred to as entity and incremental lay theories (e.g., Dweck et al., 1995). For the purposes of this paper, we use the terms fixed and growth mindsets.

hard work are valued, and feedback plays a crucial role in improvement. As a result, numerous opportunities to receive constructive feedback from instructors and peers are offered to students.²

Recent research in educational contexts has demonstrated that fixed mindset classroom cultures can worsen psychological distress (e.g., increasing negative affect and imposter feelings),³ whereas growth mindset cultures can provide psychological strength for students—even after accounting for students' own self-reported mindset beliefs (see Canning et al., 2022; LaCosse et al., 2021; Muenks et al., 2020). Consequently, growth mindset cultures tend to foster academic motivation and achievement, whereas fixed mindset cultures impede them (e.g., Canning et al., 2019, 2022; Yeager et al., 2022). A longitudinal field study by Muenks et al. (2020) examined mindset perceptions and psychological distress among college students using an experience sampling method. They found that when students perceived their professors to endorse fixed (vs. growth) mindset beliefs, students experienced greater psychological distress, such as lower belonging, increased evaluative concerns and imposter feelings, and heightened negative affect. This, in turn, predicted lower course engagement, including reduced class attendance, greater drop-out intentions, and lower grades (see also Yeager et al., 2019, 2022). Simply put, when students perceive that opportunities for growth are limited, they may feel *hopeless*, which is known to prompt *psychological distress* (Abramson et al., 1989; Liu et al., 2015).

² Here, we refer to mindset cultures as "fixed" or "growth" for brevity, but it is crucial to note that these cultures exist on a continuum, ranging from highly growth-oriented classroom cultures to highly fixed-oriented ones, similar to the continuum of student-level mindset beliefs (Murphy & Reeves, 2019).

³ We use the term "psychological distress" to refer to what was previously called "psychological vulnerability." This deliberate change emphasizes distress as a negative outcome in its own right, rather than solely a risk factor for other negative outcomes, like poor grades and retention.

Reinforcing Recursive Processes: The Mindset-Distress Cycle

So far, we have argued that perceived classroom mindset beliefs can lead to psychological distress and a considerable literature supports this conclusion (e.g., Canning et al., 2022; LaCosse et al., 2021; Muenks et al., 2020). We extend this reasoning, however, with a novel argument that this relationship is *recursive*: not only does perceiving a fixed mindset classroom culture lead to psychological distress, but psychological distress leads to perceiving the classroom culture to be fixed-minded.

The potential for psychological distress to shape perceptions of the classroom mindset culture can be understood as arising from two common cognitive responses to distress: enhanced threat detection and overgeneralization. First, when experiencing distress, people become more attuned to potential threats in their environment (e.g., Bar-Haim et al., 2007; Cisler & Koster, 2010; MacLeod et al., 2019). For distressed students, this heightened sensitivity may lead to a greater awareness of fixed mindset cues that threaten their sense of competence in the classroom, such as overhearing a peer boast, “I aced that test without even studying—physics just comes *naturally* to me” (Muenks & Yan, 2023). In contrast, less distressed students may not as readily detect fixed mindset cues, perhaps perceiving more growth mindset cues or a more balanced mix of both.

Second, people experiencing distress tend to engage in negative thinking patterns (Beck, 2016; Shickel et al., 2020), such as overgeneralization and absolutist “all-or-nothing” thinking (Al-Mosaiwi & Johnstone, 2018; Antoniou et al., 2017; Yeager & Dweck, 2023). Thus, once a few fixed-mindset cues are detected, there's a possibility that distressed students might generalize them into a broader perception of a fixed-minded culture (e.g., “*Everyone* here is trying to figure out who has what it takes and who doesn't”), fomenting feelings of hopelessness and reinforcing

the distress. Less distressed students, in contrast, may be more likely to resist the inclination to form quick judgments about the mindset culture based on limited observations, preferring more data or drawing more nuanced conclusions about the classroom mindset culture.

This creates a mindset-distress cycle that can trap distressed students: perceptions of a fixed mindset culture beget distress, which in turn reinforces the perception of a fixed-minded culture. By exploring this recursive relationship, our study offers a more nuanced, comprehensive understanding of the mutually reinforcing dynamics of classroom mindset beliefs and psychological distress than previous research.

The Current Study

We investigate the recursive relationship between perceived mindset beliefs and psychological distress in the classroom. Our goal is to determine whether changes in perceived classroom mindset predict changes in psychological distress, and whether changes in psychological distress predict changes in perceived classroom mindset. By examining these recursive relationships, we aim to enhance our understanding of the complex interplay between mindset beliefs and mental distress, as well as identify potential intervention points to disrupt the mindset-distress cycle.

Method

All procedures and measures received approval from the Institutional Review Board (IRB) at the data collection site. This study analyzes data from a larger project on psychological distress and performance in introductory college physics; measures, procedures, and research questions were pre-registered. However, the specific analytical approach was not pre-registered. For the full list of variables and research questions for the larger project, please see: https://osf.io/wt3v2/?view_only=4d3bd58b6d994256a92078b8ee5726f0.

Participants

Over one semester, 383 undergraduate students taking a physics course at a large public research university in the Midwest consented to participate in the present research, out of 503 students enrolled in the course.⁴ The consenting sample consisted of 68.9% men and 29.2% women, with 1.8% not reporting their gender. The racial/ethnic makeup of the sample was 68.7% White, 18.0% Asian, 5.0% Black, 3.9% Latine, 0.5% Pacific Islander, 0.2% American Indian/Alaska Native, and 3.7% not reported.

Sensitivity Analysis

Our final sample size, restricted to 288 students, was determined by the number of enrolled participants who consented and provided complete data. Because we used a random intercept cross-lagged panel model (RI-CLPM) to test the hypothesized recursive relationship, we implemented a sensitivity power analysis for RI-CLPM (Mulder, 2023). The results indicated that this sample size provides 75% statistical power to detect cross-lagged effects as small as $\beta = .25$ at $p = .05$.

Classroom Context

The focal classroom was an introductory calculus-based physics course designed for undergraduate students majoring in physical sciences, mathematics, and engineering. The course consisted of three large lecture sections with 91 to 156 consenting students, led by one of two main instructors and held three times per week online via Zoom due to the COVID-19 pandemic.

⁴ Throughout the term, all enrolled students completed weekly surveys, which accounted for 3% of their overall course grade. However, only students who provided consent and agreed to have their survey responses utilized for research purposes were included in the final sample.

The course also included weekly group-work recitation sections via Zoom with 13 to 24 consenting students, led by a teaching assistant.⁵

Procedure

All students enrolled in the course were invited to participate in a study exploring psychological factors affecting their academic experiences. Throughout the term, students completed weekly online surveys that included measures assessing their personal mindset beliefs, perceptions of classroom cultural mindset, and psychological distress.⁶ Attrition on primary measures was low: 97.13% completed the Week 3 survey, 96.08% completed the Week 8 survey, and 93.21% completed the Week 13 survey. However, complete covariate information (i.e., gender and ACT score) were only obtained for 82.2% participants, via university records. An overview of relevant survey questions and measurement administration details is provided in Table 1.⁷

Primary Measures

Perceived Classroom Mindset Beliefs refer to students' perceptions of the mindset culture in their classroom, including the perceived beliefs of their instructors, TAs, and peers (Good et al., 2012; Kroeper, Muenks, et al., 2022; Muenks et al., 2020). Students responded to six items that asked them to rate their perceptions of others' mindset beliefs, with higher scores indicating stronger endorsement of fixed mindset beliefs at the classroom-level.

⁵ The total number of enrolled students in the three lecture sections ranged from 136 to 206, with recitation sections ranging from 24 to 31 enrolled students.

⁶ As part of a larger data collection effort, additional measures were collected for purposes other than the present research (see the pre-registration, https://osf.io/wt3v2/?view_only=4d3bd58b6d994256a92078b8ee5726f0).

⁷ Given prior research linking teachers' mindset beliefs and student psychological distress on academic performance (Canning et al., 2019; Muenks et al., 2020; Suresh & Heckler, 2023), we retrieved final exam performance and final grade information from university records for exploratory analyses. However, all effects of interest were nonsignificant, $ps > .106$, potentially due to sample size or pandemic-related accommodations. See SOM for detailed results and discussion of these exploratory analyses.

Table 1. *Self-Report Measures by Administration Timing*

| Measure | Item(s) | Week(s) Administered |
|--|---|-------------------------|
| Student-Reported Mindset Beliefs ($\alpha = .80$) | <p><u>Item 1^b</u>: “You have a certain amount of physics intelligence, and you can’t really do much to change it.”</p> <p><u>Item 2^b</u>: “Only very few specially qualified people are capable of really understanding physics.”</p> <p><u>Item 3^{b*}</u>: “No matter how much physics intelligence you have, you can always change it quite a bit.”</p> <p><u>Item 4^{b*}</u>: “Anyone can become good at solving physics problems through hard work.”</p> | 2 |
| Perceived Classroom Mindset Beliefs ($\alpha \geq .91$) | <p><u>Item 1^b</u>: “My physics professor seems to believe that students have a certain amount of intelligence, and they really can’t do much to change it.”</p> <p><u>Item 2^b</u>: “My physics professor seems to believe that some students are smart, while others are not.”</p> <p><u>Item 3^b</u>: “My physics TA seems to believe that students have a certain amount of intelligence, and they really can’t do much to change it.”</p> <p><u>Item 4^b</u>: “My physics TA seems to believe that some students are smart, while others are not.”</p> <p><u>Item 5^b</u>: “Most others in my physics class seem to believe that people have a certain amount of intelligence, and they really can’t do much to change it.”</p> <p><u>Item 6^b</u>: “Most others in my physics class seem to believe that some students are smart, while others are not.”</p> | 3, 8, 13 |
| Psychological Distress in the Classroom ($\alpha \geq .90$) | <p><u>Belonging 1^{a*}</u>: “How comfortable do you feel during this class?”</p> <p><u>Belonging 2^{a*}</u>: “How accepted do you feel during this class?”</p> <p><u>Evaluative Concerns 1^a</u>: “In class, how much do you worry that your professor might think that you were a slow learner?”</p> <p><u>Evaluative Concerns 2^a</u>: “In class, how much do you worry that your professor might not believe in your abilities to do well in this class?”</p> <p><u>Imposter Feelings 1^b</u>: “In class, I feel afraid others will discover how much knowledge or ability I really lack.”</p> <p><u>Imposter Feelings 2^b</u>: “In class, I feel like people might find out that I am not as capable as they think I am.”</p> <p><u>Negative Affect 1^c</u>: “When I am in class, I feel distressed.”</p> <p><u>Negative Affect 2^c</u>: “When I am in class, I feel upset.”</p> <p><u>Social Comparison Concerns 1^d</u>: “I often leave this physics class feeling like I am not as smart as others.”</p> <p><u>Social Comparison Concerns 2^d</u>: “I often leave this physics class feeling like I am the only who doesn’t understand the material well.”</p> | 3, 8, 13 |

Note. ^a Rated from 1 (*Not at all*) to 6 (*Extremely*). ^b Rated from 1 (*Strongly disagree*) to 6 (*Strongly agree*). ^c Rated from 1 (*Not at all*) to 6 (*A huge amount*). ^d Rated from 1 (*Almost never true of myself*) to 7 (*Almost always true of myself*). * Item was reverse scored.

Psychological Distress measures the negative psychological experiences that occur in the classroom (Muenks et al., 2020). To evaluate the level of psychological distress students experienced in their physics class, we measured their belonging, evaluative concerns, imposter feelings, negative affect, and social comparison concerns (10-items) every week. To standardize the measurements, we used the Percent of Maximum Possible (POMP) rescaling technique to transform all items to a uniform 0 to 100 scale (Moeller, 2015). We then computed the average psychological distress score for each student for each week of the term, with higher scores indicating greater psychological distress. Confirmatory factor analyses indicated a strong fit (weekly CFI $\geq .97$; weekly RMSEA $\leq .11$; weekly SRMR $\leq .05$; see SOM). For the purposes of our model, we focused on Weeks 3, 8, and 13 to align with the frequency of the Perceived Classroom Mindset Beliefs assessments.

Covariates

Student-Reported Mindset Beliefs refer to students' beliefs about the malleability or fixedness of their own physics ability. Consistent with past mindset research, we expected students who strongly endorsed fixed mindsets to report more psychological distress in the classroom (e.g., Burnette et al., 2020). Further, previous research has also shown that one's own mindset beliefs can influence perceptions of others' mindset beliefs (e.g., Kroeper, Muenks, et al., 2022). Therefore, we included student-reported mindset beliefs as a covariate in our main analysis. Toward the start of the term (Week 2), students responded to four items adapted from Dweck (1999) assessing their personal mindset beliefs about their physics ability. Higher scores represent stronger endorsement of fixed mindset beliefs. As expected, preliminary analyses revealed that student-reported mindset beliefs toward the start of the term were moderately

correlated with psychological distress ($r \geq .26, p < .001$) and perceived mindset beliefs ($r \geq .30, p < .001$) in the classroom at all three time points, supporting its inclusion as a covariate.

Gender data were obtained from university records. We retained only students who were identified by university records as men or women (98.1%), dropping students whose gender was undisclosed (1.8%). We suspected that women, as members of a social group that is often marginalized and subject to negative stereotypes in the physics context (e.g., Eaton et al., 2020; Skibba, 2019), would experience greater classroom-related psychological distress than men (Good et al., 2012; Murphy & Zirkel, 2015; Rudolph & Conley, 2005) and suspect that others in the classroom endorse greater fixed (vs. growth) mindset beliefs (Canning et al., 2022; Good et al., 2012). Therefore, we included gender as a covariate in our main analysis. As expected, preliminary descriptive analyses revealed that women indeed reported greater psychological distress than men across the three focal time points ($M_{\text{Difference}} \geq 10.77, SE_{\text{Difference}} \leq 2.76, p < .001, d \geq 0.47$). Additionally, women perceived significantly stronger fixed mindset beliefs about physics ability among others in the classroom (i.e., instructors, TAs, peers) compared to men ($M_{\text{Difference}} \geq 0.26, SE_{\text{Difference}} \leq 0.13, p \leq .050, d \geq 0.23$). We also found that women self-reported slightly stronger endorsement of fixed mindset beliefs about their own physics ability toward the start of the term ($M = 2.37, SD = 0.89$) compared to men ($M = 2.12, SD = 0.90, p = .006, d = 0.28$). Taken together, these findings justify the inclusion of gender as a covariate in our main analysis.⁸

ACT scores were obtained from university records and included as a covariate in our main analysis to control for pre-course academic performance. The ACT is a standardized test that measures college readiness in English, math, reading, and science, with scores ranging from

⁸ Exploratory analyses examining moderation by gender and prior academic achievement can be found in the SOM. No significant moderation effects were found for either.

14 to 36 in this sample. We suspected that students with lower ACT scores would be more vulnerable to psychological distress in the physics classroom. Indeed, preliminary analyses revealed negative correlations between ACT scores and classroom psychological distress at all three time points ($r \leq -.17, p \leq .004$), indicating that students with lower ACT scores experienced greater distress. These findings support the inclusion of ACT scores as a covariate in our analysis.

Data Accessibility

To comply with FERPA regulations regarding the protection of students' academic records, the data can be accessed upon request, provided that requesters obtain approval from the IRB. The analysis code is available in the SOM.

Results

We were interested in understanding the recursive, longitudinal relationship between perceived mindset beliefs and psychological distress in the classroom.

We first analyzed descriptive statistics (see Table 2). In line with past research (e.g., Muenks et al., 2021), students perceived their physics classrooms as relatively growth-minded (i.e., $M \geq 2.03$ on a 6-point scale). However, these perceptions slightly shifted towards a fixed mindset over the course of the term, $t(350) = -2.80, p = .005, d = 0.15, 95\% \text{ CI } [0.04, 0.25]$. Students also reported relatively low levels of psychological distress,⁹ but these averages increased throughout the term too, $t(350) = 6.39, p < .001, d = 0.34, 95\% \text{ CI } [0.23, 0.45]$.

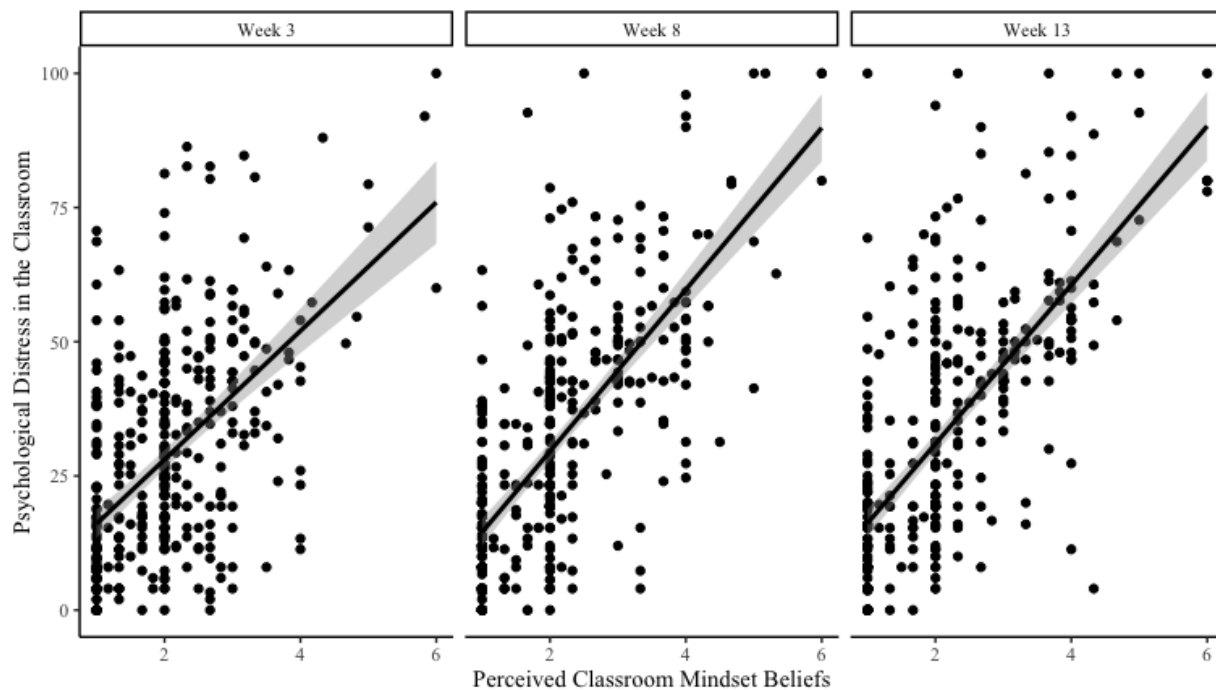
We then examined basic correlational relationships between these variables. Consistent with past work (LaCrosse et al., 2021; Muenks et al., 2020), perceived fixed classroom mindset

⁹ Even though the average levels of psychological distress among students were generally low, a substantial portion still reported experiencing significant distress. For example, in the Week 13 survey conducted at the end of the semester, 23% of the participating students reported a distress score of 50 or more.

beliefs and psychological distress were positively correlated throughout the term (see Figure 1 and Table 2).

Next, we used a random intercept cross-lagged panel model (RI-CLPM) with Mplus (ver. 8.8) to test recursive relationships between perceived classroom mindset beliefs and psychological distress over three time points (Week 3, 8, and 13 of the term). The RI-CLPM controls for trait-like between-person differences, allowing us to test whether within-person changes in perceived classroom mindset beliefs and within-person changes in psychological distress mutually predict each other over time (see Hamaker, 2023 and Hamaker et al., 2015 for technical details of RI-CLPM).¹⁰

Figure 1. *Perceived Mindset Beliefs and Psychological Distress in the Classroom Across the Term*



¹⁰ We also conducted a cross-lagged panel model (CLPM). The results of the CLPM were consistent with those of the RI-CLPM. See SOM for the full CLPM results.

Table 2. *Descriptive Statistics and Zero-Order Correlations*

| Measure | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|--|-----------|--------|--------|---------|--------|--------|-------|------|-------|
| 1) Perceived Classroom Mindset Beliefs (Week 3) | - | | | | | | | | |
| 2) Perceived Classroom Mindset Beliefs (Week 8) | .70*** | - | | | | | | | |
| 3) Perceived Classroom Mindset Beliefs (Week 13) | .63*** | .81*** | - | | | | | | |
| 4) Psychological Distress in the Classroom (Week 3) | .54*** | .64*** | .56*** | - | | | | | |
| 5) Psychological Distress in the Classroom (Week 8) | .53*** | .70*** | .64*** | .83*** | - | | | | |
| 6) Psychological Distress in the Classroom (Week 13) | .49*** | .66*** | .69*** | .73*** | .88*** | - | | | |
| 7) Student-Reported Mindset Beliefs (Week 2) | .40*** | .34*** | .30*** | .39*** | .30*** | .26*** | - | | |
| 8) Student Gender | .13* | .12* | .11 | .28*** | .21*** | .23*** | .13* | - | |
| 9) Student ACT Score | -.07 | -.15** | -.14* | -.19*** | -.18** | -.17** | -.02 | .03 | - |
| | <i>M</i> | 2.03 | 2.16 | 2.16 | 28.41 | 32.02 | 33.30 | 2.20 | 29.22 |
| | <i>SD</i> | 0.95 | 1.08 | 1.14 | 20.83 | 23.21 | 24.35 | 0.90 | 4.06 |
| | α | .91 | .95 | .96 | .94 | .94 | .95 | .80 | - |

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

In these models, we controlled for student-reported mindset beliefs, gender, and ACT performance.^{11, 12} Only participants with complete data for all variables ($N = 288$) were included in the RI-CLPM.¹³ In addition, we placed cross-wave equality constraints for the RI-CLPM, which increases the statistical power of the analyses and enhances the precision of estimates (Orth et al., 2021). We report estimates for the standardized effects (β)¹⁴, 95% CIs for β , and p values.

The overall fit for the RI-CLPM model was good, $\chi^2(20) = 20.47, p = .429$, Comparative Fit Index (CFI) = 1.00, Root Mean Square Error of Approximation (RMSEA) = 0.01. The autoregressive effects were positive and significant for both perceived classroom mindset beliefs and psychological distress (see Figure 2). That is, changes in perceived classroom mindset beliefs at Week 3 were positively associated with changes in perceived classroom mindset beliefs at Week 8, which were positively associated with those at Week 13 ($ps \leq .013$). The same pattern was shown for psychological distress ($ps < .001$, see SOM for the full results).

More importantly, we found significant cross-lagged effects, indicating that perceived classroom mindset beliefs and psychological distress had bidirectional effects over time. Specifically, perceiving other individuals in the classroom as endorsing more fixed mindset beliefs predicted increased psychological distress at the next time point (Week 3 to 8: $\beta = .18$, 95% CI [.05, .31], $p = .009$), and, in turn, increased psychological distress predicted perceiving

¹¹ We also conducted a RI-CLPM that includes classroom section, along with these covariates, and the results remained unchanged.

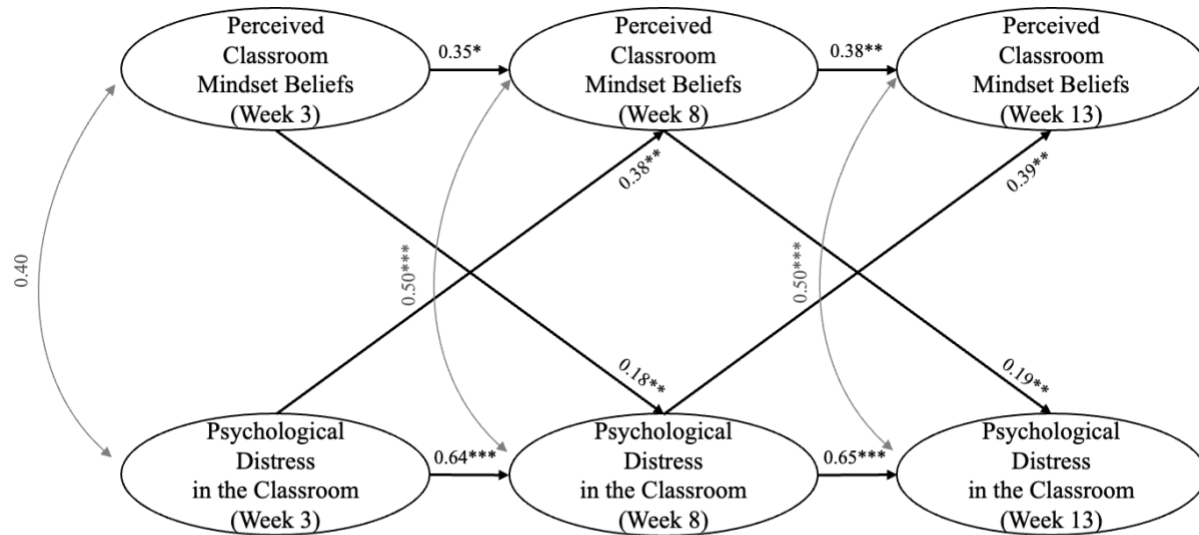
¹² The results of the RI-CLPM remained the same even when these covariates were excluded, indicating that the observed recursive effects are robust and independent of these potential confounding factors.

¹³ We also conducted a RI-CLPM using a full information maximum likelihood (FIML) estimation approach to handle missing data, and the results remained unchanged.

¹⁴ Because we placed cross-wave equality constraints on the *unstandardized* autoregressive and cross-lagged effects, the *standardized* autoregressive and cross-lagged effects are slightly different across waves.

others as endorsing more fixed mindset beliefs (Week 8 to 13: $\beta = .39$, 95% CI [.15, .63], $p = .002$). This pattern suggests the mutual reinforcement of these factors over time.

Figure 2. *The Mindset-Distress Cycle: A Random Intercept Cross-Lagged Model*



Note. $N = 288$ physics students with complete data. Standardized coefficients. Covariates: Student-Reported Mindset Beliefs, Gender, ACT Scores. * $p < .05$, ** $p < .01$, *** $p < .001$

Discussion

Reflecting on the urgent mental health crisis among college students, this study provides novel evidence of a feedback loop between perceived classroom-level fixed mindset beliefs and psychological distress. We found that perceiving others in the classroom as more fixed-minded predicted increased psychological distress in the classroom, which, subsequently predicted perceiving others as more fixed-minded, implying that these factors may be *mutually reinforcing* over time.

Theoretical & Practical Implications

Recent research has delved into how students perceive classroom mindset cultures, focusing particularly on the role of instructor and classroom characteristics (Good et al., 2012; Kroeper, Fried, et al., 2022; Kroeper, Muenks, et al., 2022). Our study expands on this by

considering the influence of student-specific factors, such as psychological distress, on these perceptions. Exploring the temporal dynamics of this relationship constitutes an important and novel contribution to this field of research. Prior studies have established that perceived classroom mindset beliefs can predict psychological distress (Canning et al., 2019, 2022; LaCosse et al., 2021; Muenks et al., 2020; Yeager et al., 2022; Yeager & Dweck, 2023). However, we are the first to document the reverse: psychological distress can foment perceptions of a fixed-minded classroom culture, which in turn intensifies distress. By investigating how these factors reciprocally influence each other over time, we gain valuable insights into students' distress experiences in the classroom.

To contextualize our contribution to the mindset literature, we offer several critical clarifications. First, we recognize that personal distress is just one of many factors that shape perceived mindset beliefs (and vice versa). Specifically, we see our work as an extension of research showing that signals from teachers and peers, such as their messages and behaviors, inform mindset perceptions (e.g., Kroeper, Fried, et al., 2022; Muenks et al., 2021; Yeager et al., 2019). Rather than being mere figments of distressed imaginations, we suggest that these mindset perceptions are grounded in reality—they are reasonable interpretations of tangible cues within the classroom environment (e.g., Canning et al., 2019, 2022; Muenks & Yan, 2022; Rattan et al., 2012; Williams et al., 2021; Yeager et al., 2022). For instance, a teacher's casual remark, 'This topic isn't for everyone,' can signal a fixed mindset culture to students (Kroeper, Muenks, et al., 2022), perhaps especially to those who are already feeling distressed. As such, we interpret distressed students' acute sensitivity to such fixed mindset cues through the lens of threat-orientation, where distress heightens the awareness (Bar-Haim et al., 2007; Cisler & Koster, 2010; MacLeod et al., 2019) and perceived impact of negative stimuli (e.g., Al-Mosaiwi

& Johnstone, 2018). In other words, distressed students might spot fixed mindset cues in the classroom more readily than their non-distressed peers, and then generalize these cues into an impression that the overall culture is fixed-minded. Encountering these cues, which imply limited or undervalued growth opportunities, may lead to feelings of hopelessness and thus, deepen their distress (Abramson et al., 1989; Liu et al., 2015). While our study does not delineate the specific cognitive mechanisms involved in this mindset-distress cycle, it does lay the groundwork for future research. For instance, subsequent studies could use techniques like eye-tracking to dissect how attention to fixed mindset cues is influenced by distress. Finally, it is crucial that our findings are not misinterpreted as a reason to shift blame onto students for their mindset perceptions. Instead, our research suggests one avenue to support student well-being is by creating classroom environments that minimize fixed mindset signals. This approach acknowledges the collective responsibility of students, educators, *and* institutions to cultivate conditions that promote growth mindset cultures on campus.

Recognizing the recursive relationship between perceived mindset beliefs and distress also raises practical considerations for mindset culture interventions. For instance, it may be the case that neither fixed mindset perceptions nor distress can be fully addressed unless they are considered together (Walton & Wilson, 2018). If true, multipronged interventions that simultaneously reduce psychological distress *and* minimize fixed-mindset cues in the classroom may be optimal (Kubzansky et al., 2023). In classrooms where growth mindsets are already the norm, breaking the mindset-distress cycle could entail sharing evidence of the collective growth mindset beliefs among students, TAs, and instructors and, afterward, regularly assessing psychological distress to provide timely support. However, in classrooms where a fixed mindset culture prevails, emphasis could be placed on reshaping the mindset culture. This could involve

collaborating with instructors (who often play a significant role in shaping classroom culture) to create *growth mindset affordances* in their classrooms (Walton & Yeager, 2020; Yeager et al., 2022). These affordances might include shifting classroom norms, values, policies, and practices to emphasize (1) *everyone's* ability to learn, (2) offering feedback and revision opportunities to all students, (3) supporting struggling students with additional emotional and material assistance, and (4) placing value on student learning and development (Kroeper, Fried, et al., 2022; Kroeper, Muenks, et al., 2022). Future research should explore how to integrate these reforms effectively, alongside assessing and addressing students' psychological distress.

Strengths, Limitations & Future Directions

A key strength of the present study is that it uses field data, enabling us to capture contemporaneous mindset perceptions and distress experienced by college STEM students in an actual class, repeatedly throughout an academic term. It is important to note, however, that like other correlational field studies, this research cannot definitively establish causal relations between perceived mindset beliefs and psychological distress. The observed relations may be influenced by an unmeasured third variable affecting both perceived mindset *and* distress. Nevertheless, the study's longitudinal design rules out reverse causation,¹⁵ and by collecting data at multiple timepoints, we mitigate issues related to recollection. Despite the limitations in causal inference, field data bolsters ecological and external validity.

In our study, there were only three course sections, and most students perceived them as growth-minded, which limited the variability in perceived classroom mindset. Yet, despite this limited variability, we detected a self-defeating cycle linking perceived fixed-mindset beliefs and distress. This raises the possibility that the observed effect sizes may be *underestimations* and

¹⁵ As Week 3 temporally precedes Week 8, it is impossible for Week 8 mindset perceptions to have caused Week 3 distress. This same reasoning applies to the observed relationships linking Weeks 8 and 13.

that this cycle might be even stronger in more fixed-minded classrooms. Moreover, these results suggest that, even within a generally growth-oriented environment, small shifts towards fixedness are both significant and noteworthy, as they are recursively linked to psychological distress in the classroom. Regardless, future research should seek to increase variability by recruiting a larger number of course sections and instructors.

We acknowledge that our data were collected in spring 2021, one year into the COVID-19 pandemic, during which classes and recitations were held remotely. This unconventional format might have limited students' ability to infer the mindset beliefs of their instructors, TAs, and classmates, potentially affecting the generalizability of our findings. In-person classes, which enable more direct student-instructor and student-student interaction, might foster stronger perceptions of mindset beliefs, and, consequently, create more (or less) distress. However, the specific influence of in-person versus remote classroom settings on mindset perceptions and related distress constitutes an empirical question in itself, warranting further study. Although remote classes are becoming increasingly common (Ezarik, 2021), and the present study carries immediate implications for these online classroom environments, we recommend that future research replicate our results in more traditional classroom settings.

The generalizability of our findings might also be constrained by our sample characteristics, namely physics students who are predominantly white and male, attending a four-year university in the United States. Future research should explore whether these findings extend to other challenging courses and more diverse samples. The relationship between perceived classroom mindset beliefs and psychological distress could be particularly critical during middle and high school, a period when adolescents are forming foundational beliefs and are more susceptible to mental health issues (Sisk & Gee, 2022). Or, perhaps, this recursive cycle

could manifest differently cross-culturally. In cultures where negative affect is perceived as less aversive and more motivating (e.g., Eastern cultures, cultures emphasizing dialectical thinking; Eid & Diener, 2001; Miyamoto et al., 2014), the linkages between perceived mindset beliefs and psychological distress may be weaker or even absent.

Conclusion

The mental health crisis in college settings calls for effective interventions. The present work represents an important advance toward this end by documenting for the first time that perceiving classroom mindsets as more fixed rather than growth is both an antecedent and a consequence of psychological distress. These recursive processes may create a mindset-distress cycle that poses challenges for interventions that focus on only one or the other of these processes. By understanding the dynamics of this relationship, we hope to make progress in not only creating more supportive and inclusive learning environments, but also in alleviating psychological distress among college students.

References

- Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological Review*, 96, 358–372.
<https://doi.org/10.1037/0033-295X.96.2.358>
- Al-Mosaiwi, M., & Johnstone, T. (2018). In an absolute state: Elevated use of absolutist words is a marker specific to anxiety, depression, and suicidal ideation. *Clinical Psychological Science*, 6(4), 529–542. <https://doi.org/10.1177/2167702617747074>
- Antoniou, E. E., Bongers, P., & Jansen, A. (2017). The mediating role of dichotomous thinking and emotional eating in the relationship between depression and BMI. *Eating Behaviors*, 26, 55–60. <https://doi.org/10.1016/j.eatbeh.2017.01.007>
- Bar-Haim, Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & van IJzendoorn, M. H. (2007). Threat-related attentional bias in anxious and nonanxious individuals: A meta-analytic study. *Psychological Bulletin*, 133, 1–24. <https://doi.org/10.1037/0033-2909.133.1.1>
- Beck, A. T. (2016). Cognitive therapy: Nature and relation to behavior therapy. *Behavior Therapy*, 47(6), 776–784. <https://doi.org/10.1016/j.beth.2016.11.003>
- Burnette, J. L., Knouse, L. E., Vavra, D. T., O’Boyle, E., & Brooks, M. A. (2020). Growth mindsets and psychological distress: A meta-analysis. *Clinical Psychology Review*, 77, 101816. <https://doi.org/10.1016/j.cpr.2020.101816>
- Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances*, 5(2), eaau4734. <https://doi.org/10.1126/sciadv.aau4734>

- Canning, E. A., Ozier, E., Williams, H. E., AlRasheed, R., & Murphy, M. C. (2022). Professors who signal a fixed mindset about ability undermine women's performance in STEM. *Social Psychological and Personality Science*, 13(5), 927–937.
<https://doi.org/10.1177/19485506211030398>
- Cisler, J. M., & Koster, E. H. W. (2010). Mechanisms of attentional biases towards threat in anxiety disorders: An integrative review. *Clinical Psychology Review*, 30(2), 203–216.
<https://doi.org/10.1016/j.cpr.2009.11.003>
- Duffy, M. E., Twenge, J. M., & Joiner, T. E. (2019). Trends in mood and anxiety symptoms and suicide-related outcomes among U.S. undergraduates, 2007–2018: Evidence from two national surveys. *Journal of Adolescent Health*, 65(5), 590–598.
<https://doi.org/10.1016/j.jadohealth.2019.04.033>
- Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality, and development*. Psychology Press.
- Dweck, C. S., Chiu, C., & Hong, Y. (1995). Implicit theories and their role in judgments and reactions: A world from two perspectives. *Psychological Inquiry*, 6(4), 267–285.
- Eaton, A. A., Saunders, J. F., Jacobson, R. K., & West, K. (2020). How gender and race stereotypes impact the advancement of scholars in STEM: Professors' biased evaluations of physics and biology post-doctoral candidates. *Sex Roles*, 82(3/4), 127–141.
<https://doi.org/10.1007/s11199-019-01052-w>
- Eid, M., & Diener, E. (2001). Norms for experiencing emotions in different cultures: Inter- and intranational differences. *Journal of Personality and Social Psychology*, 81, 869–885.
<https://doi.org/10.1037/0022-3514.81.5.869>

Ezarik, M. (2021, June 20). How COVID-19 damaged student success. *Inside Higher Ed*.

<https://www.insidehighered.com/news/2021/06/21/what-worked-and-what-didnt%E2%80%99t-college-students-learning-through-covid-19>

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, 102(4), 700–717. <https://doi.org/10.1037/a0026659>

Hamaker, E. L. (2023). The within-between dispute in cross-lagged panel research and how to move forward. *Psychological Methods*. <https://psycnet.apa.org/record/2024-20850-001>

Hamaker, E. L., Kuiper, R. M., & Grasman, R. P. P. P. (2015). A critique of the cross-lagged panel model. *Psychological Methods*, 20, 102–116. <https://doi.org/10.1037/a0038889>

Kroeper, K. M., Fried, A. C., & Murphy, M. C. (2022). Towards fostering growth mindset classrooms: Identifying teaching behaviors that signal instructors' fixed and growth mindsets beliefs to students. *Social Psychology of Education*, 25(2), 371–398. <https://doi.org/10.1007/s11218-022-09689-4>

Kroeper, K. M., Muenks, K., Canning, E. A., & Murphy, M. C. (2022). An exploratory study of the behaviors that communicate perceived instructor mindset beliefs in college STEM classrooms. *Teaching and Teacher Education*, 114, 103717. <https://doi.org/10.1016/j.tate.2022.103717>

Kubzansky, L. D., Kim, E. S., Boehm, J. K., Davidson, R. J., Huffman, J. C., Loucks, E. B., Lyubomirsky, S., Picard, R. W., Schueller, S. M., Trudel-Fitzgerald, C., VanderWeele, T. J., Waran, K., Yeager, D. S., Yeh, C. S., & Moskowitz, J. T. (2023). Interventions to modify psychological well-being: Progress, promises, and an agenda for future research. *Affective Science*, 4(1), 174–184. <https://doi.org/10.1007/s42761-022-00167-w>

- LaCosse, J., Murphy, M. C., Garcia, J. A., & Zirkel, S. (2021). The role of STEM professors' mindset beliefs on students' anticipated psychological experiences and course interest. *Journal of Educational Psychology, 113*(5), 949–971.
<https://doi.org/10.1037/edu0000620>
- Le, T. (2022). *Physics students' mindsets and their impact on learning and perceived satisfaction*. Oregon State University.
- Lipson, S. K., Lattie, E. G., & Eisenberg, D. (2019). Increased rates of mental health service utilization by U.S. college students: 10-year population-level trends (2007–2017). *Psychiatric Services, 70*(1), 60–63. <https://doi.org/10.1176/appi.ps.201800332>
- Liu, R. T., Kleiman, E. M., Nestor, B. A., & Cheek, S. M. (2015). The hopelessness theory of depression: A quarter century in review. *Clinical Psychology : A Publication of the Division of Clinical Psychology of the American Psychological Association, 22*(4), 345–365. <https://doi.org/10.1111/cpsp.12125>
- MacLeod, C., Grafton, B., & Notebaert, L. (2019). Anxiety-Linked Attentional Bias: Is It Reliable? *Annual Review of Clinical Psychology, 15*(1), 529–554.
<https://doi.org/10.1146/annurev-clinpsy-050718-095505>
- Miyamoto, Y., Ma, X., & Petermann, A. G. (2014). Cultural differences in hedonic emotion regulation after a negative event. *Emotion, 14*, 804–815.
<https://doi.org/10.1037/a0036257>
- Moeller, J. (2015). A word on standardization in longitudinal studies: Don't. *Frontiers in Psychology, 6*, 1389. <https://doi.org/10.3389/fpsyg.2015.01389>
- Muenks, K., Canning, E. A., LaCosse, J., Green, D. J., Zirkel, S., Garcia, J. A., & Murphy, M. C. (2020). Does my professor think my ability can change? Students' perceptions of their

- STEM professors' mindset beliefs predict their psychological vulnerability, engagement, and performance in class. *Journal of Experimental Psychology: General*, Advance online publication. <https://doi.org/10.1037/xge0000763>
- Muenks, K., & Yan, V. X. (2022). University STEM instructors with stronger failure-as-debilitating mindsets are perceived to engage in fewer mastery-oriented teaching Practices by their students: An exploratory study. *Social Psychology of Education*, 25(5), 1205–1219. <https://doi.org/10.1007/s11218-022-09718-2>
- Muenks, K., Yan, V. X., & Telang, N. K. (2021). Who is part of the “mindset context”? The unique roles of perceived professor and peer mindsets in undergraduate engineering students' motivation and belonging. *Frontiers in Education*, 6. <https://doi.org/10.3389/feduc.2021.633570>
- Muenks, K., & Yan, Y. (2023). Do my peers have a fixed or growth mindset? Exploring the behaviors associated with undergraduate STEM students' perceptions of their peers' mindsets about intelligence. *Motivation and Emotion*. <https://doi.org/10.1007/s11031-023-10049-8>
- Mulder, J. D. (2023). Power analysis for the random intercept cross-lagged panel model using the powRICLPM R-Package. *Structural Equation Modeling: A Multidisciplinary Journal*, 30(4), 645–658. <https://doi.org/10.1080/10705511.2022.2122467>
- Murphy, M. C., & Dweck, C. S. (2010). A culture of genius: How an organization's lay theory shapes people's cognition, affect, and behavior. *Personality and Social Psychology Bulletin*, 36(3), 283–296. <https://doi.org/10.1177/0146167209347380>
- Murphy, M. C., & Reeves, S. L. (2019). Personal and organizational mindsets at work. *Research in Organizational Behavior*, 39, 100121. <https://doi.org/10.1016/j.riob.2020.100121>

- Murphy, M. C., & Zirkel, S. (2015). Race and belonging in school: How anticipated and experienced belonging affect choice, persistence, and performance. *Teachers College Record, 117*, 1–40. <https://doi.org/10.1177/016146811511701204>
- Orth, U., Clark, D. A., Donnellan, M. B., & Robins, R. W. (2021). Testing prospective effects in longitudinal research: Comparing seven competing cross-lagged models. *Journal of Personality and Social Psychology, 120*(4), 1013–1034. <https://doi.org/10.1037/pspp0000358>
- Rattan, A., Good, C., & Dweck, C. S. (2012). “It’s ok — Not everyone can be good at math”: Instructors with an entity theory comfort (and demotivate) students. *Journal of Experimental Social Psychology, 48*(3), 731–737. <https://doi.org/10.1016/j.jesp.2011.12.012>
- Rissanen, I., Kuusisto, E., Hanhimäki, E., & Tirri, K. (2018). Teachers’ implicit meaning systems and their implications for pedagogical thinking and practice: A case study from Finland. *Scandinavian Journal of Educational Research, 62*(4), 487–500. <https://doi.org/10.1080/00313831.2016.1258667>
- Rudolph, K. D., & Conley, C. S. (2005). The socioemotional costs and benefits of social-evaluative concerns: Do girls care too much? *Journal of Personality, 73*(1), 115–138. <https://doi.org/10.1111/j.1467-6494.2004.00306.x>
- Schleider, J. L., Abel, M. R., & Weisz, J. R. (2015). Implicit theories and youth mental health problems: A random-effects meta-analysis. *Clinical Psychology Review, 35*, 1–9. <https://doi.org/10.1016/j.cpr.2014.11.001>
- Seo, E., Lee, H. Y., Jamieson, J. P., Reis, H., Josephs, R. A., Beevers, C. G., & Yeager, D. S. (2022). Trait attributions and threat appraisals explain why an entity theory of personality

- predicts greater internalizing symptoms during adolescence. *Development and Psychopathology*, 34(3), 1104–1114. <https://doi.org/10.1017/S0954579420001832>
- Shickel, B., Siegel, S., Heesacker, M., Benton, S., & Rashidi, P. (2020). Automatic detection and classification of cognitive distortions in mental health text. *2020 IEEE 20th International Conference on Bioinformatics and Bioengineering (BIBE)*, 275–280. <https://doi.org/10.1109/BIBE50027.2020.00052>
- Sisk, L. M., & Gee, D. G. (2022). Stress and adolescence: Vulnerability and opportunity during a sensitive window of development. *Current Opinion in Psychology*, 44, 286–292. <https://doi.org/10.1016/j.copsyc.2021.10.005>
- Skibba, R. (2019). Women in physics. *Nature Reviews Physics*, 1(5), Article 5. <https://doi.org/10.1038/s42254-019-0059-x>
- Sun, K. L. (2019). The mindset disconnect in mathematics teaching: A qualitative analysis of classroom instruction. *The Journal of Mathematical Behavior*, 56, 100706. <https://doi.org/10.1016/j.jmathb.2019.04.005>
- Suresh, S., & Heckler, A. F. (2023). Evolution of grades and social comparison concern within an introductory physics course. *Physical Review Physics Education Research*, 19(1), 010129. <https://doi.org/10.1103/PhysRevPhysEducRes.19.010129>
- Walton, G. M., & Wilson, T. D. (2018). Wise interventions: Psychological remedies for social and personal problems. *Psychological Review*, 125(5), 617–655. <https://doi.org/10.1037/rev0000115>
- Walton, G. M., & Yeager, D. S. (2020). Seed and soil: Psychological affordances in contexts help to explain where wise interventions succeed or fail. *Current Directions in Psychological Science*, 29(3), 219–226. <https://doi.org/10.1177/0963721420904453>

- Williams, C. L., Hirschi, Q., Hulleman, C. S., & Roksa, J. (2021). Belonging in STEM: Growth Mindset as a Filter of Contextual Cues. *International Journal of Community Well-Being*, 4(4), 467–503. <https://doi.org/10.1007/s42413-021-00111-z>
- Yeager, D. S., Carroll, J. M., Buontempo, J., Cimpian, A., Woody, S., Crosnoe, R., Muller, C., Murray, J., Mhatre, P., Kersting, N., Hulleman, C., Kudym, M., Murphy, M., Duckworth, A. L., Walton, G. M., & Dweck, C. S. (2022). Teacher mindsets help explain where a growth-mindset intervention does and doesn't work. *Psychological Science*, 33(1), 18–32. <https://doi.org/10.1177/09567976211028984>
- Yeager, D. S., & Dweck, C. S. (2023). Mindsets and adolescent mental health. *Nature Mental Health*, 1(2), 79–81. <https://doi.org/10.1038/s44220-022-00009-5>
- Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., Tipton, E., Schneider, B., Hulleman, C. S., Hinojosa, C. P., Paunesku, D., Romero, C., Flint, K., Roberts, A., Trott, J., Iachan, R., Buontempo, J., Yang, S. M., Carvalho, C. M., ... Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, 1–6. <https://doi.org/10.1038/s41586-019-1466-y>

Supplemental Online Materials (SOM) for:
The Recursive Cycle of Perceived Mindset and Psychological Distress in College

Table of Contents

| Section | pp. |
|--|------------|
| <u>Measurement Details</u> | 2-3 |
| <u>Psychological Distress CFA Code</u> | 4-5 |
| <u>Random Intercept Cross-Lagged Panel Model (RI-CLPM)</u> | 6 |
| <u>RI-CLPM Analysis Code</u> | 7-8 |
| <u>Cross-Lagged Panel Model (CLPM)</u> | 9 |
| <u>Exploratory Analyses</u> | 10-13 |
| <u>...Moderation by Gender</u> | 10 |
| <u>...Moderation by Prior Academic Performance</u> | 10 |
| <u>...Academic Performance Outcomes</u> | 10-13 |
| <u>Supplemental References</u> | 14 |

Measurement Details

We operationalized “psychological distress” using a hierarchical model with one higher-order latent factor (“psychological distress”) that is indirectly measured through five lower-order latent factors (“belonging”, “evaluative concerns”, “imposter feelings”, “negative affect”, and “social comparison concerns”).

Each of these lower-order latent factors is directly measured by two observed indicators:

Belonging 1: “How comfortable do you feel during this class?”

Belonging 2: “How accepted do you feel during this class?”

Evaluative Concerns 1: “In class, how much do you worry that your professor might think that you were a slow learner?”

Evaluative Concerns 2: “In class, how much do you worry that your professor might not believe in your abilities to do well in this class?”

Imposter Feelings 1: “In class, I feel afraid others will discover how much knowledge or ability I really lack.”

Imposter Feelings 2: “In class, I feel like people might find out that I am not as capable as they think I am.”

Negative Affect 1: “When I am in class, I feel distressed.”

Negative Affect 2: “When I am in class, I feel upset.”

Social Comparison Concerns 1: “I often leave this physics class feeling like I am not as smart as others.”

Social Comparison Concerns 2: “I often leave this physics class feeling like I am the only who doesn’t understand the material well.”

As reported in the main text, internal consistency reliability across the semester was strong for this 10-item measure (weekly α ’s $\geq .93$). Additionally, confirmatory factor analysis (CFA) fit indices were good (CFIs $\geq .97$; RMSEAs $\leq .11$; SRMRs $\leq .05$; see Table S1). Given these results, we combined these items into a single composite.

Table S1. Confirmatory Factor Analysis Fit Indices

| Week | N | α | CFI | RMSEA | SRMR |
|------|-----|----------|------|-------|------|
| 3 | 372 | .939 | .983 | .073 | .022 |
| 8 | 368 | .945 | .973 | .105 | .032 |
| 13 | 357 | .949 | .976 | .113 | .050 |

As an exploratory analysis, we examined how each lower-order factor correlated with perceived classroom mindset beliefs across all time points. These results, detailed in Table S2, revealed significant correlations ($r \geq .329$, $ps < .001$) between each of the lower-order factors and students’ perceived classroom mindset beliefs. In short, it appears that all these lower-order factors are related to students’ classroom mindset perceptions, and we cannot definitively pinpoint one factor as the main driver.

Table S2. Exploratory Correlation Analysis of Lower-Order Factors with Perceived Classroom Mindset Beliefs

| | | Perceived Classroom Mindset Beliefs | | |
|----------------|----------------------------|-------------------------------------|---------|---------|
| | | Week 3 | Week 8 | Week 13 |
| Week 3 | | | | |
| | Lack of Belonging | .433*** | | |
| | Evaluative Concerns | .498*** | | |
| | Imposter Feelings | .429*** | | |
| | Negative Affect | .482*** | | |
| | Social Comparison Concerns | .439*** | | |
| Week 8 | | | | |
| | Lack of Belonging | .329*** | .421*** | |
| | Evaluative Concerns | .497*** | .657*** | |
| | Imposter Feelings | .430*** | .586*** | |
| | Negative Affect | .463*** | .622*** | |
| | Social Comparison Concerns | .515*** | .652*** | |
| Week 13 | | | | |
| | Lack of Belonging | .344*** | .444*** | .436*** |
| | Evaluative Concerns | .439*** | .613*** | .648*** |
| | Imposter Feelings | .402*** | .554*** | .603*** |
| | Negative Affect | .421*** | .569*** | .591*** |
| | Social Comparison Concerns | .455*** | .609*** | .622*** |

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

Given the results of the confirmatory factor analyses, exploratory correlation analyses, the pre-registered measurement plan, and established precedent in previous research (e.g., Muenks et al., 2020), we find it justifiable to pool these measures into a single construct, namely psychological distress.

Psychological Distress CFA Code (in R)

```

#install Lavaan
install.packages("lavaan", dependencies=TRUE)
library(lavaan)

#import data
WCdata <- read.csv("SP21 Physics Dataset.csv", header = TRUE, sep = ",")
View(WCdata)

#Week 3-----

#Define the model

WC3_Model <- '
#latent variable definitions
Distress =~ SCC + NBel + EC + IF + NAff
SCC =~ WC3SCC1+WC3SCC2
NBel =~ WC3NBel1+WC3NBel2
EC =~ WC3EC1+WC3EC2
IF =~ WC3IF1+WC3IF2
NAff =~ WC3NA1+WC3NA2
'

#Fit the model and get the summary

WC3_Model_Fit <- cfa(WC3_Model, data=WCdata,std.lv=TRUE)
summary(WC3_Model_Fit, fit.measures=TRUE,standardized=TRUE)

#Week 8-----

#Define the model

WC8_Model <- '
#latent variable definitions
Distress =~ SCC + NBel + EC + IF + NAff
SCC =~ WC8SCC1+WC8SCC2
NBel =~ WC8NBel1+WC8NBel2
EC =~ WC8EC1+WC8EC2
IF =~ WC8IF1+WC8IF2
NAff =~ WC8NA1+WC8NA2
'

#Fit the model and get the summary

WC8_Model_Fit <- cfa(WC8_Model, data=WCdata,std.lv=TRUE)

```

```
summary(WC8_Model_Fit, fit.measures=TRUE,standardized=TRUE)
```

```
#Week 13-----
```

```
#Define the model
```

```
WC13_Model <- '
#latent variable definitions
Distress =~ SCC + NBel + EC + IF + NAff
SCC =~ WC13SCC1+WC13SCC2
NBel =~ WC13NBel1+WC13NBel2
EC =~ WC13EC1+WC13EC2
IF =~ WC13IF1+WC13IF2
NAff =~ WC13NA1+WC13NA2
'
```

```
#Fit the model and get the summary
```

```
WC13_Model_Fit <- cfa(WC13_Model, data=WCdata,std.lv=TRUE)
summary(WC13_Model_Fit, fit.measures=TRUE,standardized=TRUE)
```

```
#All Plots-----
```

```
#install semPlot
```

```
install.packages("semPlot", dependencies=TRUE)
library(semPlot)
```

```
semPaths(WC3_Model_Fit,what = "paths",whatLabels="std",style = "mx"
,layout="tree",rotation=1,intercepts=FALSE,residuals=TRUE
,nCharNodes=0,curvePivot = FALSE,edge.label.cex = 0.7
,sizeMan = 6,sizeLat = 8)
```

```
semPaths(WC8_Model_Fit,what = "paths",whatLabels="std",style = "mx"
,layout="tree",rotation=1,intercepts=FALSE,residuals=TRUE
,nCharNodes=0,curvePivot = FALSE,edge.label.cex = 0.7
,sizeMan = 6,sizeLat = 8)
```

```
semPaths(WC13_Model_Fit,what = "paths",whatLabels="std",style = "mx"
,layout="tree",rotation=1,intercepts=FALSE,residuals=TRUE
,nCharNodes=0,curvePivot = FALSE,edge.label.cex = 0.7
,sizeMan = 6,sizeLat = 8)
```

Random Intercept Cross-Lagged Panel Model (RI-CLPM)

Here, we provide additional details regarding the RI-CLPM reported in the main text. For the autoregressive effects, changes in perceived classroom mindset beliefs at Week 3 were positively associated with changes in perceived classroom mindset beliefs at Week 8 ($\beta = .35$, 95% CI [.08, .63], $p = .013$), which were positively associated with those at Week 13 ($\beta = .38$, 95% CI [.11, .65], $p = .006$). Furthermore, changes in psychological distress at Week 3 were positively associated with changes in psychological distress at Week 8 ($\beta = .64$, 95% CI [.41, .86], $p < .001$), which were positively associated with those at Week 13 ($\beta = .65$, 95% CI [.46, .84], $p < .001$).

For the cross-lagged effects, perceiving other individuals in the classroom as endorsing more fixed mindset beliefs at Week 3 predicted increased psychological distress at Week 8 ($\beta = .18$, 95% CI [.05, .31], $p = .009$), which in turn predicted perceiving others as endorsing more fixed mindset beliefs at Week 13 ($\beta = .39$, 95% CI [.15, .63], $p = .002$). Similarly, increases in psychological distress at Week 3 predicted perceiving others as endorsing more fixed mindset beliefs at Week 8 ($\beta = .38$, 95% CI [.12, .64], $p = .004$), which in turn predicted increased psychological distress at Week 13 ($\beta = .19$, 95% CI [.06, .32], $p = .004$).

RI-CLPM Analysis Code (Mplus)

TITLE: RI-CLPM, 3 waves.

DATA: FILE = raw.csv;

LISTWISE = ON;

VARIABLE: NAMES = x1-x3 y1-y3 ACT SEX Pmindset
section_1 section_2 section_3;

USEVARIABLES = x1-x3 y1-y3 ACT SEX Pmindset;

Missing are all (-9999);

ANALYSIS: MODEL = NOCOV; ! Set all default covariances to zero
Estimator = MLR; ! Use robust standard error estimates

MODEL: ! Create between-person variables

RIx BY x1@1 x2@1 x3@1 ;

RIy BY y1@1 y2@1 y3@1 ;

! Create within-person variables

wx1 BY x1@1;

wx2 BY x2@1;

wx3 BY x3@1;

wy1 BY y1@1;

wy2 BY y2@1;

wy3 BY y3@1;

! Constrain measurement error variances to 0

x1-y3@0;

! Regression of covariates on x1-y3

x1-x3 ON ACT(s1);

x1-x3 ON Sex(s2);

x1-x3 ON Pmindset(s3);

y1-y3 ON ACT(s4);

y1-y3 ON Sex(s5);

y1-y3 ON Pmindset(s6);

! Estimate autoregressive and lagged effects between within-person variables

wx2 wy2 ON wx1 wy1 (a b c d);

wx3 wy3 ON wx2 wy2 (a b c d);

! Estimate covariance between between-person variables
RIx WITH RIy;

! Estimate covariance between within-person variables at Week 3
wx1 WITH wy1;

! Estimate covariances between residuals of within-person variables
! constrain covariances and residual variances to be invariant
! over time

wx2 WITH wy2 (cov); wx2 (vx); wy2 (vy);

wx3 WITH wy3 (cov); wx3 (vx); wy3 (vy);

OUTPUT: TECH1 STDYX SAMPSTAT CINTERVAL TECH4;

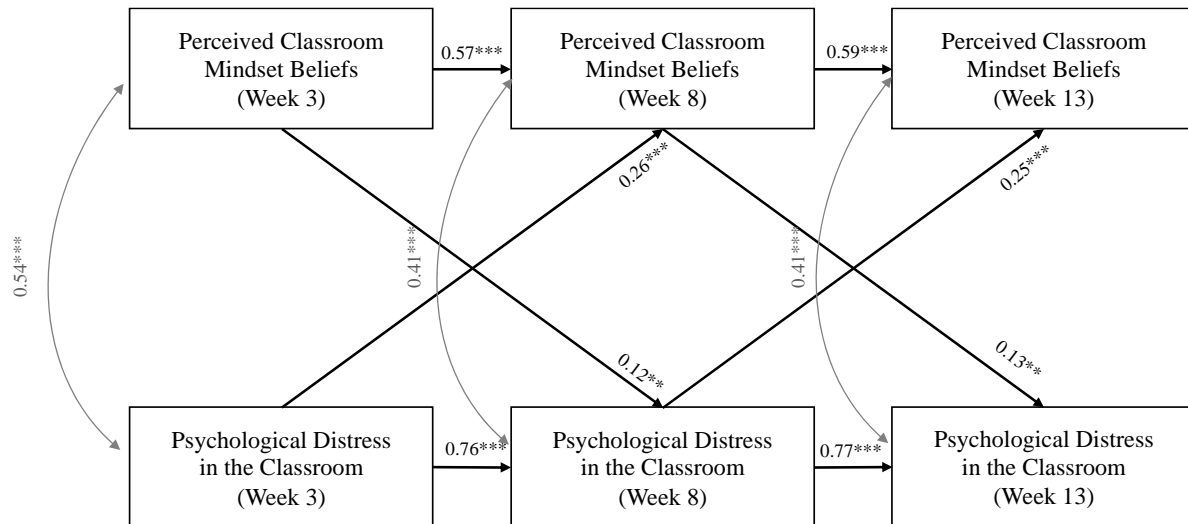
Cross-Lagged Panel Model (CLPM)

In addition to the random intercept cross-lagged panel model (RI-CLPM) reported in the main text, we used an equivalent cross-lagged panel model linking perceived classroom mindset beliefs and psychological distress over three time points (Week 3, 8, and 13), controlling for possible confounds like student-reported mindset beliefs, gender, and ACT performance.

The autoregressive effects were positive and significant for both perceived classroom mindset beliefs and psychological distress. That is, perceived classroom mindset beliefs at Week 3 were positively associated with perceived classroom mindset beliefs at Week 8, which were positively associated with those at Week 13 (all $ps < .001$). The same pattern was shown for psychological distress (all $ps < .001$).

Moreover, we found that perceived classroom mindset beliefs and psychological distress had significant bidirectional effects over time. Specifically, perceiving other individuals in the classroom to endorse higher levels of fixed mindset beliefs predicted increased psychological distress at the next time point, and, in turn, higher levels of psychological distress predicted perceiving others as endorsing increased fixed mindset beliefs (see Figure S1).

Figure S1. *The Mindset-Distress Culture Cycle: A Cross-Lagged Longitudinal Model*



Note. $N = 288$ physics students with complete data. Standardized coefficients. Covariates: Student-Reported Mindset Beliefs, Gender, ACT Scores. * $p < .05$, ** $p < .01$, *** $p < .001$

Exploratory Analyses

Moderation by Gender

We used multigroup analyses in Mplus (Mulder & Hamaker, 2021) to test whether gender moderates the path coefficients in the RI-CLPM. Specifically, in the analysis, we constrained the path coefficients of the autoregressive and cross-lagged effects in the RI-CLPM to be invariant across genders and compared the fit of this constrained model to the fit of the unconstrained model in which all path coefficients are allowed to vary across genders. We used the chi-square statistics to evaluate the difference in model fit. The difference in fit between the constrained model and unconstrained model was not statistically significant ($\Delta\chi^2(4) = 5.96, p = .202$), indicating that none of the autoregressive and cross-lagged effects differ between genders. Thus, the results of the RI-CLPM were consistent across men and women.

Moderation by Prior Academic Performance

We also test whether prior academic performance moderates the path coefficients in the RI-CLPM. We operationalized prior academic performance using students' ACT scores. Because multigroup analyses cannot handle a continuous moderator, we used a Bayesian Structural Equation Modelling framework (Speyer et al., 2023). Specifically, interaction terms between ACT scores and within-person changes in perceived classroom mindset beliefs and between ACT scores and within-person changes in psychological distress were included in the RI-CLPM, and a Bayesian estimator was used to estimate the parameters of the interactions. The results showed that none of the autoregressive and cross-lagged effects were moderated by ACT scores ($ps \geq .230$), indicating that the results of the RI-CLPM were consistent across people with varying ACT scores.¹⁶

Academic Performance Outcomes

Background

Student distress is an aversive outcome that should be minimized, irrespective of its influence on grades or retention. However, prior research links teachers' mindset beliefs and student psychological distress to students' academic performance (Canning et al., 2019; Muenks et al., 2020; Suresh & Heckler, 2023). In this context, we investigated whether perceived fixed classroom mindset beliefs and psychological distress could predict lower final exam scores and course grades. However, given the small effects in past studies and their larger sample sizes—between three and *fifty* times larger than ours—we recommend a careful interpretation of our analyses. This disparity in sample size suggests our study might lack the statistical power to detect these small effects. Nonetheless, in the interest of transparency, we have included these analyses in the SOM.

¹⁶ We also median-split participants into high and low ACT groups and used traditional multigroup analyses to test whether high versus low ACT groups moderate the path coefficients in the RI-CLPM. The results were consistent with those using the Bayesian Structural Equation Modelling framework. Specifically, the difference in fit between the constrained model and unconstrained model was not statistically significant ($\Delta\chi^2(4) = 3.44, p = .487$), indicating that none of the autoregressive and cross-lagged effects differ between high and low ACT groups.

Measures

Final exam performance was retrieved from university records. Scores were based on 10 multiple-choice questions (worth 5 points each) and 4 open-ended, show-work questions (worth between 10 and 15 points). Final exam scores ranged from 0 to 96 points in this sample ($M = 56.60$, $SD = 18.05$).

Final grades were also retrieved from university records. These grades were based on lab (10%) and prelab work (3%), online homework (12%), hand-in homework (6%), recitation participation (6%), online practice problems (3%), quizzes (16%), midterms (24%), and the final exam (20%). On a 4.0 scale, the average final grades ranged from 0.0 to 4.0 ($M = 2.73$, $SD = 1.05$).

Results

Our first step was to analyze bivariate correlations. The perceived classroom mindset beliefs showed no significant correlation with final exam performance at any of the three time points, although the trends aligned with our expectations (Week 3: $r = -.04$, $p = .431$; Week 8: $r = -.09$, $p = .09$; Week 13: $r = -.04$, $p = .482$). Psychological distress, on the other hand, demonstrated a significant negative correlation with final exam performance during Week 3 ($r = -.20$, $p < .001$) and Week 8 ($r = -.15$, $p = .004$), while the correlation in Week 13 was negative but not significant ($r = -.09$, $p = .115$).

Regarding final grades, there was no significant correlation with perceived classroom mindset beliefs at any of the three time points (Week 3: $r = .02$, $p = .699$; Week 8: $r = -.03$, $p = .602$; Week 13: $r = -.01$, $p = .893$). Psychological distress showed a significant negative correlation with final grades in Week 3 ($r = -.14$, $p = .006$), while the correlation in Week 8 was negative but not significant ($r = -.09$, $p = .103$). By Week 13, the correlation between final grades and distress was statistically insignificant ($r = -.03$, $p = .537$).

Next, we performed regression analyses to study the impact of Week 13 perceived classroom mindset beliefs and Week 13 psychological distress on final exam scores and grades, while adjusting for student-reported mindset beliefs, gender, and ACT scores. In these analyses, the only significant predictor of both final exam scores and grades was the ACT score, with higher ACT scores predicting better outcomes ($B = 0.46$, $p < .001$ for exam scores; $B = 0.38$, $p < .001$ for grades). All other variables had no significant effect ($ps \geq .106$; see Tables S3 and S4). It's important to note that the estimates for psychological distress align with the trends in previous research (Canning et al., 2019; Muenks et al., 2020), albeit not reaching statistical significance in this study. Furthermore, these coefficients reflect the expected direction of the relationship. The absence of statistical significance might be due to our study being underpowered to detect these effects.

Table S3. Regression: Predictors on Final Exam Performance

| Effect | Est. | SE | 95% CI | | <i>p</i> |
|---|--------|-------|-----------|-----------|----------|
| | | | <i>LL</i> | <i>UL</i> | |
| Psychological Distress in the Classroom | -0.094 | 0.073 | -0.238 | 0.05 | .199 |
| Perc. Classroom Mindset Beliefs | 0.084 | 0.072 | -0.057 | 0.225 | .242 |
| ACT Score | 0.457 | 0.053 | 0.352 | 0.561 | < .001 |
| Gender | -0.021 | 0.114 | -0.246 | 0.203 | .851 |
| Student-Reported Mindset Beliefs | -0.086 | 0.053 | -0.191 | 0.019 | .106 |

Note. Continuous predictors and the outcome variable were standardized before analysis. Gender was coded as 0 for "Man" and 1 for "Woman."

Table S4. Regression: Predictors on Final Grades

| Effect | Est. | SE | 95% CI | | <i>p</i> |
|---|--------|-------|-----------|-----------|----------|
| | | | <i>LL</i> | <i>UL</i> | |
| Psychological Distress in the Classroom | -0.019 | 0.066 | -0.149 | 0.112 | .780 |
| Perc. Classroom Mindset Beliefs | 0.065 | 0.065 | -0.063 | 0.192 | .318 |
| ACT Score | 0.384 | 0.048 | 0.289 | 0.479 | < .001 |
| Gender | 0.048 | 0.103 | -0.155 | 0.251 | .645 |
| Student-Reported Mindset Beliefs | -0.015 | 0.048 | -0.110 | 0.080 | .759 |

Note. Continuous predictors and the outcome variable were standardized before analysis. Gender was coded as 0 for "Man" and 1 for "Woman."

Lastly, we included final exam performance in the RI-CLPM model as an outcome and controlled for student-reported mindset beliefs, gender, and ACT performance. We found that neither changes in perceived classroom mindset beliefs nor psychological distress over time predicted final exam performance or final grades.

Discussion

While previous research (e.g., Canning et al., 2019; Muenks et al., 2020) has established a connection between mindsets of others' the classroom, distress, and performance, our study provided only limited support for these relationships. In the following section, we delve into possible explanations for our study's inability to replicate these previously identified relationships.

As previously noted, our study's limited sample size may have constrained our ability to detect small effects. This challenge is further underscored when comparing our sample size with those of past studies. For instance, Muenks et al. (2020) in their fourth study surveyed over 900 students, and Canning et al. (2019) examined a sample exceeding 15,000 students. In contrast, our recruitment efforts yielded only 288 participants. This smaller sample could potentially introduce a higher margin of error and may not offer the same statistical power to detect small yet meaningful relationships that larger studies can capture. Hence, these discrepancies in sample size could partially explain the different findings between our study and the preceding research.

Furthermore, the limited variation in perceived classroom mindset within our study could have constrained our ability to detect significant effects on academic outcomes. Although there

were relative differences in perceptions of classroom mindsets, overall most of our students perceived their course sections as endorsing a growth mindset, resulting in a more homogeneous sample. This homogeneity could limit our ability to uncover potential differences and relationships that a more diverse set of mindset perceptions might reveal. In contrast, past research has covered a broader range of classrooms, affording a more varied mindset perceptions. For instance, Muenks et al. surveyed students from 37 classrooms, while Canning et al. extended their study to 634 classrooms. Such larger, more diverse samples are more capable of detecting subtle effects or nuanced relationships. Therefore, the limited classroom representation in our study may have contributed to our deviating findings.

Lastly, the unique circumstances of the COVID-19 pandemic may also explain our inability to detect an effect on academic performance. The data for this study were collected in spring 2021, one year into the pandemic. Research suggests that during this time, instructors were more lenient towards students' poor performance (Ezarik, 2021). In a typical semester, when instructors adhere more stringently to classroom policies, the perceived mindset and distress of students may have a greater impact on grades.

In summary, our study diverged from previous research findings, providing only minimal evidence of the influence of classroom mindset and distress on academic performance. This discrepancy can be attributed to several factors. Our smaller sample size, compared to past studies, likely impacted our statistical power to detect minor but significant effects. Furthermore, limited variability in perceived classroom mindset beliefs in our study may have restricted our ability to uncover significant relationships. Lastly, the unprecedented circumstances of the COVID-19 pandemic during our data collection period could have affected student performance and instructor leniency, thus potentially obscuring the relationships under investigation. Our findings underline the necessity for larger, more diverse studies, and highlight the impact of external factors such as global crises on educational research outcomes.

References

- Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances*, 5(2), eaau4734. <https://doi.org/10.1126/sciadv.aau4734>
- Ezarik, M. (2021, June 20). How COVID-19 damaged student success. *Inside Higher Ed*. <https://www.insidehighered.com/news/2021/06/21/what-worked-and-what-didn%E2%80%99t-college-students-learning-through-covid-19>
- Muenks, K., Canning, E. A., LaCrosse, J., Green, D. J., Zirkel, S., Garcia, J. A., & Murphy, M. C. (2020). Does my professor think my ability can change? Students' perceptions of their STEM professors' mindset beliefs predict their psychological vulnerability, engagement, and performance in class. *Journal of Experimental Psychology: General*, Advance online publication. <https://doi.org/10.1037/xge0000763>
- Speyer, L. G., Ushakova, A., Blakemore, S.-J., Murray, A. L., & Kievit, R. (2023). Testing for Within \times Within and Between \times Within Moderation Using Random Intercept Cross-Lagged Panel Models. *Structural Equation Modeling: A Multidisciplinary Journal*, 30(2), 315–327. <https://doi.org/10.1080/10705511.2022.2096613>
- Suresh, S., & Heckler, A. F. (2023). Evolution of grades and social comparison concern within an introductory physics course. *Physical Review Physics Education Research*, 19(1), 010129. <https://doi.org/10.1103/PhysRevPhysEducRes.19.010129>