



# Investigating the Relations between Mindfulness Training, Psychological Threat, and Physics Problem Solving

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## OVERVIEW

- ▶ **Introductory physics courses** serve as a gateway to many STEM careers; face challenges with equity, inclusion, engagement, and retention (Kalender et al., 2011; Marshman et al., 2012, 2018; Whitcomb, Doucette, & Singh, 2022)
- ▶ **Psychological threat** is associated with impaired performance; may affect problem solving in physics (Jamieson et al., 2016; Seery et al., 2010; Turner et al., 2012)
- ▶ **Mindfulness training** interventions focus on allowing difficult emotions with non-reactivity; have been shown to reduce stress reactivity (Creswell, 2017; Lindsay et al., 2018)
- ▶ **Work needed to determine how psychological threat operates at in the moment during problem solving** and whether mindfulness training can intervene

## RESEARCH QUESTIONS:

**Q1.** What is the association between psychological threat and problem solving accuracy and perceptions during problem solving in physics?

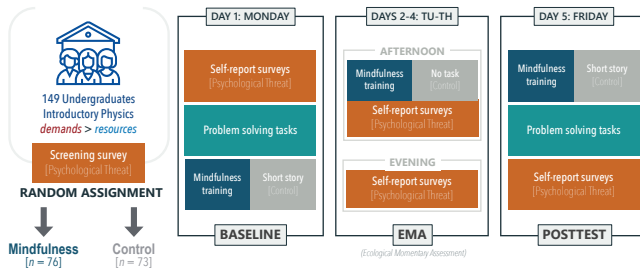
**Q2.** Does mindfulness training affect problem solving outcomes?

**Q3.** Does psychological threat mediate the association between mindfulness training and problem solving outcomes?

## HYPOTHESIZED MODEL:



## METHOD



## MINDFULNESS TRAINING

▶ Built around a mindfulness practice called RAIN and adapted to a physics context based on focus groups

▶ 5, 20-minute audio lessons

Students were asked to bring stressful experiences in physics to mind and practiced applying the steps of RAIN



## PHYSICS PROBLEM SOLVING TASKS

▶ Two outcomes: accuracy and momentary perceptions

**0129**

7. A brick slides on a horizontal surface. Which of the following will increase the frictional force on it?

- A) Putting a second brick on top
- B) Decreasing the surface area of contact
- C) Increasing the surface area of contact
- D) Decreasing the mass of the brick
- E) None of the above

Please provide a brief explanation for your answer below.

[example qualitative problem solving item]

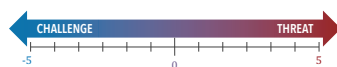
**PROBLEM SOLVING ACCURACY**  
Two test versions; balanced between baseline and posttest  
10 items of variable difficulty, item type, and response type:  
Quantitative Problem Solving (1 item, open-ended)  
Problem Categorization (5 items, forced-choice)  
Qualitative Problem Solving (4 items, open-ended and multiple-choice)

**MOMENTARY PERCEPTIONS**  
Students rated their agreement to 3 statements for each item on a scale of 1 (strongly disagree) to 6 (strongly agree):  
I am **confident** in my answer  
I felt **anxious** working on this item  
This item was **difficult**

## PSYCHOLOGICAL THREAT

▶ Students rated their perceptions of demands and resources on a scale of 1 (strongly disagree) to 6 (strongly agree)

▶ Psychological threat was calculated as the difference between mean ratings of demands and resources



## RESOURCES

*I feel that I have the abilities to succeed on my physics work.*

*It is very important to me that I perform well on my physics work.*

*I'm the kind of person that does well on my physics work.*

*I expect to perform well on my physics work.*

*I view physics work as a positive challenge.*

## DEMANDS

*Working on physics is very demanding.*

*I am uncertain about how I will perform in physics.*

*My physics work will take a lot of effort to complete.*

*Working on physics is very stressful.*

*Poor performance on physics work would be very distressing for me.*

*I think physics work represents a threat to me.*



**SAMPLE TASK ITEMS**  
<https://osf.io/fm8q/>



**PROJECT OVERVIEW**  
<https://osf.io/723rd/>



**PLANNED ANALYSES**  
<https://osf.io/t57et/>



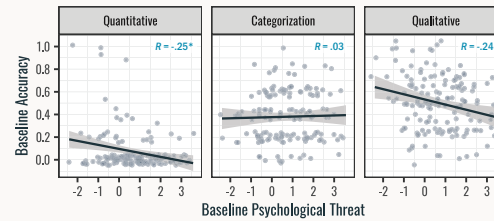
This analysis was conducted in the context of a broader project, preregistered on the Open Science Framework.

Use the QR codes below to access the broader project overview, detailed methods, materials, and planned analyses

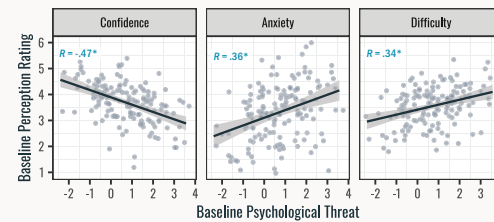
## RESULTS

### Q1: PSYCHOLOGICAL THREAT & PHYSICS OUTCOMES AT BASELINE

▶ Psychological threat negatively associated with accuracy on 2 of 3 item types



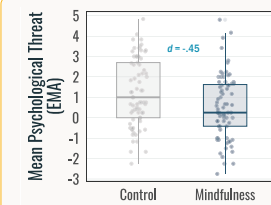
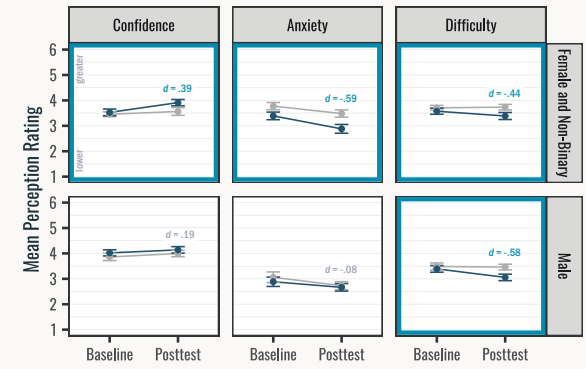
▶ Psychological threat negatively associated with confidence and positively associated with anxiety and difficulty



### Q2: MINDFULNESS TRAINING & PHYSICS OUTCOMES AT POSTTEST

▶ No effects on problem solving accuracy

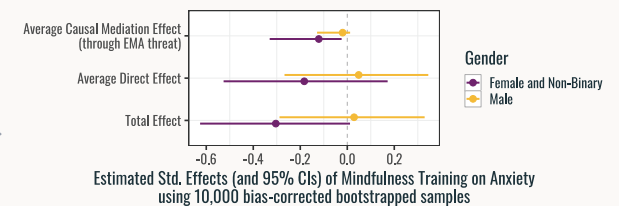
▶ Students who received mindfulness training reported greater reduction in perception of difficulty at posttest compared to control; Mindfulness training associated with greater confidence and less anxiety for female and non-binary identifying students but not for male identifying students [significant results highlighted below]



### Q3: MEDIATION THROUGH PSYCHOLOGICAL THREAT (EMA)

▶ Students in the mindfulness condition reported lower threat during EMA (left)

▶ Mediation was only found for perceptions of anxiety; moderated by gender (right)



## DISCUSSION

- ▶ Psychological threat is associated with students' in-the-moment problem solving perceptions and performance
- ▶ Mindfulness training reduces physics psychological threat and affects momentary perceptions of problem solving, but does not benefit accuracy at posttest
- ▶ Effects on perceived confidence and difficulty are not explained by reductions in physics psychological threat
- ▶ Effects on problem solving accuracy may take more time to appear (learning model)
- ▶ Mindfulness training may be especially beneficial for historically excluded gender identities

## ACKNOWLEDGMENTS

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