



# Effects of Perceived Stress on Psychological Well–Being, Cognitive Function, and Neural Pathways in Surgical Trainees Practicing Mindfulness–Based Stress Reduction

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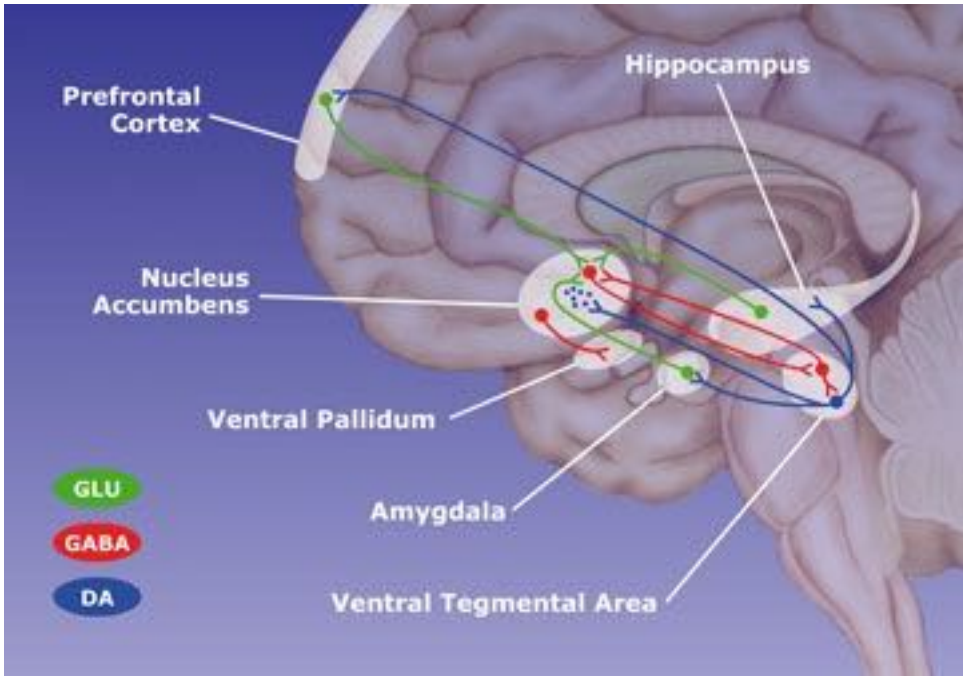
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## Introduction

- Burnout is a growing issue among physicians that has been associated with decreased performance, professionalism, and well-being as well as increased medical errors.
- Burnout has a direct relationship to overwhelming stress, which is known to have a detrimental effect on cognition.<sup>1</sup> This effect is believed to be mediated by glucocorticoid receptors in the prefrontal cortex, amygdala, and hippocampus – areas known to be critical in learning, memory and executive function.<sup>2</sup>

### Reward Circuitry



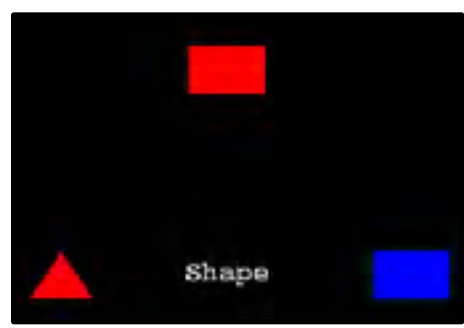
- Mindfulness–Based Stress Reduction (MBSR) teaches non-reactive awareness of thoughts, feelings, and experiences. Through breathing exercises, body scans, and emotion regulation, MBSR has been shown to reduce perceived stress, positively impact cognitive function and enhance neuroanatomic pathways believed to subserve executive function.<sup>3</sup>

## Hypothesis

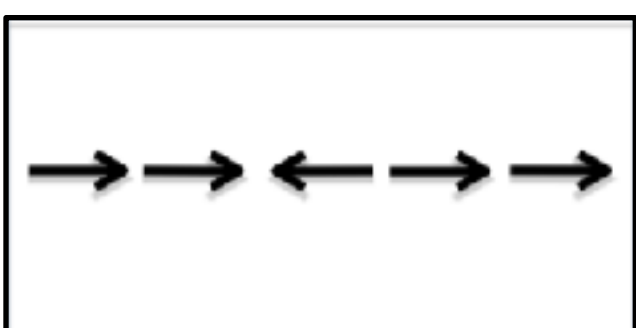
In this pilot randomized, controlled trial, surgical trainees assigned to 8 weeks of Mindfulness–Based Stress Reduction training will demonstrate lower perceived stress. This will result in improved executive function and changes in neural correlates of problem-solving and decision-making from post intervention to one year.

## Methods

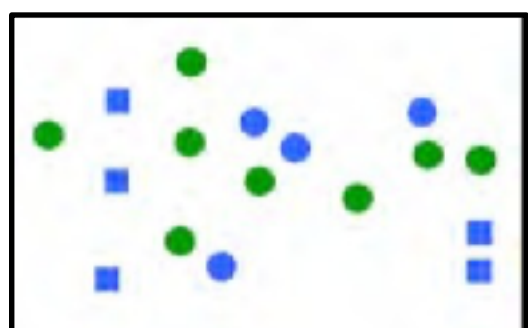
- Twenty one surgical residents from various sub specialties at the University of California, San Francisco were randomized to an active control (self-care unrelated to work) or intervention (mindfulness training) and received two hours of training each week for eight weeks. Both groups were asked to practice for twenty minutes each day. This pilot study was statistically underpowered.
- At baseline (before starting residency), pre-intervention, post-intervention, and one year time points, surgical interns in both groups self-reported their degree of perceived stress, underwent an assessment of cognitive function in multiple domains, and had functional brain scans to evaluate neuroanatomic changes.
- Validated psychological questionnaires, including Cohen's Perceived Stress Scale (PSS) and the Cognitive Affective Mindfulness Scale – Revised (CAMS–R) were used to assess stress and mindfulness while the EXAMINER neuropsychiatric battery was used to analyze cognitive function via tests of set shifting, dot counting, n-back, flanker, anti-saccades and fluency (both categorical and phonemic).<sup>4</sup>



Set Shifting



Flanker



Dot Counting

- Functional neuroimaging (fMRI) involved T1 weighted anatomic scans with BOLD and DTI components to observe neuroanatomic and functional changes in *a priori* Regions of Interest and connectivity circuits that may be critical to complex cognition such as surgical learning. (*Data in progress*)

### Psych Scales

- PSS questions are measured on a 5 point Likert scale and scored from zero to 40. A score equal to or greater than 17 signifying a high level of stress. CAMS–R questions are measured on a 4 point Likert scale and scored from 10 to 40. It has a normative mean value of 31.
- Residents in the intervention group reported a lower amount of perceived stress at post-intervention and one year than the controls. At one year, the magnitude of difference between the two groups decreased for perceived stress scores.
- Interns practicing MBSR reported a statistically higher score of mindfulness at post intervention (P = 0.049) and one year (P = 0.041) compared to the controls. At one year, the magnitude of difference between the two groups increased for mindfulness scores.

Table 1. Comparison of perceived stress and mindfulness between MBSR and control, post intervention and one year

Outcome	Post-Intervention Control and Intervention Deltas (95% CI)	P Value*
Mindfulness (CAMS-R)	+3.7 (0.1 to 7.3)	0.049
Perceived stress (PSS)	-5.5 (-11.5 to 0.6)	0.074

Outcome	One Year Control and Intervention Deltas (95% CI)	P Value*
Mindfulness (CAMS-R)	+4.4 (0.2 to 8.6)	0.041
Perceived stress (PSS)	-4.2 (-8.2 to -0.2)	0.041

\*These p-values are based on unpaired t-tests.

### Psychosocial Outcomes from Post Intervention to One Year

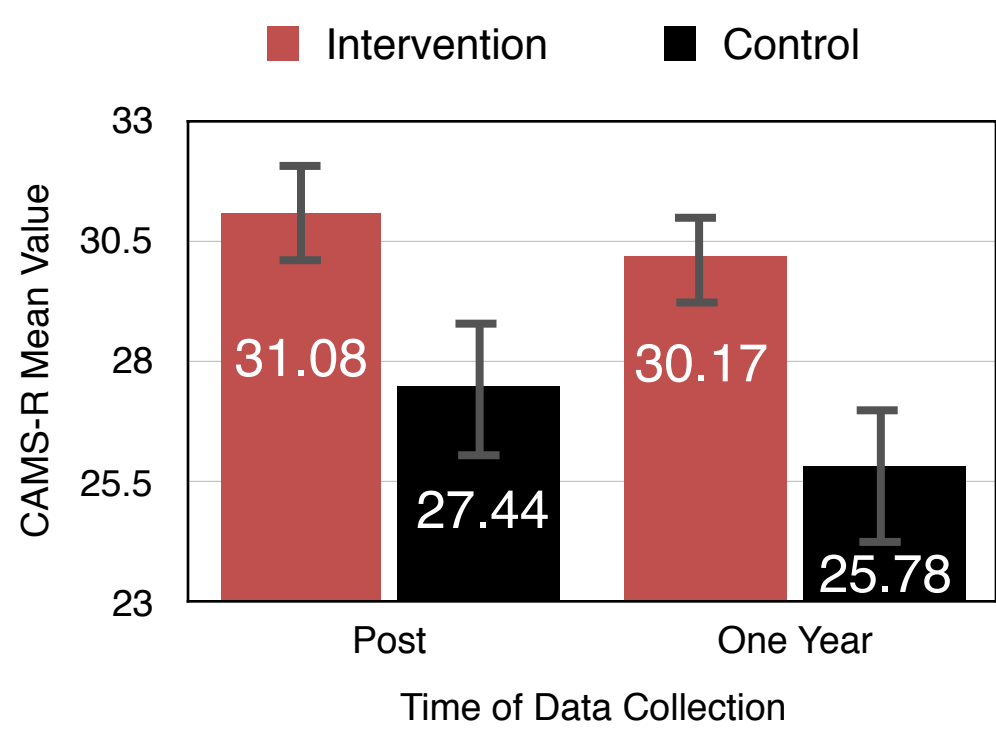


Figure 1. Mindfulness (CAMS–R) outcome means.

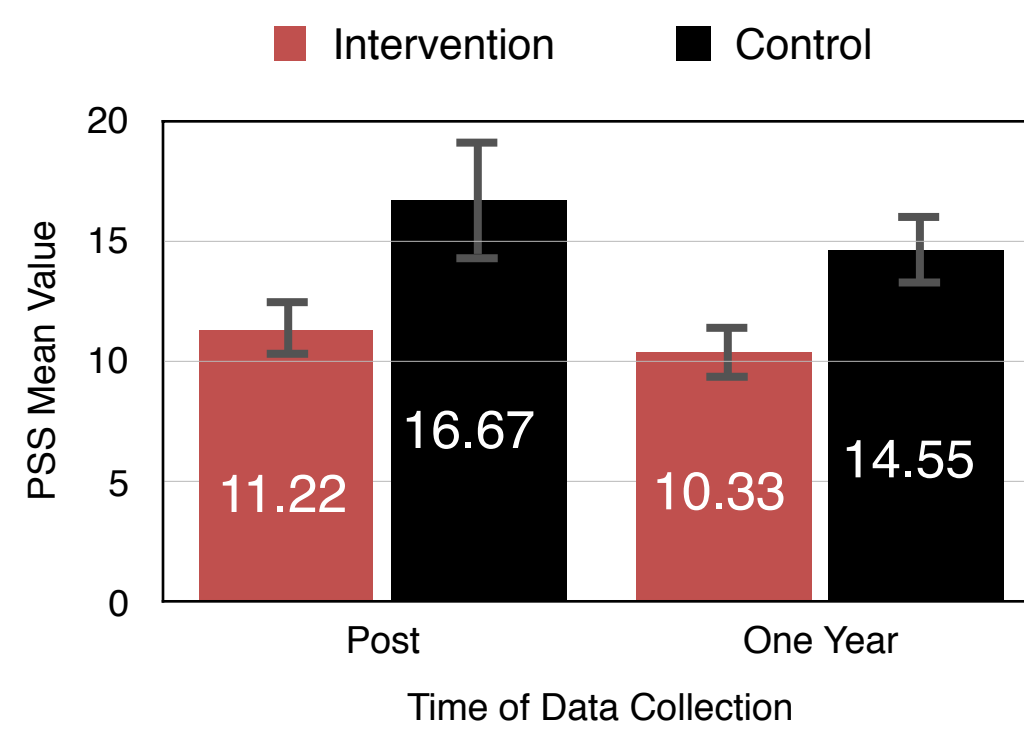


Figure 2. Perceived stress (PSS) outcome means.

### EXAMINER Battery

- Executive composite values were scored on a 0–10 scale and factor scores were scored on a 0–5 scale.
- At post intervention, residents in the MBSR group showed higher executive composite, working memory, cognitive control, and fluency scores than the controls.
- At one year, residents in the MBSR group showed statistically higher executive composite scores (P = 0.037). The MBSR group had higher scores for working memory, cognitive control, and fluency compared to controls. At one year, the magnitude of difference between the two groups increased for executive composite, working memory, and cognitive control factor scores.

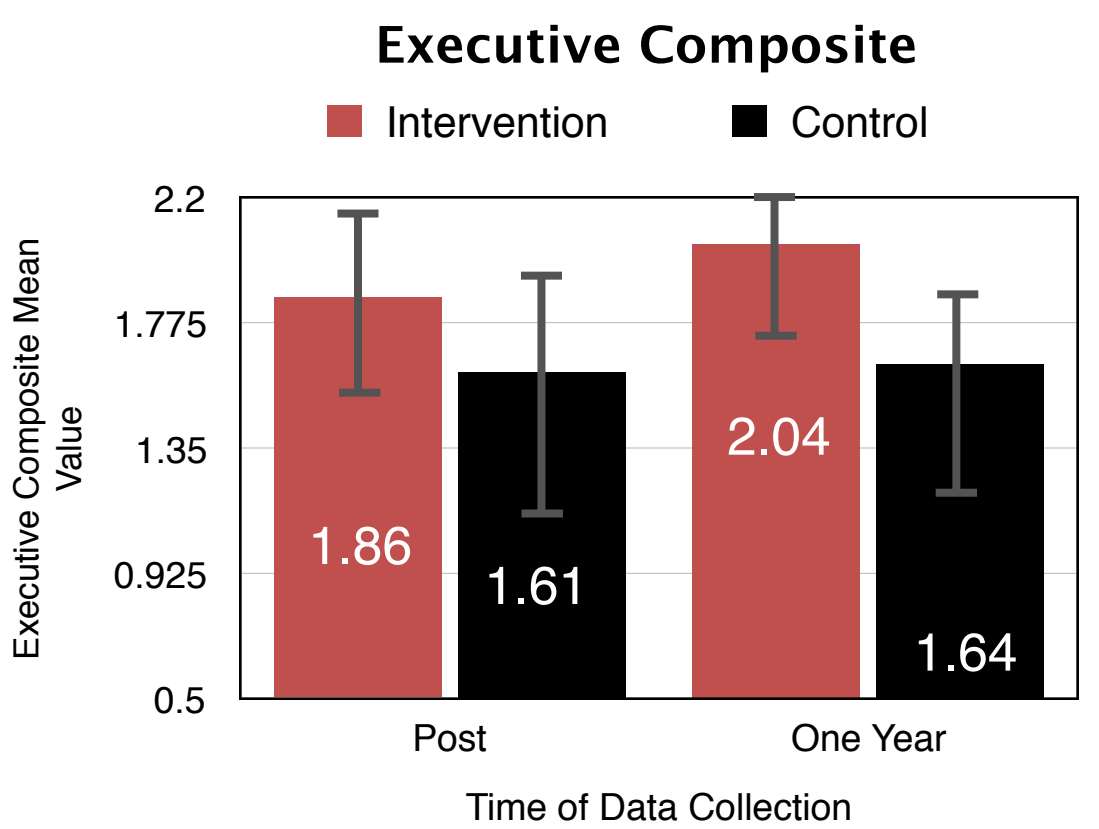


Figure 3. Executive composite mean outcomes.

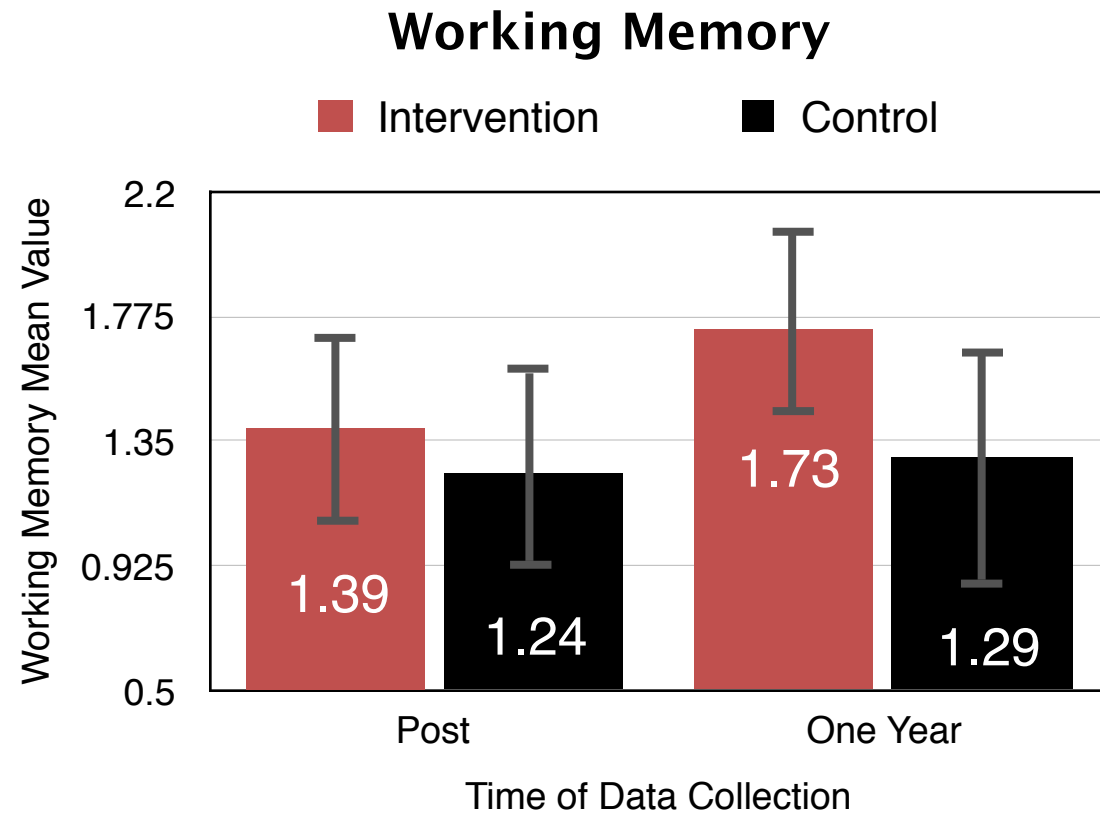


Figure 4. Working memory mean outcomes.

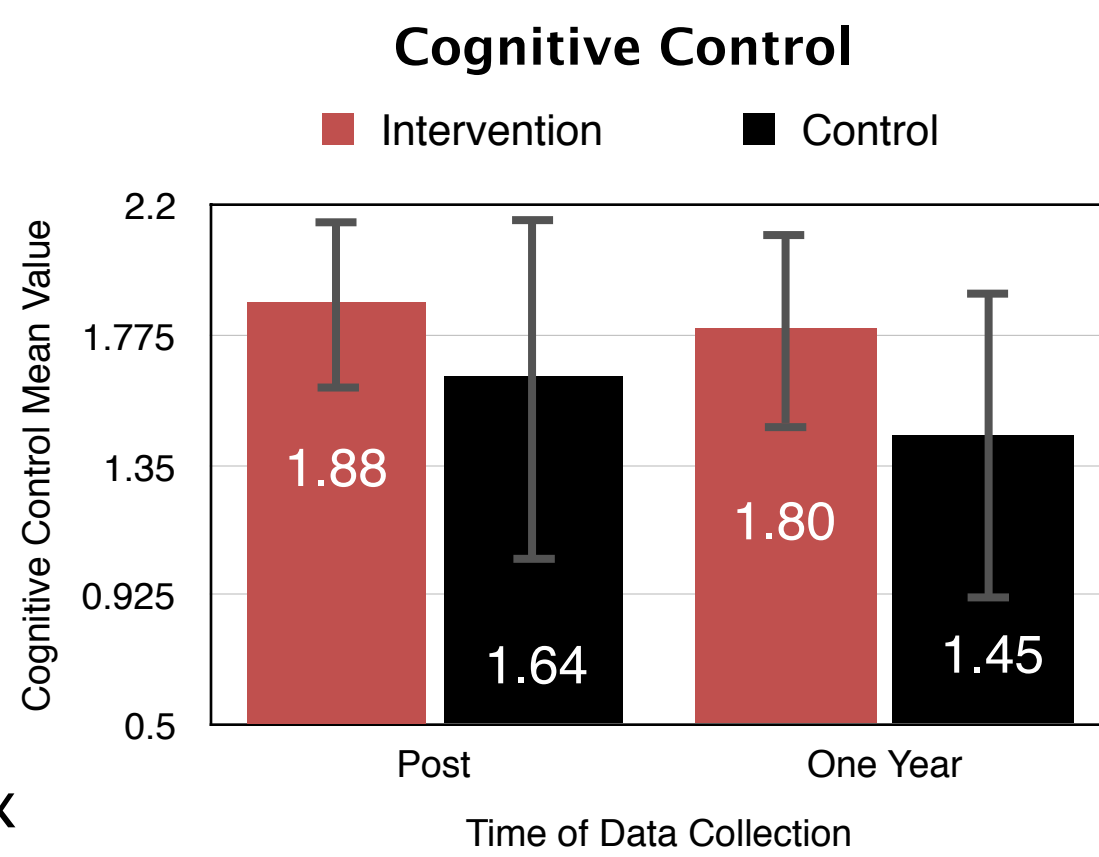


Figure 5. Cognitive control mean outcomes.

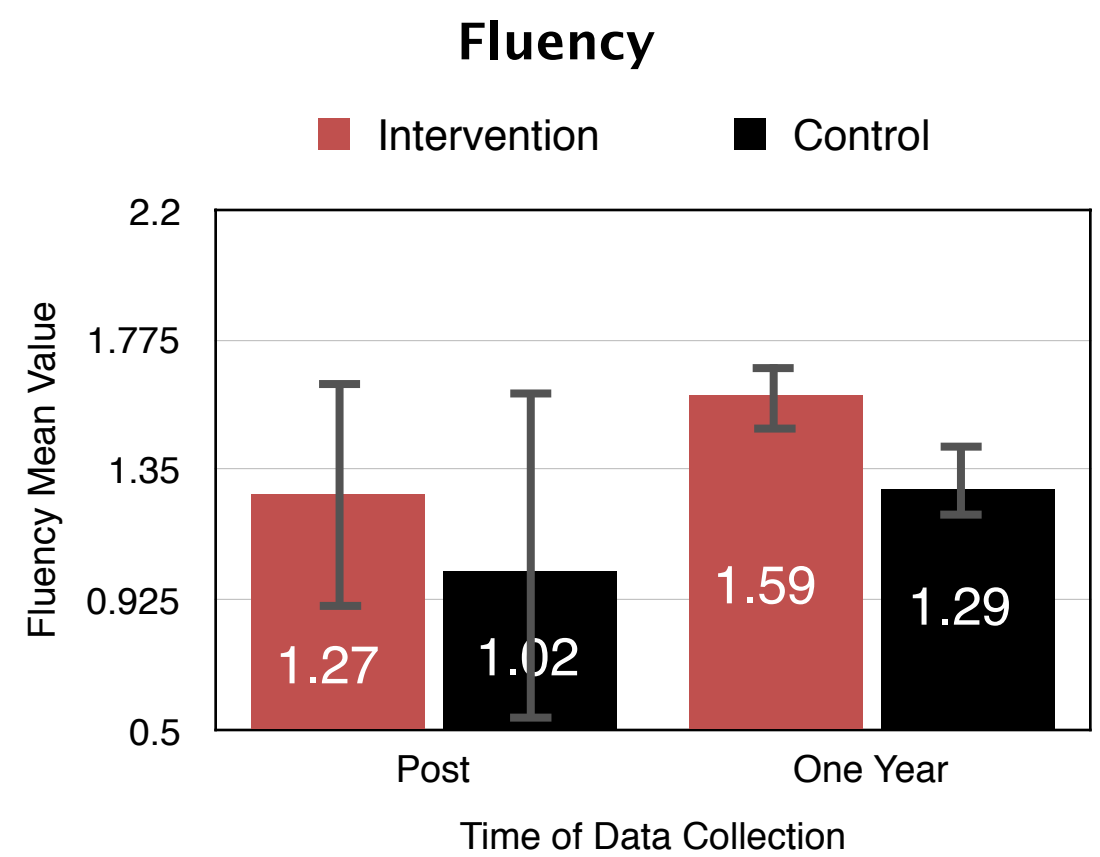


Figure 6. Fluency mean outcomes.

Table 2. Comparison of cognitive function between MBSR and control, post intervention and one year

Outcome	Post-Intervention Control and Intervention Deltas (95% CI)	P Value*
Mindfulness (CAMS-R)	+3.7 (0.1 to 7.3)	0.049
Perceived stress (PSS)	-5.5 (-11.5 to 0.6)	0.074

Outcome	One Year Control and Intervention Deltas (95% CI)	P Value*
Mindfulness (CAMS-R)	+4.4 (0.2 to 8.6)	0.041
Perceived stress (PSS)	-4.2 (-8.2 to -0.2)	0.041

\*These p-values are based on unpaired t-tests.

### Psychological Well–Being of Surgical Residents Practicing MBSR

- “I’m on Neurosurgery at the General. I find I’m more purposeful and present with the patients and families. I wrote the orders to withdraw care on a 32 year old today. It is really painful and I am feeling that. But at the same time it’s okay”.
- “I thought I would be calmer but it made me more present instead. Rather than waiting to get to the end, my perception of my place in the world seems clearer”.
- “This allowed me to parse out sources of my stress. A lack of control leads to stress. I tackled this by getting better at my job but some things must be let go of, they’re out of my control. Now I can tell the difference”.

## Conclusions

- Interns who received MBSR training showed a statistically higher mindfulness score and lower perceived stress as compared to controls, post-intervention and one year.
- Additionally, for measures believed to reflect complex problem-solving and decision-making ability, interns who received MBSR had higher composite, working memory, cognitive control, and fluency scores.
- Interns who received MBSR training verbally reported subjective improvements in psychological well-being and stress management.
- These results suggest that through a reduction in perceived stress, MBSR may increase or protect cognitive function in highly stressful settings.
- Our findings support the inclusion of MBSR as part of formal training to promote well-being in surgical residents, in accordance with ACGME common program requirements.<sup>5</sup>
- One of the major limitations of this study was statistically underpowered data. Our results indicate the need for a larger sample size and analysis of pre-intervention scores.

## Acknowledgments

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## References

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## Keywords

perceived stress, MBSR, executive function, resilience, mindfulness

