



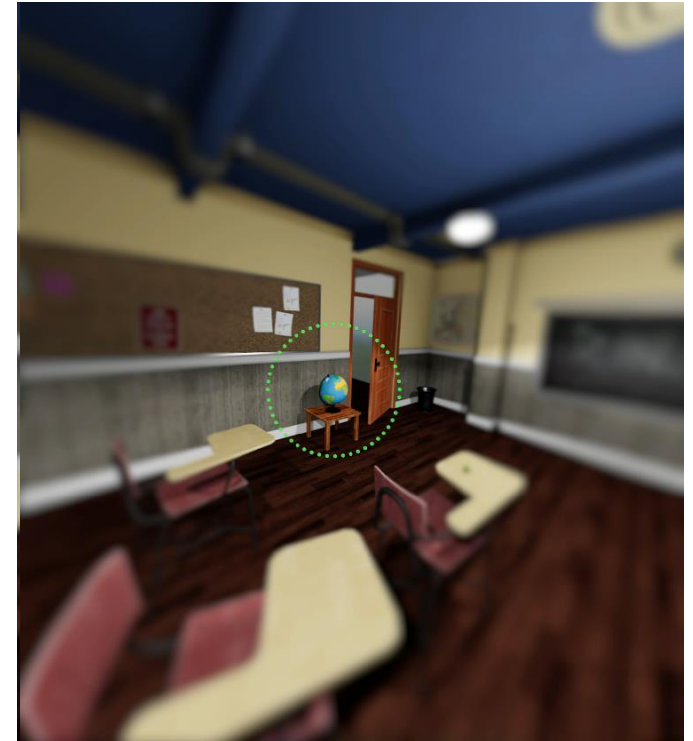
# READING SPEED DECREASES FOR FAST READERS UNDER GAZE-CONTINGENT RENDERING

Rachel Albert (NVIDIA), Angelica Godinez (UC Berkeley), David Luebke (NVIDIA)

# GAZE-CONTINGENT DISPLAY (GCD) IS A USEFUL STRATEGY

It can be costly, impractical, or even impossible to display high-fidelity content everywhere

GCD limits resources where they aren't necessary





# TEXT-LIKE CONTENT IS UBIQUITOUS AND PROBLEMATIC

Many types of gaze-contingent content include text

Text is both high contrast and high spatial frequency

Augmented reality



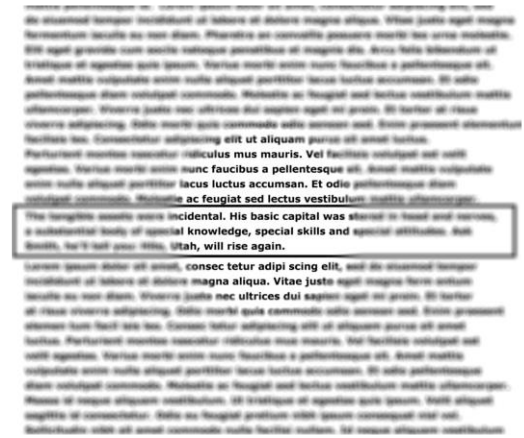
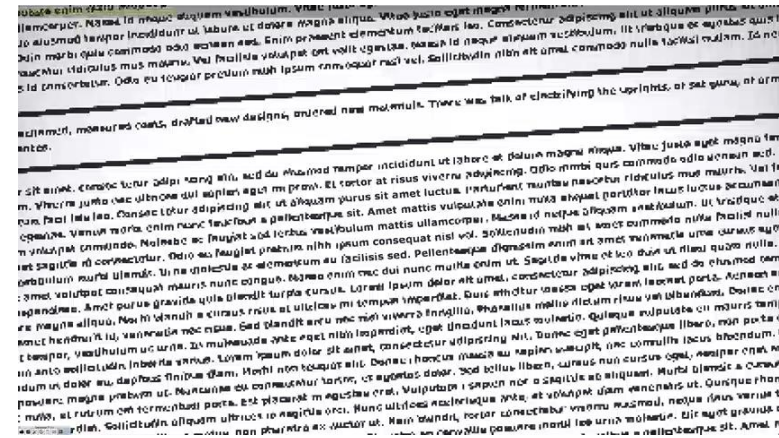
Gaming



Virtual reality



Virtual workstation



Aliasing produces flicker

Blurring breaks contrast constancy

# DOES GCD NEGATIVELY IMPACT READING?

## Experiment design:

- Timed reading of short (40-60 word) text passages (Flesch-Kincaid difficulty of 4<sup>th</sup>-10<sup>th</sup> grade)
- 4 Fovea Sizes × 2 Kernel Sizes × 2 Text Sizes
- Word recognition question after each trial (90.6% avg pct. correct)
- Baseline speed (no GCD) recorded at the beginning of the experiment
  
- 17 subjects (13 Men, 4 Women, Ages 19-56)
- 8K Desktop Monitor (60 Hz) + EyeLink 1000+ Eye Tracker (250 Hz)
- 20 ms total motion-to-photon latency







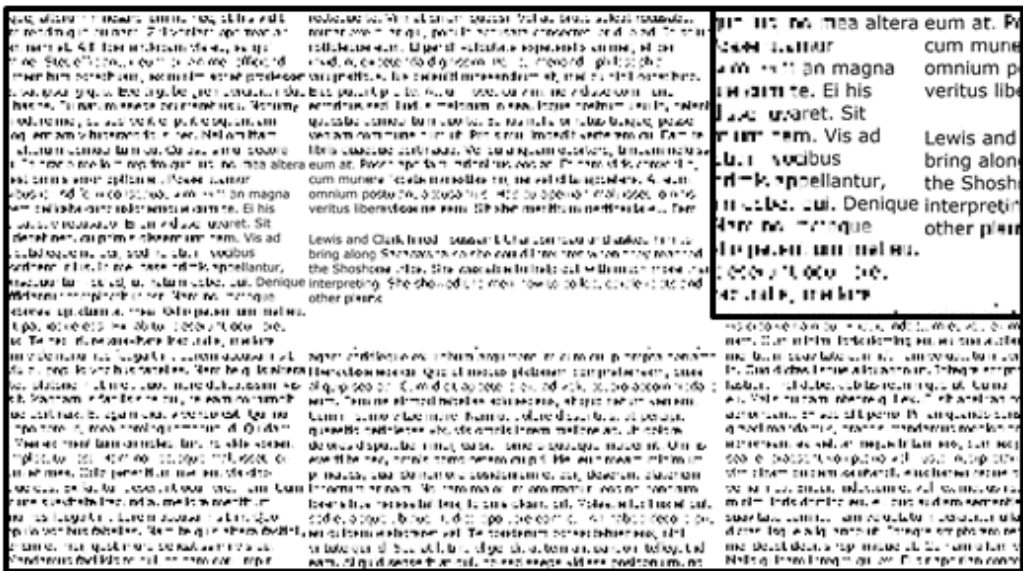
# Small Kernel Size

# Large Kernel Size

Small Text



Large Text



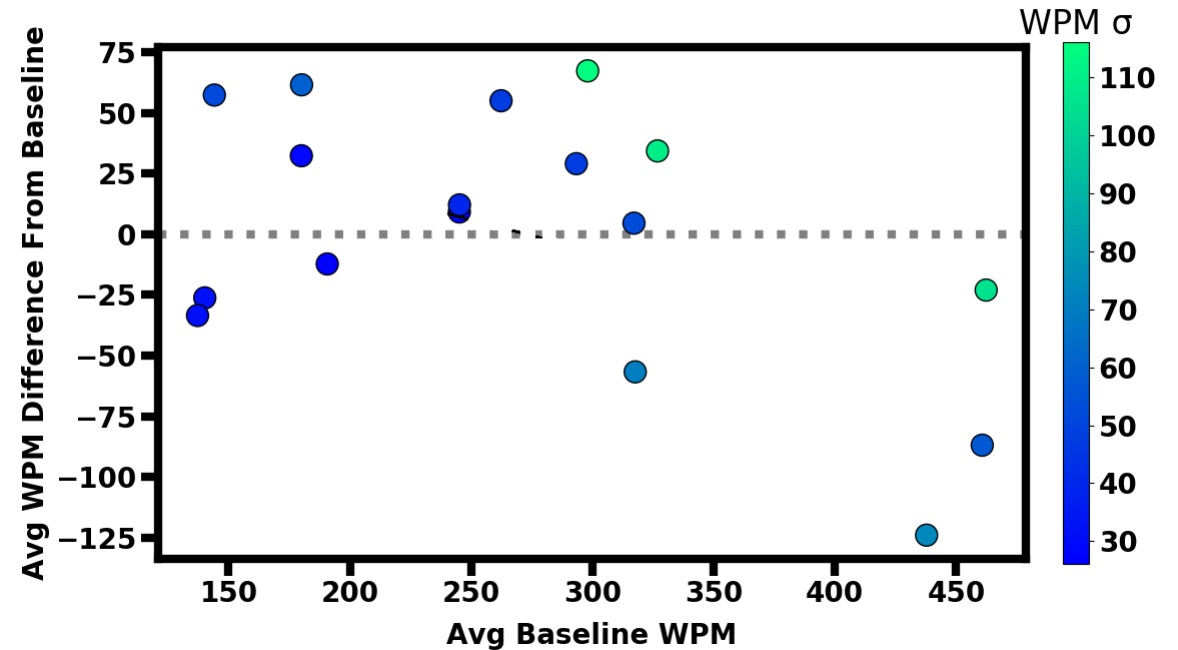
# HUGE VARIABILITY ACROSS SUBJECTS

Large variability in reading speeds  
(Words Per Minute)

- Baseline (150 to 450 WPM)
- Differential (-123 to +67 WPM)

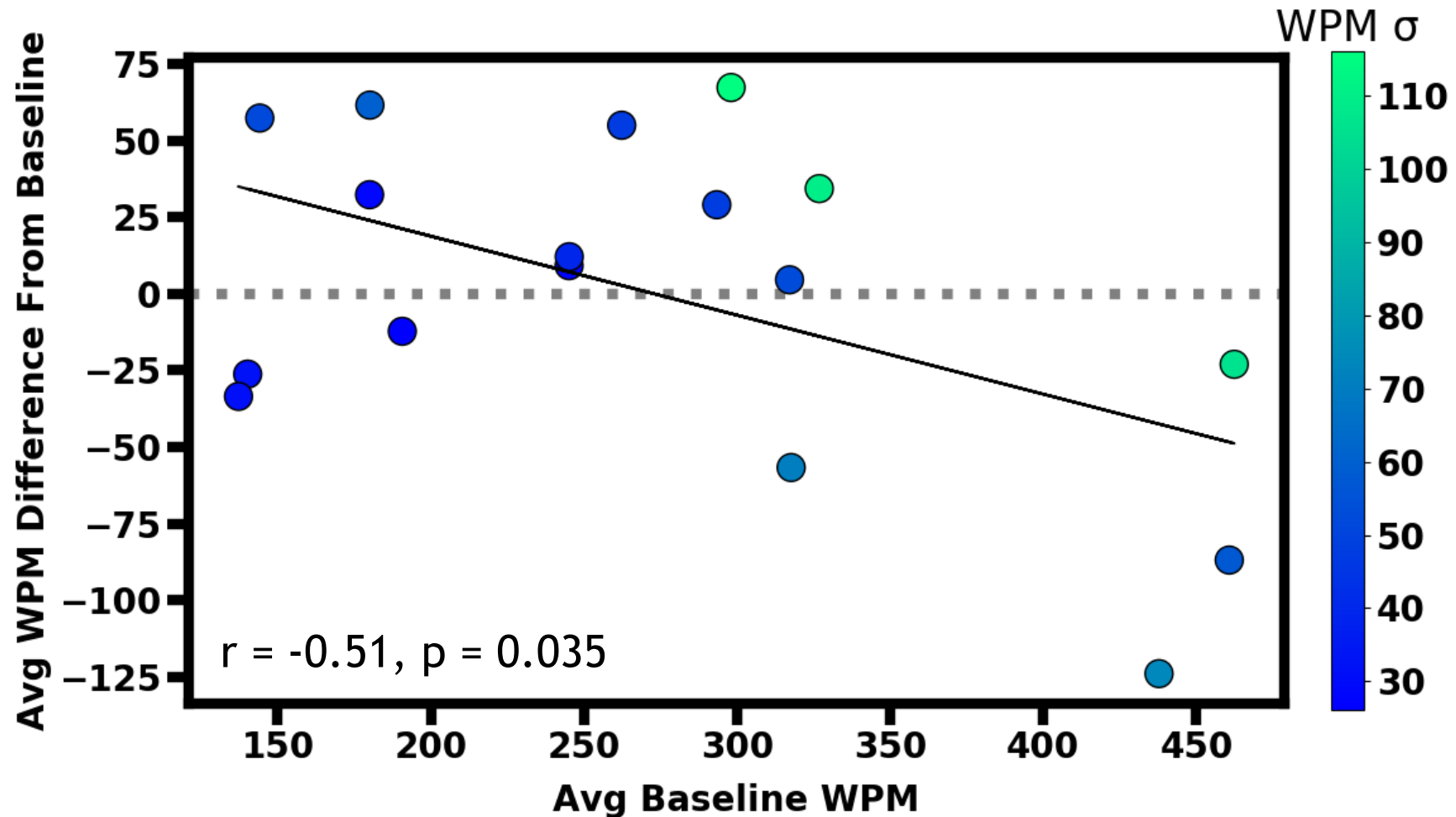
No significant correlations between  
differential reading speed and:

- Age
- Gender
- Glasses
- Fluency
- Task performance

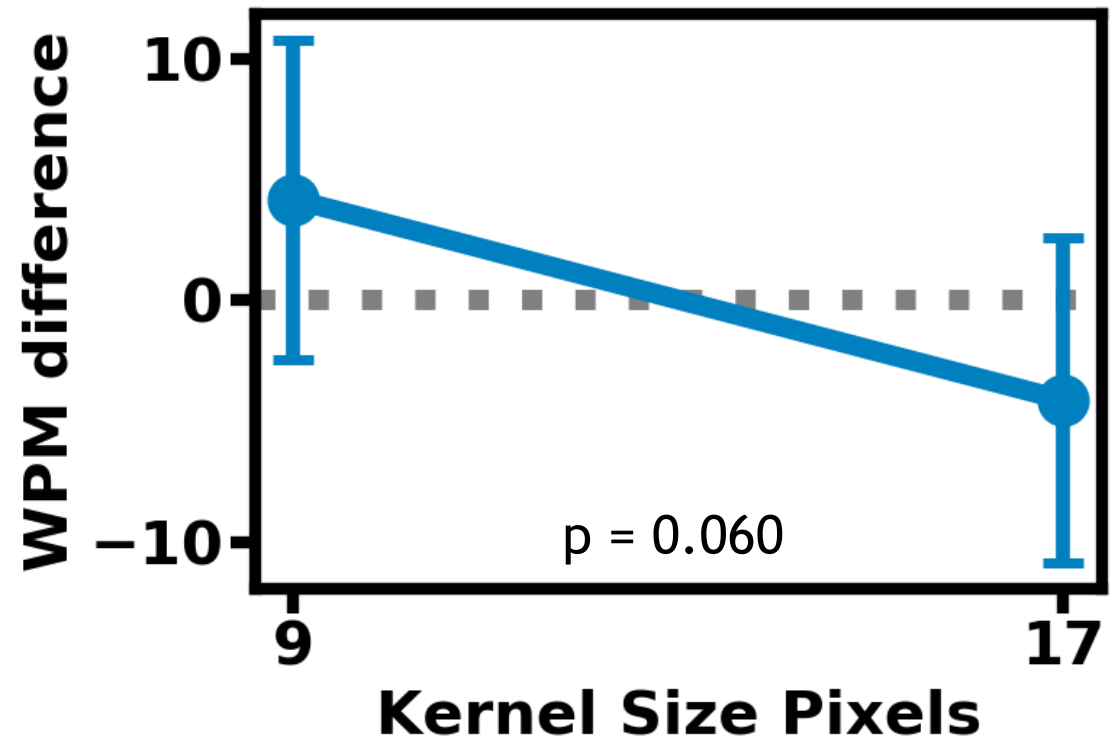
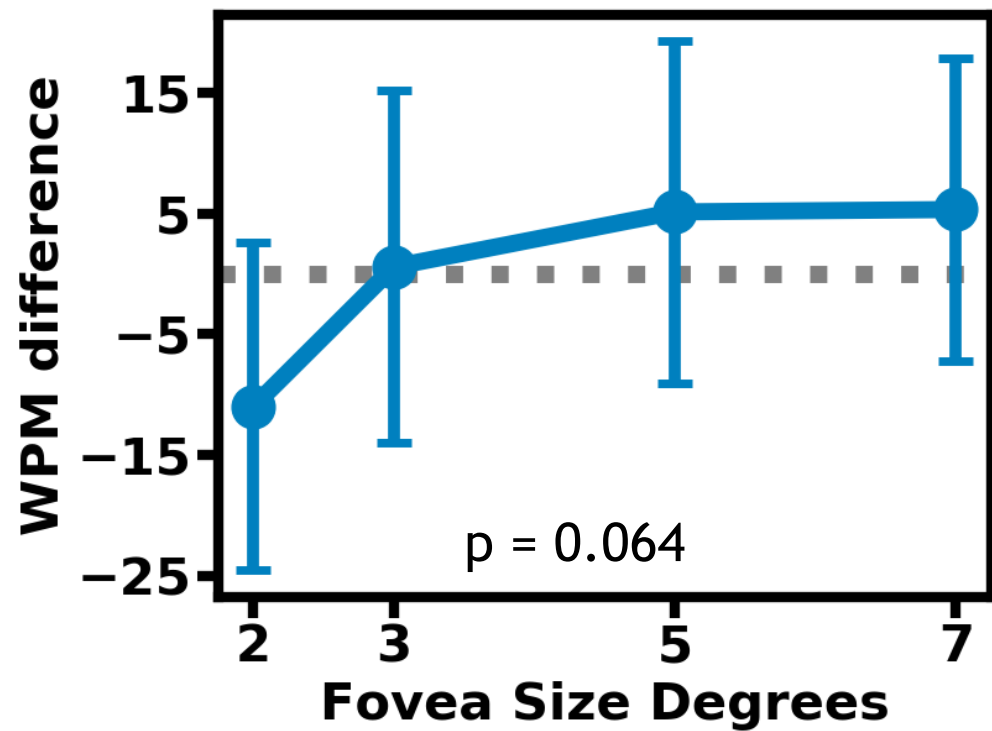




# FASTER READERS ARE MORE NEGATIVELY IMPACTED



# NON-SIGNIFICANT TRENDS FOR FOVEA SIZE & KERNEL SIZE



# CAVEATS & LIMITATIONS

- Small subject pool
- Complex and/or differential practice effects
- Only one type of reading (vs. notifications, longer prose, HUD info, etc)



# FUTURE WORK

- Balanced study with more fast readers
- Focus on improvement in some subjects (focus aid?)
- Other tasks (e.g. visual search with text, navigating text interfaces)

Text passages will be posted online

We are happy to provide collaboration and advice

THANK YOU!  
ANY QUESTIONS?



Berkeley Vision Science