



# Does Driver Response to a Stopped or Slow-Moving Lead Vehicles Happen Gradually or Suddenly?



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## Background

- It has been proposed that drivers do not respond to a lead vehicle (LV) until they perceive it as an immediate hazard and that this occurs when the optical expansion rate, or looming threshold, of a LV reaches .006 radians/second (Muttart, J. W., Messerschmidt, W. F., & Gillen, L. G., 2005)
- However, it is possible that the response is gradual rather than abrupt (Weaver et. al, 2019b). In addition, there is limited research on the effect of cell phone conversation on looming threshold (REF). These gaps in the literature are examined in the current study.

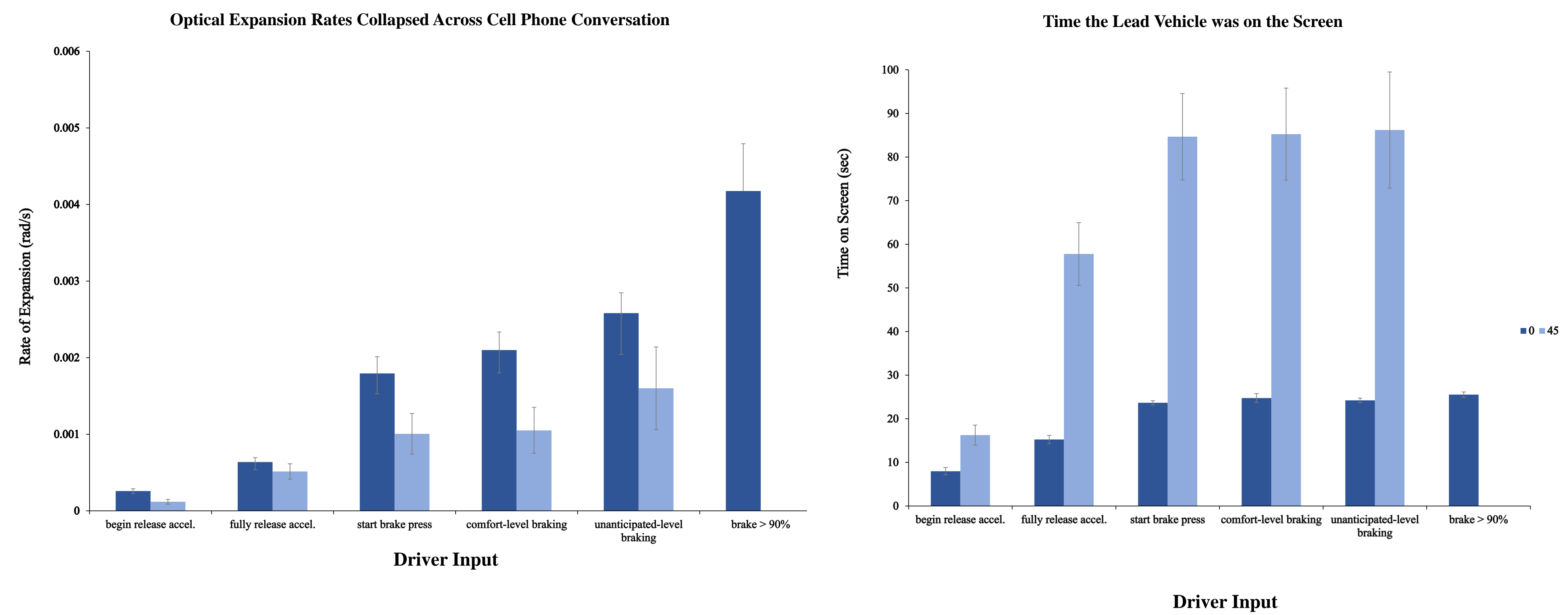
## Hypotheses

- A driver's response to a stopped or slow-moving LV is gradual and occurs in stages (e.g., gradually release accelerator, start depressing brakes, fully brake)
- When the driving task is less demanding, drivers not using a cell phone respond to LV before drivers using a cell phone

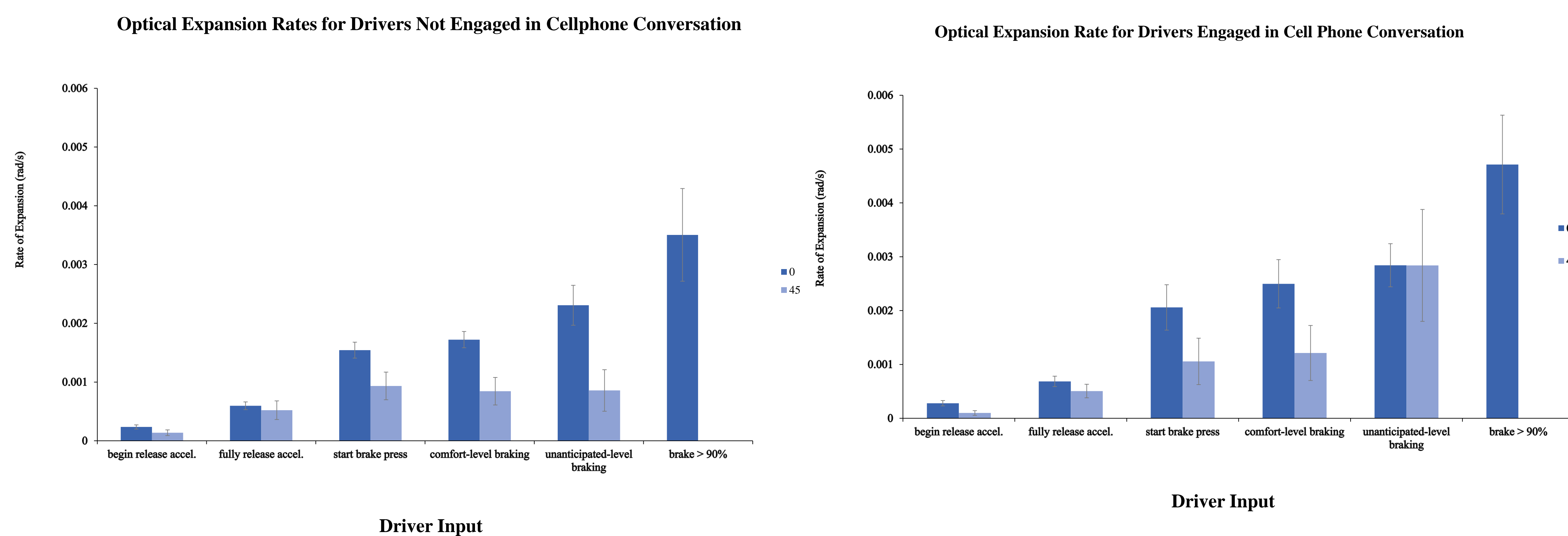
## Methods

- Forty participants with normal vision, hearing, and motor control were instructed to drive as they normally would on a rural road using a STISIM driving simulator. At an unpredictable time, a stopped (0 mph) or slow-moving (45 mph) LV appeared in front of the participant's vehicle
- Half of the participants completed a cognitive task known as the last letter task to simulate a cell phone conversation (Strayer, 2001)
- Optical expansion rate was measured at various driver inputs
- The time the LV was on screen was also measured

## Results



## Graphs for Hypothesis 1



## Graphs for Hypothesis 2

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## Discussion

### Hypothesis 1

- Results of an ANOVA on optical expansion rate indicated a main effect of driver input ( $F = 24.979$ ,  $p < .001$ ) and all pairwise comparisons were significant
- The time the LV was on the screen was significant for both driver inputs ( $F = 14.98$ ,  $p < .001$ ) and lead vehicle velocity ( $F = 24.005$ ,  $p = .003$ )
- This supports our hypothesis that responses to a LV is gradual rather than abrupt when expansion rate reaches .006 r/s
- None of the driver inputs reached the previously reported looming threshold for an immediate hazard (.006 r/s; Muttart et. al., 2005); the driver input of braking more than 90% was the closest (.0048 r/s) when collapsed across cellphone conditions. The implication is that .006 r/s may be used only when a collision is rapidly imminent

### Hypothesis 2

- The cell phone conversation was not significant ( $F = 3.195$ ,  $p = .124$ ) but there was a 3-way interaction between cell phone conversation, driver input, and lead vehicle velocity that needs to be analyzed further

## Limitations

- The use of a driving simulator limits generalizability to real traffic situations because participants are never actually in danger of crashing

## References

- Muttart, J. W., Messerschmidt, W. F., & Gillen, L. G. (2005). *Relationship Between Relative Velocity Detection and Driver Response Times in Vehicle Following Situations* (SAE Technical Paper No. 2005-01-0427). SAE International.
- Strayer, D. L., & Johnston, W. A. (2001). Driven to Distraction: Dual-Task Studies of Simulated Driving and Conversing on a Cellular Telephone. *Psychological Science*, 12(6), 462-466.
- Weaver, B. W., DeLucia, P. R., & Jupe, J. (2019). Effects of Cell Phone Conversation and Roadway Complexity on the Perception of an Immediate Hazard While Driving. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 63(1), 2098-2098.
- Weaver, B. W., DeLucia, P. R., & Jupe, J. (2019b). Effects of Cell Phone Conversation on the First Driver Response to a Stopped Lead Vehicle. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, 63(1), 2031-2035.