Influence of Visual Signal Flash Intensity and Duration on Perception

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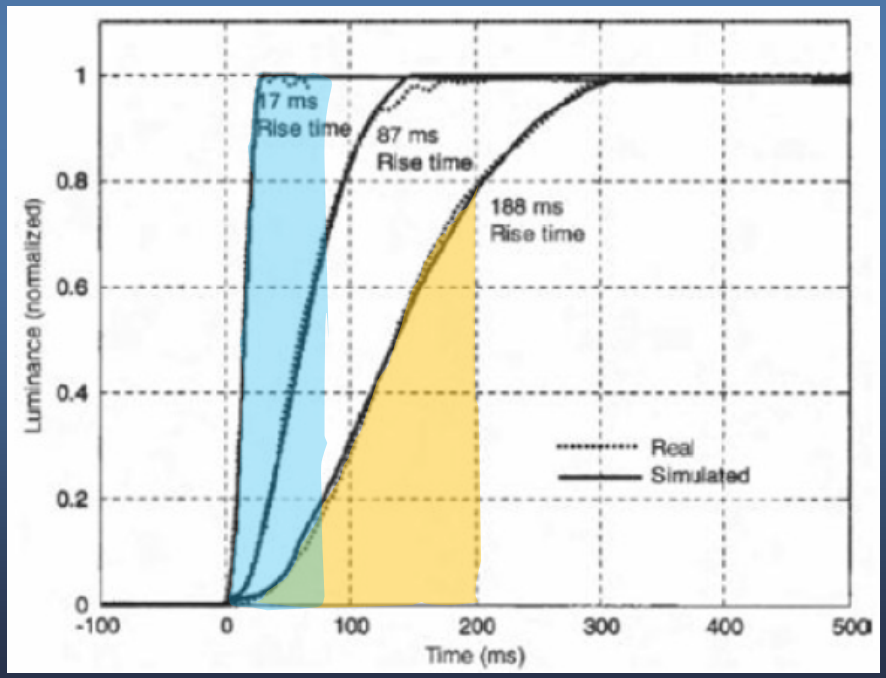
Introduction

- Flashing lights are often used in warning and signaling systems because of their increased conspicuity relative to steady lights (Gerathewohl 1953; Wagner and Laxar 1996)

- Relationships between flashing light characteristics and relevant performance measures for ***direct*** detection are described

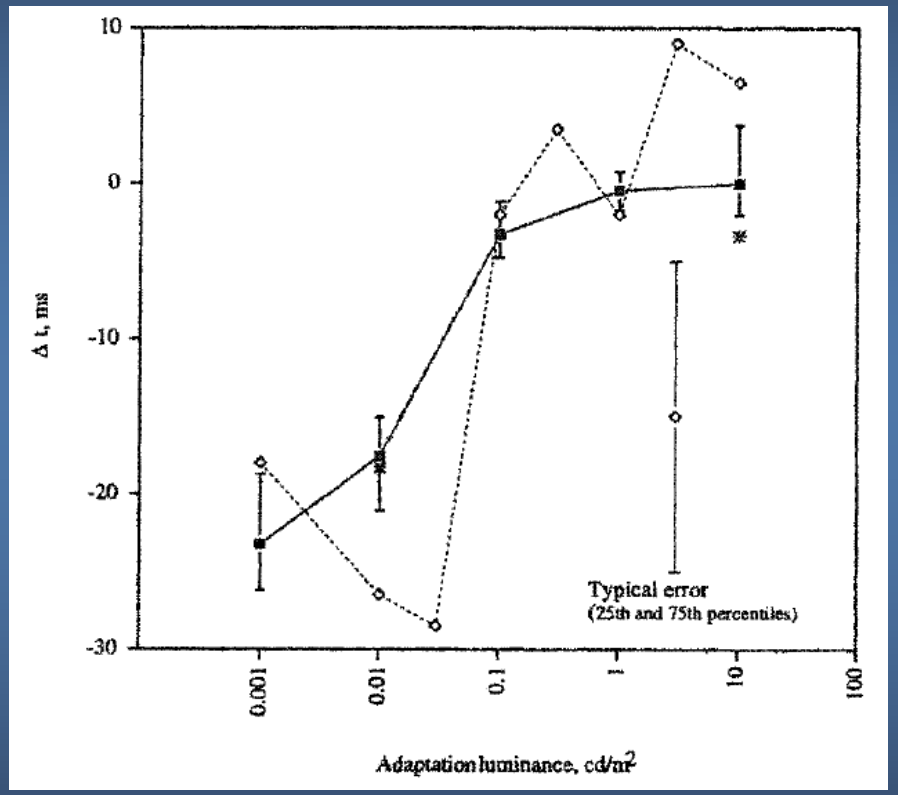
Background

- One performance measure for flashing signal lights is the reaction time to the signal onset
  - Measured reaction times (Bullough 2005) were strongly correlated with a criterion “flash-energy” level (in cd·s)



Apparent Simultaneity

- Bierman et al. (1998) demonstrated that two flashes of light with different intensities, presented at the same time, do not appear to be simultaneous
  - The higher-intensity flash appears sooner
  - Could provide a more precise way to assess reaction times



Apparent Brightness

- For some flashing lights, not only detection but visual fixation and location can be important (e.g., flashing exit signs – [Boyce 1994])
  - Relative brightness of a warning signal can be a relevant cue
- Raab and Osman (1962) reported the longer of two equal-intensity flashes appeared brighter
  - Consistent with Broca-Sulzer effect showing light flashes ~50-100 ms could be judged as brighter than shorter flashes

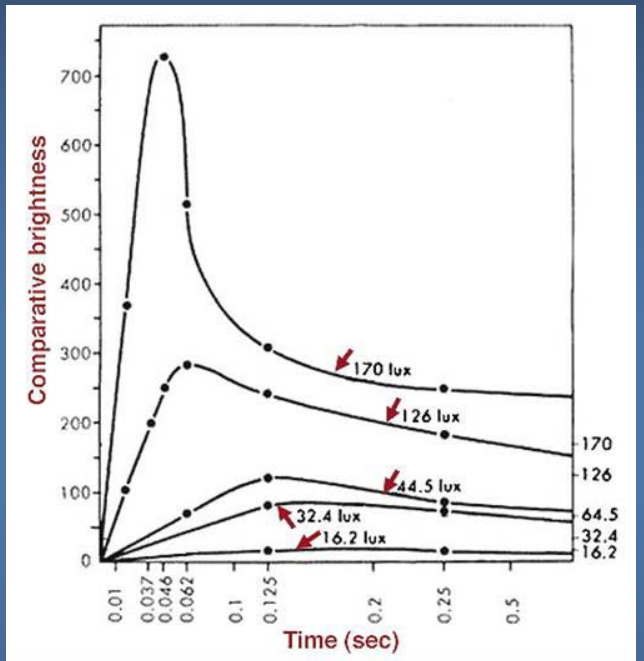
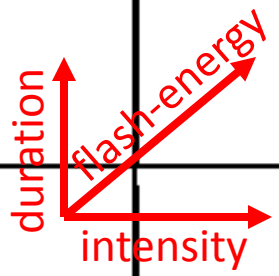


Fig. 6. Apparent brightness of flashes with various luminances, as a function of flash duration. Broca and Sulzer data from Hart Jr, W. M., The temporal responsiveness of vision. In: Moses, R. A. and Hart, W. M. (ed) Adler's Physiology of the eye, Clinical Application. St. Louis: The C. V. Mosby Company, 1987.

Objective

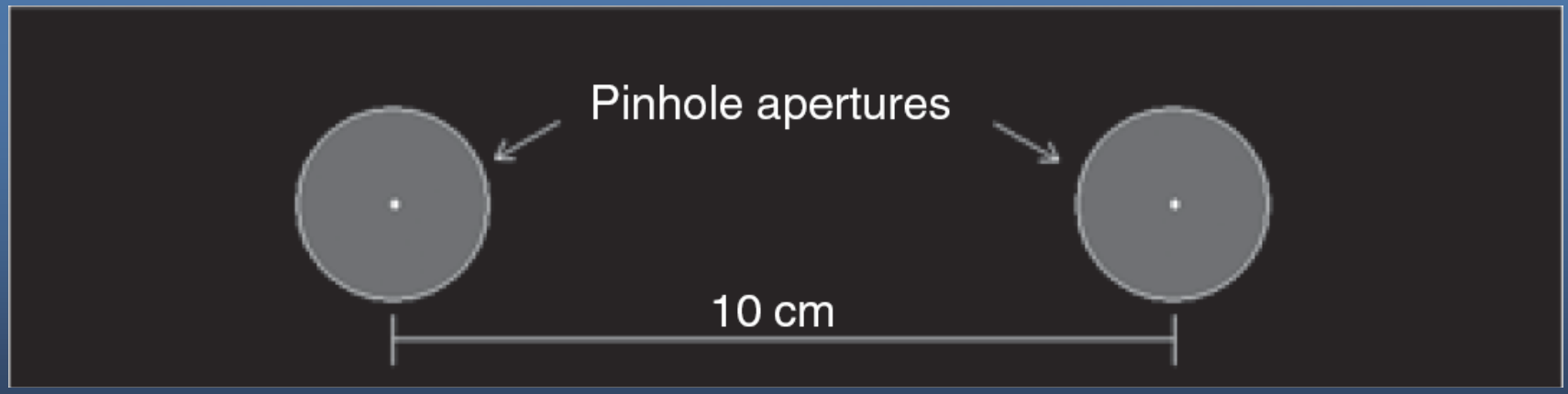
- To measure apparent onset speed and brightness of flashes of light differing systematically in intensity, duration and flash-energy

5 ms 0.003 cd 0.015 cd·ms	25 ms 0.003 cd 0.075 cd·ms	125 ms 0.003 cd 0.375 cd·ms
5 ms 0.015 cd 0.075 cd·ms	25 ms 0.015 cd 0.375 cd·ms	125 ms 0.015 cd 1.875 cd·ms
5 ms 0.075 cd 0.375 cd·ms	25 ms 0.075 cd 1.875 cd·ms	125 ms 0.075 cd 9.375 cd·ms



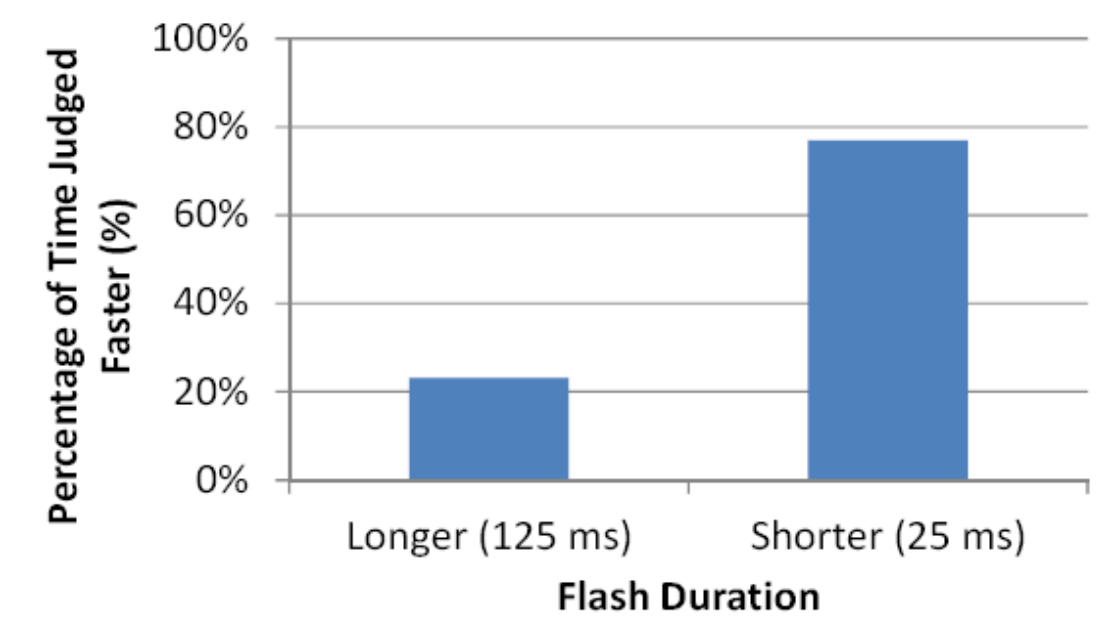
Procedure

- 10 subjects (8 M/2 F, 25-71 years old, mean 39)
- Balanced left-right pairs of flashes displayed through pinhole apertures from 2 m, in randomized order
- Subject responses: Which appeared faster, which was brighter?



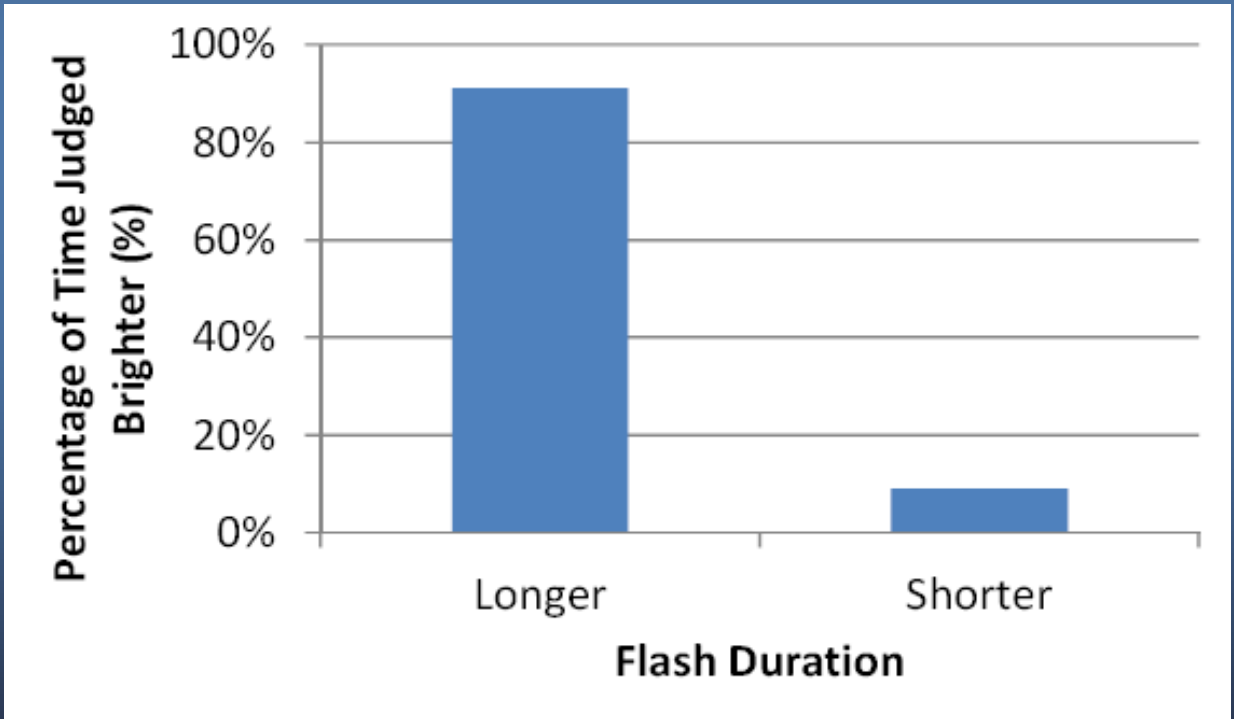
Results: Equal-Intensity Flashes

- For 5-25 ms durations, equal-intensity flashes were judged as equally fast
- For 25-125 ms durations, shorter durations were reliably ($p<0.05$) judged as faster



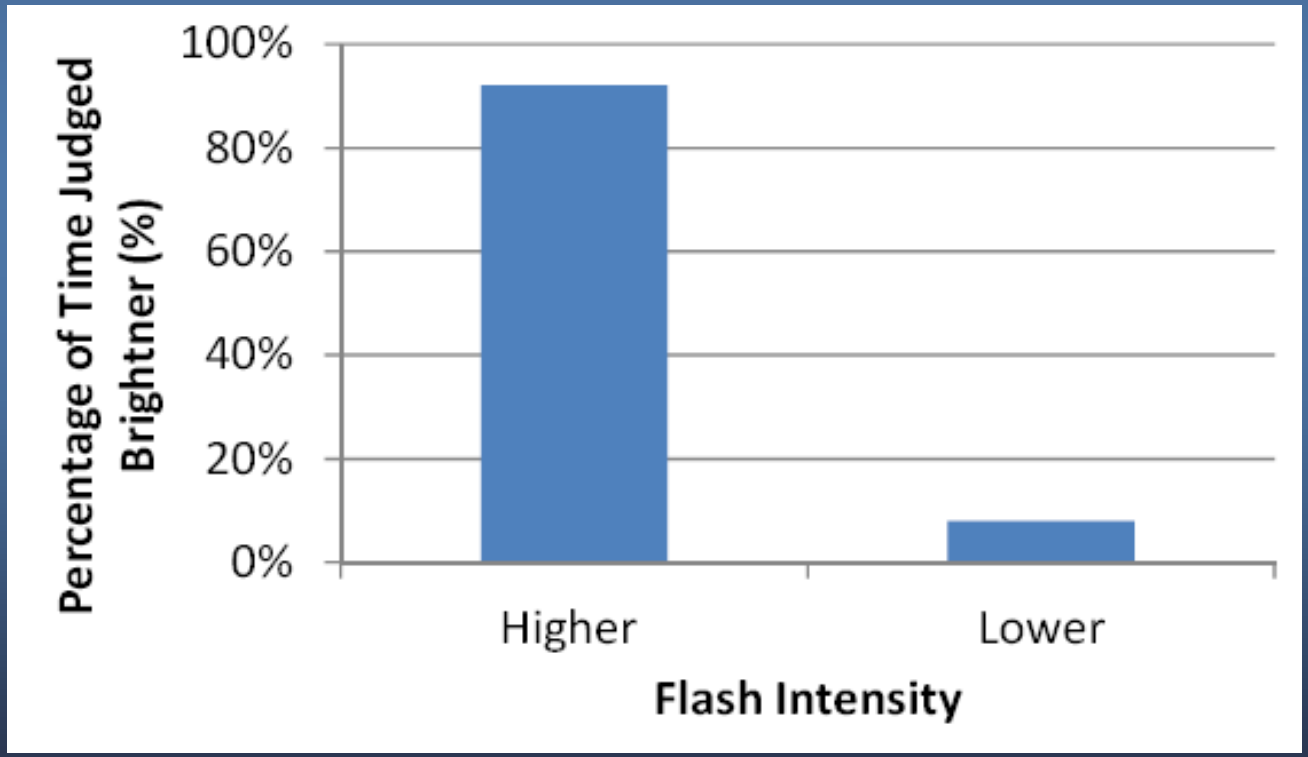
Results: Equal-Intensity Flashes (cont'd.)

- The flash with the longer duration was reliably ($p<0.05$) judged as brighter



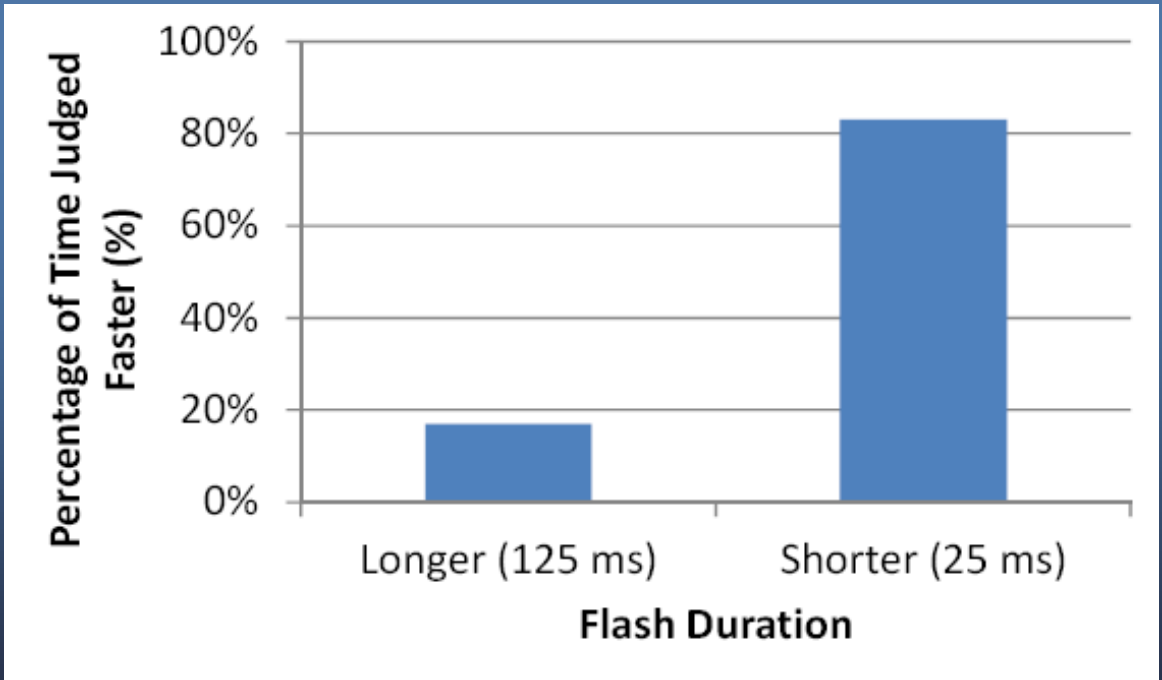
Results: Equal-Duration Flashes

- No differences in apparent speed for equal duration flashes
- Higher intensity flashes were reliably ($p<0.05$) judged as brighter



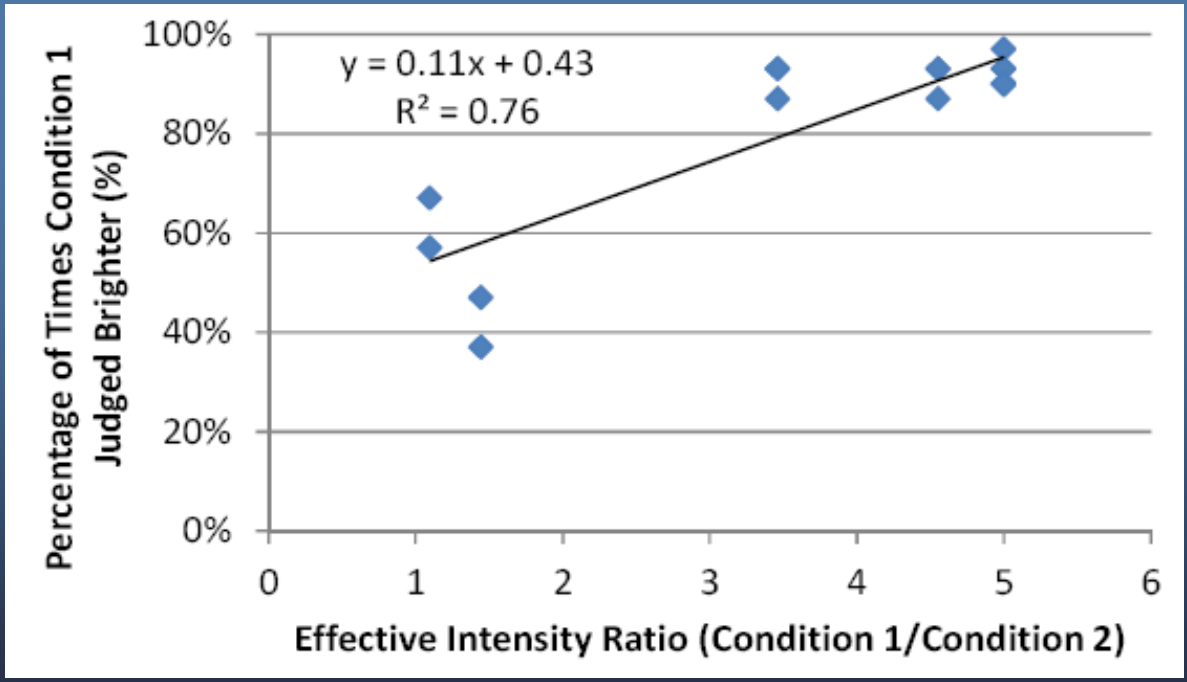
Results: Equal-Energy Flashes

- Between 25-125 ms, shorter flashes were reliably ($p<0.05$) judged as faster, but not between 5-25 ms
- Equal-energy flashes were judged equally bright



Discussion

- Judgments of apparent speed and of brightness are distinct visual responses
- Apparent brightness was correlated with effective intensity (Blondel and Rey 1912), but apparent speed was not



Discussion (cont'd.)

- Flashing lights with similar flash-energy (or effective intensity) and with durations ≤ 25 ms were judged equally fast and equally bright
  - When one of the flash durations was 125 ms, it was still judged equally bright, but not fast
- For ***direct*** viewing conditions, flashing lights with durations < 25 ms offer little advantage over shorter duration flashes
  - LEDs would need to be driven at higher currents (temporarily) to achieve similar perceptions under direct viewing with very short durations

Acknowledgments

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- Thank you!